Ministry of Water and Energy

Bursa Rural Pipe System

SPECIFICATION

For Civil and Pipe Works and Supply of Pipes, Fittings and Devices

Contents

SECTION 1

PARTICULAR REQUIREMENTS

1.1 General

Bursa Rural Pipe System Project involves construction of major works among others such as; supply and installation of submersible pump with all accessories, supply and installation of pressure pipeline, service reservoirs, distribution pipe line, water points, supply and installation fittings and devices, and auxiliary buildings.

The contract includes civil structures and E&M works, supply and installation of pipes, fittings, devises and design, supply, and commissioning of E&M equipment.

1.2 Location of the Works

Bursa RPS is located in Amhara Regional state, North Gonder Zone, East Belesa woreda, at a distance of about 172 km from the regional capital, Bahir-Dar.

The project area is characterized by moderately undulated topography varies between 1500 to 2300a.m.s.l.The topographic features accounts 40% flat land, 30% Gorge &30%undulated land.

1.3 Scope of the Works under this Contract

The scope of the Works to be executed is as indicated on the Drawings and Specification, as itemized in the Bill of Quantities and as detailed in this Specification. The scope of the Work is to build and commission the following civil and E&M works;

- Supply and installation of submersible pumps with all accessories and generator
- Pressure main,
- Construction of service reservoirs,
- Distribution pipe line,

- Construction of water points,
- Supply, installation and commissioning of pipes, fittings, devise, etc.
- Construction of auxiliary buildings,

1.4 Program of Works

The program to be submitted by the Contractor shall include a bar chart indicating in sufficient detail, mobilization and de-mobilization of the Works, the main activities in each Section of the Works (listed in Clause 1.3).

1.5 Extent of the Site

a) The major Works to be constructed at Bursa RPS among others include; supply and installation of submersible pump with all accessories, supply and installation of pressure pipeline, service reservoirs, distribution pipe line, water points, supply and installation fittings and devices, and auxiliary buildings. The Works shall be constructed such that the existing works shall remain in operation during the construction period.

b) The Contractor shall ensure that the construction and commissioning of new works shall not adversely affect the supply of potable water into distribution

1.6 Access to and Use of the Site

1. If access to the site is gained from public highways. The Contractor shall be responsible for cleaning and maintaining all existing Site roads affected by his work while he is on Site. He shall also be responsible for repairing and making good any damage to these roads. If the damage is caused by the Contractor his sub-contractors or suppliers the repairs will be at his own cost.
2. The Contractor shall be responsible for the construction, maintenance and repair of any temporary Site roads.

3. The lands and other places outside the Site, which are the property of or under the control of the Employer, shall not be used except with the approval of the Engineer.
4. The Contractor shall at any time remove any vehicle, wagon, barge or vessel or any other obstruction within his control that may be required to be moved by the Engineer for any purpose and the Contractor shall move such obstruction promptly on instruction being given and at his own cost, unless the Engineer shall decide otherwise.
5. The Contractor shall maintain access for the inspection, operation and maintenance of any of the Employer's Plant or work, which lies within the Site or elsewhere.
6. The Contractor shall not use any portion of the Site for any purpose not connected with the Works unless the prior written permission of the Engineer has been obtained.
7. Except with the written permission of the Engineer, to be given when necessary for the execution of the Works, the Contractor's employees will not be permitted to enter any of the Employer's buildings or lands or sites under the control of other contractors or the Engineer. The Contractor shall warn his employees that any man found within such buildings or sites without authority is liable to be removed from the Works in accordance with the provisions of Clause 16 of the Conditions of Contract.
8. During the progress of the works, the contractor shall clear up and remove from the surface of the ground of the site all temporary buildings, plant, material, debris resulting from demolition litter, rubbish & surplus soil which may be left on the ground as per the Engineers instructions.
9. Where the pipe lines pass through agricultural land or any other ground not used as a road, street or foot path the contractor shall confine his operations to a strip 2.0 m in width.

1.7 Entry onto the Site

1. The Contractor shall follow the Employer's procedures as directed by the Engineer.

1.8 Drawings

1. The drawings issued with the documents are listed below;.

1.1. Public water points

1.2. 200 m3 Service Reservoir

1.3. Pressure and distribution pipeline layout

1.4. Pressure main profile

1.5. Office building

1.6. Fittings detail

2. The Contractor's attention is drawn to the classification of drawings, which is that the Tender Drawings will become Contract Drawings once the award of Contract has been made.
3. Any drawings issued to show mechanical and electrical information are issued in good faith without guarantee as to the accuracy of the information contained therein. These drawings will not form part of the Contract.

1.9. Climatic Data

1.9.1. Air Temperature

Agro climatically, the project area falls 87% Waynadega 0.6% is Dega and the rest 12.5% is kola. Regarding temperature the highest temperature is 22.5oc and the lowest is 15 oc. It is characterized by a mono modal rainfall. It receives rainfall only from June to July and has annual rainfall ranges from 700mm to 1200mm.

1.10 Testing Facilities

1.10.1 Testing Laboratory and Equipment

a) The Contractor shall supply and maintain temporary testing laboratories with equipment for the duration of the Contract.

b) The laboratory equipment shall include, but shall not necessarily be limited to, that required for testing temperature, slump and compressive strength of concrete, for testing the compressive strength of concrete blocks, mortar. The minimum recommended

equipment for each laboratory shall consist of one set of screens for sieve analysis, a cone for concrete slump tests, 12 reusable molds for making concrete test cylinders or cubes, one hydraulic press equipped with a force meter for breaking concrete test samples.

c) Test specimens and samples shall be collected by the Contractor under the direction of the Engineer. The Contractor shall be responsible for the proper care of test specimens and samples at the Site and their delivery to the testing laboratory or to the independent testing service.

d) The Contractor shall be responsible for the costs of providing all test specimens and samples used for independent testing, and for all costs incurred as a result of additional testing requested by the Engineer or as deemed necessary to retest substandard materials.

1.11 Soils Investigation

a) Soils investigation shall be carried out by the Contractor for all permanent structures to confirm soil bearing capacity, permeability and cohesion properties at foundation level.

b) The soils investigation and subsequent testing shall be carried out by the Contractor under the direction of the Engineer.

c) A soils report together with test pit logs and laboratory test data shall be submitted to the Engineer for review at least 28 days prior to construction.

d) The soils investigation shall include, but not be limited to, the following:

1) Three trial pits each at the intake, treatment plant, and service reservoir and booster station sites.

2) At the route of the pressure mains where the Engineer deem necessary,

3) The investigation and soil testing shall conform to the Ethiopian code of practices.

1.12 Services for the Engineer

1.12.1 Engineer's Office

a) Engineer’s office shall be built as depicted in the drawing and the BoQ and shall be furnished as stipulated in the BoQ,

b) The Engineer's office will be the property of the Employer on the completion of the contract,

1.12.2 Assistance for the Engineer - Surveying

a) The Contractor shall provide the following survey equipment for the use of the Engineer throughout the Contract:

1 (No) Total station with tripod, reading to 20 seconds on both circles

1 (No) automatic level and tripod

1 No 30 m steel tape

3 No 30 m linen or plastic tapes

2 No 5 m steel tapes

3 No rechargeable battery hand lamps

4 No wooden ranging poles 2 m long

2 No collapsible metal ranging rod stands

5 No steel arrows

1 No plumb bob

1 No max/min thermometer

b) The Contractor shall provide a sufficient supply of pegs, nails, chalk, paint, lines and other small tools required for checking the setting out of the works.

c) The Contractor shall be responsible for the maintenance of the equipment and shall promptly provide suitable replacements should the equipment need to be sent away for repair.

d) The Contractor shall provide suitable labor to assist in checking setting out and in taking measurements. This labor shall be made available within 1 hour of the Engineer's request.

1.12.3 Parking and Access

a) The Contractor shall provide an area suitable for car parking adjacent to the Engineer's office. The area shall consist of hard standing blinded with compacted ballast or otherwise to the approval of the Engineer. A minimum parking area for 2 No. cars shall be provided for the sole use of the Engineer, his staff and his visitors. The car park shall be clearly sign posted and an access shall be provided to the nearest road suitable for private car use. Where necessary footpaths shall be provided around the premises.

1.14 Site Sign Board

1. The Contractor shall erect a sign board at the well field at the Auxiliary buildings and at proper location within the town as directed by the Engineer.
2. Each sign board shall have 4 separate boards, on below the other, and of the following specification:
    - Size of each board to be 2 m long x 450 mm deep.
    - Boards to be painted white background with blue lettering.
    - The top board shall be at a level of no less than 3 metres above existing ground level and shall display the title of the project:

      "Bursa rural pipe system water supply project"
    - The second board shall display the name of the Employer.
    - The third board shall display the name of the Funding Agency.
    - The fourth board shall display the name of the Engineer.
    - The boards are to be fixed to treated or painted vertical posts capable of supporting the said boards and withstanding adverse weather conditions, and shall be set into adequate concrete surrounds to ensure durability.
3. The Contractor shall provide details of his proposals for the fabrication, fixings and locations of the said sign boards for the Engineers approval before proceeding with their fabrication and erection.

1.15 Provisional Sums

Provisional sums are shown in the Bill of Quantities for a number of elements of work.

Each provisional sum shall be expended as directed. The amount of payment under each Provisional Sum will be determined as specified under an article of the General Conditions entitled Provisional Sum. Any unused portions of Provisional Sums will be retained by the Owner.

1.16 Mobilization

Mobilization shall consist of preparatory work and operations including, but not limited to, those necessary to the movement of personnel, equipment; supplies and incidentals to the project site; and for all other work and operations which must be performed or costs incurred prior to beginning work on the various items on the project site.

1.17 Demobilization

Demobilization shall consist of cleanup work and operations including, but not limited to, those necessary to the removal of personnel, equipment, and incidentals from the project site.

SECTION 2

GENERAL REQUIREMENTS

2.1 Units

1. In the Specification, Drawings, and Bill of Quantities, the S.I. (System International 'Units) metric system of dimensioning has been adopted except where it is understood that suppliers and manufacturers are not yet able to provide materials in metric sizes.
2. Where dimensions are given in metric units for materials which are only available in Imperial dimensions, and vice versa, the Contractor may, subject to his obtaining the prior approval of the Engineer, substitute the nearest equivalent available standard size in the other system.

2.2 Standard Specifications

1. For convenience and in order to establish the necessary standards of quality, reference has been made to specifications issued by national or other widely recognized bodies. Such specifications shall be referred to as 'Standard Specifications' and shall be the latest editions of such Standard Specifications issued prior to the issue of the Tender Documents together with such additions or amendments as may have been issued prior to the same date.
2. Subject to the written approval of the Engineer, any other internationally accepted Standard Specification which requires an equal quality of work may be used.
3. If the Contractor proposes to use a Standard Specification other than that specified, three copies of the proposed Standard Specification in English, shall be submitted to the Engineer not less than 28 days before approval of the Standard Specification is required.
4. In referring to Standard Specifications, the following abbreviations are used:

- BSCP - British Standard Code Practice
- BS - British Standard

- ISO - International Organization for Standardization
- DN - Dutch Institute for Norming e.v.

2.3 Construction and Checking of Work

1. The Contractor shall be solely responsible for and shall provide all labor, tools, lifting tackle and other equipment required for the construction of the Works.
2. No operative shall be allowed to execute any type of work which is normally carried out by a skilled tradesman unless he is thoroughly experienced and proficient in the trade concerned. Supervisors and operatives may be required to demonstrate their proficiency or produce a certificate of competence to the satisfaction of the Engineer.
3. As each part of the work is erected, it shall be subject to the approval of the Engineer.

2.4 Supervision and Labor

1. The Contractor will be required to maintain a competent supervising engineer and staff on Site throughout the construction period until completion of the Works, and thereafter as required during the Defects Liability Period. The Engineer shall give prior approval to the appointment of this supervising engineer and shall have the authority to withdraw this approval at any time in accordance with Clause 15 of the Conditions of Contract.
2. All staff and labor employed on the Works shall be employed in accordance with the labor and employment laws and regulations of the Federal Democratic Republic of Ethiopia.

2.5 Specialist Sub-Contractors

1. Where sub-contractors are not nominated by the Engineer, the Contractor shall appoint specialist sub-contractors in accordance with Clause 4 of the Conditions of Contract, for any sections of the Works herein in which he is not himself an experienced, recognized and approved operator.
2. The Contractor shall, on submission of his Tender, indicate the names of all proposed specialist sub-contractors, together with the precise sections of the Works for which each

will be responsible, for approval by the Engineer. He may be required to seek alternative sub-contractors, or to accept sub-contractors nominated by the Engineer.

3. A sub-contractor nominated by the Engineer will be required to hold the Contractor indemnified against all claims, accidents, damage or loss occasioned by any act of the sub-contractor in the performance of the sub-contract.
4. The Contractor shall allow in his prices for phasing the work to meet the requirements of sub-contractors and for varying his program, or otherwise, to comply with the program of the sub-contractors. No additional costs will be allowed to the Contractor for any reasonable disruptions to his program, or otherwise, in his compliance with the above requirements.

2.6 Works Executed by the Employer or by Other Contractors

1. The Employer reserves the right to execute on the Site works not included under this Contract and to employ for this purpose either his own employees or other contractor whose contract may be either a sub-contract under this Contract, or an entirely separate contract. The Contractor shall ensure that neither his own operations nor trespass by his employees shall interfere with the operations of the Employer, or his contractor employed on such works and the same obligations shall be imposed on the Employer or contractor in respect of work being executed under this Contract.

2.7 Contractor's Site Offices, Workshops, Stores and Working Areas

1. The Employer will provide the areas of land the Contractor requires for his site offices, workshops, stores and working areas as specified in Section 1 of the Specification.
2. The Contractor shall be responsible for providing all buildings, fences, etc. that he may require and on completion of the Works shall be required to remove all such buildings,

fencing, etc., and to restore the land to its original condition to the satisfaction of the Engineer.

3. The location of all the Contractor's offices stores, etc. shall be agreed beforehand with the Engineer.
4. The Contract shall be responsible for obtaining telephones or other means of communication for his own use and shall be deemed to have included for the cost thereof in his Tender.

2.8 Interference with Existing Works

1. The Contractor shall not interfere in any way with any existing works whether the property of the Employer or of a third party and whether the position of such works is indicated to the Contractor by the Engineer or not, except where such interference is specifically described as part of the Works, either in the Contract or in any instructions from the Engineer.
2. Except with the written permission of the Engineer to be given when necessary for the execution of the Works the Contractor's employees will not be permitted to enter any of the Employer's buildings or lands or sites under the control of other contractors or the Engineer. The Contractor shall warn his employees that any man found within such buildings or sites without authority is liable to be removed from the Works in accordance with the provisions of Clause 16 of the Condition of Contract.
3. To avoid interference with and pollution of any existing works, the Contractor shall take all precautions necessary to ensure that no sand, paper, dust or any other foreign matter from the Site is blown or otherwise carried into any works and shall act promptly at his own cost on all instructions given to him by the Engineer to this effect.
4. No connections shall be made to live potable water mains or water retaining structures unless all the new works have been successfully sterilized in accordance with Clause 8.3 of this Specification and approval has been obtained in writing from the Engineer.

2.9 Materials for the Works

1. All materials supplied by the Contractor shall comply with the appropriate Standard listed in the Specification unless otherwise required hereinafter.
2. The Contractor shall, before placing any order for materials, manufactured articles or plant for incorporation in the Works, submit for the approval of the Engineer the names of the firms from whom he proposes to obtain such materials, etc. together with a list of the materials, manufactured articles and plant, giving the origin, quality, weight, strength, description etc. which he proposes that the firms should supply together with any explanatory drawings as may be required. No materials, manufactured articles or plant shall be ordered or obtained from any firm of which the Engineer shall not have previously approved in writing.
3. All materials shall be delivered to the Site a sufficient period of time before they are required for use in the Works to enable the Engineer to take such samples as he may wish for testing and approval.
4. Notwithstanding the fact that approval has been given to the source of supply, the Engineer may forbid the use of any such materials if upon delivery, they are found to be defective, or he considers them unsuitable for incorporation in the Works. Such rejected materials shall be removed from the Site forthwith.
5. The Contractor may propose alternative materials to those specified, provided that they are of equivalent quality and, subject to the Engineer's approval, such materials may be used in the Works.
6. The Contractor shall have no claim against the Employer in respect of any financial loss which he may suffer as a result of the rejection of any such materials, and he shall also bear the cost of removing them from the Site of the Works.

2.10 Dust, Insect and Vermin Proofing

1. All Plant supplied under this Contract shall be dust and vermin proofed where no protection is afforded in its normal manufactured form to ensure that no mechanical

breakdown or excessive wear shall occur due to interference or damage by dust, insect or vermin.

2. All materials used in the Works shall be resistant to attack by insects, microbiological life or other local fauna.
3. Dust caused by the contractor's operations shall be controlled at all times by watering or other approved means. Tanker trucks equipped with spray bars, complete with suitable control apparatus shall be used for application of water to dust areas.

2.11 Rejected Materials and Defective Work

Materials or work which, in the opinion of the Engineer, do not comply with the Specification, shall be classified as rejected materials or defective work, and shall be cut out and removed from the Works and replaced as directed by the Engineer, all at the Contractor's expense.

2.12 Alternatives

The Tenderer is at liberty to put forward alternatives for items of plant or methods of construction for which he claims advantages to that indicated in the Specification and Drawings, providing the mode of operation and method of construction is fully detailed and is at least equal to that shown on the Drawings or implied in this Specification. The Tenderer shall fully state his reasons for submitting any alternatives. The Engineer may not necessarily accept any alternatives proposed.

2.13 Contract Language

1. All correspondence between the Contractor and the Engineer or the Engineer's staff shall be in the English language.
2. All books, time sheet records, notes, drawings, documents shall be in the English language or, if the original documents are in any other language, a certified translation in English shall be submitted to the Engineer's Representative.

2.14 Existing Works and Services

1. The Contractor shall acquaint himself with the position of all existing works and services inter alia water mains, sewers, storm-water drains, cables for electricity, telephone lines, telephone, electricity and lighting poles before the excavation is commenced.
2. The Contractor will be held responsible for damage, however caused in the course of the execution of the Works, to such existing works and services. Any damage caused shall be made good at the Contractor's expense.
3. Such existing works and services where exposed by the execution of the Works shall be properly shored, hung-up and supported to the satisfaction of the Engineer and of the authority concerned. The Contractor shall exercise special care when refilling trenches or other excavations around such existing works or services and water meters. Stop cock boxes and the like shall not be covered up.
4. Poles supporting cables etc. adjacent to the Works, shall be kept securely in place until the Works are completed and shall then be made as safe and permanent as before.
5. Notwithstanding the foregoing requirements and without lessening the Contractor's responsibility, the Contractor shall inform the Engineer immediately any existing works have been exposed and comply with any requirements of the authority concerned.
6. The Contractor shall not interfere in any way with any existing works whether they be the property of the Employer or of a third party and whether the position of such works is or is not indicated to the Contractor by the Engineer. The only exceptions shall be where such interference is specifically described as part of the Works in the Contract, or subsequent to approval being obtained from the Employer or the third party, in a written instruction from the Engineer.
7. Only when and as directed by the Engineer shall the position of an existing work or service be changed by the Contractor to meet the requirements of the proposed work and the cost of such work will be paid for on a Day work basis.
8. The Contractor shall make adequate provision so that when carrying out his work, no interference, damage or pollution is caused to highways, footpaths, or to any mains,

drains, sewers, etc. or other parts of the Works. Wherever loads have to be carried over ground in which pipes, valves, culverts, etc. are buried, the Contractor shall take all precautions including where necessary, the provision and use of sleepered roads, light gauge railways or other means to prevent damage occurring to such underground works. The fact that the Engineer has approved any means of protection employed shall not relieve the Contractor of any responsibility in respect of damage occasioned by his operations. The Contractor shall not store any plant or materials or spoil heaps over existing water mains, or in such positions that interference with access to the mains, control valves, etc. is created.

9. The laying of pipe work, ducts, drains, etc. shall be arranged so as to cause as little interference as possible with the smooth operation of the existing works.
10. When making good the walls of existing structures due to the addition of new structures or the passage of pipes, cables, drains, etc. the Contractor shall disturb the existing structures as little as possible. All structures shall be made good with a material similar to that used in the existing works, or such materials which are considered by the Engineer to be of similar appearance and suitable in all other respects.
11. Disruptions to the existing water supplies are to be kept to a minimum and the Contractor is to maintain operational integrity of the existing works on the Site throughout the period of the Contract. The Contractor shall not interfere with the existing works in order to comply with this Sub-Clause unless clearance to do so has been obtained from the Engineer as specified in Sub-Clause 6 of this Clause.
12. Existing access to lands property and all other things shall be maintained by the Contractor during the continuance of the Works to the Engineer's satisfaction, the cost of such maintenance being deemed to be covered by and included in the rates entered in the Bill of Quantities.

2.15 Overhead Power Lines

1. Where work is being carried out in the vicinity of overhead power lines, the Contractor is responsible for ensuring that all persons working in such areas are aware of the relatively

large distance that high voltage electricity can "short" to earth when cranes or other large masses of steel are in the vicinity of power lines.

2. The Contractor shall take all necessary precautions to ensure the safety of his employees and all other persons where work is being carried out in the vicinity of overhead power lines.

2.16 Excavation in Roads and Tracks

1. Ten days before excavating in or adjacent to any public or private road or track, the Contractor shall request the permission of the Engineer and the appropriate local authority to excavate and shall include, in writing, the precautions he proposes to take for the continuance of passage and safety of traffic and details of the warning signs and lights to be provided and operated. The excavation shall not commence until the written approval of the Engineer and the appropriate local authority has been given.
2. The Contractor shall further give the Engineer 24 hours' notice before excavating in or adjacent to any road or track.
3. The cost of providing all diversions, lights, signs, signal operators, flagmen and the like shall be at the Contractor's expense and shall be deemed to be included in the rates entered in the Bill of Quantities.
4. For the purposes of this Clause any railway track shall be deemed to extend the full width between the railway reserve fences.

2.17 Liaison with Police and Other

1. The Contractor shall keep in close contact with the Police and other officials of the areas concerned regarding their requirements in the control of workmen, movement of traffic, or other matters and shall provide all assistance or facilities which may be required by such officials in the execution of their duties.

2.18 Preservation of Trees, Bushes and Hedges

1. No trees, bushes or hedges shall be removed without prior permission of the Engineer who will limit the removal of trees, bushes and hedges to the minimum necessary to accommodate the Permanent Works.
2. If trees, bushes or hedges are removed or damaged by the Contractor, or his employees and without approval, then the Contractor shall replace such trees, bushes or hedges at his own expense with trees, bushes or hedges of not less than two years of age obtained from a reputable nursery and of species to be approved by the Engineer. The Contractor shall plant, water and ensure that the replacement trees, bushes or hedges are properly established all at his own expense.

2.19 Protection from Water

1. The Contractor shall keep the whole of the Works free from water and he will be deemed to have included in his rates in the Bill of Quantities for all pumping, shoring, temporary drains, and sumps and other measures and provisions necessary for such purposes and for clearing away and making good to the satisfaction of the Engineer damage caused thereby.

2.20 Protection against Fires

1. The Contractor is advised that at all times, it is necessary to guard against fires starting within the Site or in the environs thereof, particularly as the result of the Works or from actions of his employees. The Contractor shall have available at all times, a trained fire-fighting team provided with adequate fire-fighting equipment and shall deal with all fires howsoever caused.

2.21 Watching, Fencing and Lighting

1. From the time that any portion of the Works shall be commenced, until the end of the Defects Liability Period, the Contractor shall be responsible for protecting against anything dangerous to persons or livestock or property and for the safe and easy passage of pedestrians and vehicular traffic.
2. The Contractor shall employ competent watchmen and guard the Works both by day and night.
3. Any excavations, material dumps, spoil dumps or other obstructions likely to cause injury to any person or thing shall be suitably fenced off and at night and be protected by red warning lights.
4. Fences shall consist of at least three 15mm diameter hemp ropes or 8 S.W.G. wires, or more if required, stretched tightly between poles, standards, etc. securely planted in solid ground, well clear of the excavation and enclosing the spoil from the excavation or as per the drawings or as per the Engineer order.
5. The poles, standards, etc. shall not be more than 1.5m apart, and where circumstances require, they shall be placed closer, and the ropes or wires shall be stretched tight approximately 0.4m, 0.8m, and 1.2m respectively above the ground or as per the drawings or as per the Engineer order.
6. Banks of spoil may be accepted by the Engineer in lieu of fencing if of suitable height and form.
7. If a road is closed, or partly closed to traffic, temporary traffic signs and barricades shall be erected by the Contractor to the satisfaction of the Engineer and the police, to give proper warning to traffic and the public. Road signs shall be not less than 1.2m x 0.8m in size, surmounted by a red hollow circle. Lettering shall be black on a yellow background and shall incorporate reflective material. The signs shall be adequately illuminated at night.
8. Access to property shall be maintained at all times, except where authorized by the Engineer. Where necessary, the Contractor shall lay steel plates, or other temporary bridges of sufficient strength for the traffic likely to be encountered, to enable access to be maintained.

2.22 Water and Power for Use on the Works

1. The Contractor shall be solely responsible for the location, procurement and maintenance of water supplies adequate in quality and quantity to meet his obligations under the Contract.
2. The Contractor shall be responsible for the supply of all electrical power to meet his obligations under the contract and for the distribution thereof.
3. The Contractor shall be deemed to have allowed in the rates entered in the Bill of Quantities for all costs associated with the supply of water and power.

2.23 Employer as Supplier of Water, Power and Equipment

1. The position of the Employer or his agent as a supplier of water or power shall be identical with that of other suppliers and quite separate from his position as Employer under the Contract. As in the case of a supplier, a failure on the part of the Employer (or his Agent) to supply water or power will not relieve the Contractor of any of his obligations under the Contract nor, in respect of any such failure, shall the Contractor have any claim under the Contract against the Employer.
2. No Employer's equipment is available for use by the Contractor in carrying out his duties under the Contract.

2.24 Sanitation

1. The Contractor shall provide adequate sanitation and refuse collection and disposal facilities complying with the Laws of the Federal Democratic Republic of Ethiopia and Local Bye-Laws at the Site and for all houses, offices, workshops, etc. erected on the sites, all to the satisfaction of the Engineer.
2. The Contractor shall warn his employees and Sub-Contractors that any employee found fouling the Site shall be removed from the Site immediately in accordance with the provisions of Clause 16 of the Conditions of Contract.

3. The Contractor is required to make available, toilet facilities with the necessary services to maintain and clean for his employees and mechanical and electrical contractor at major sites.

2.25 First Aid and Medical Services

1. The Contractor shall provide and maintain in operating condition, all equipment necessary to render first aid in case of accidents, snake-bites or other emergencies. This equipment shall be kept in readiness at the sites of the Works, at camps and wherever the Contractor's staff may regularly live and work. The Contractor shall ensure that there are persons available at all such places with a knowledge of simple first aid procedure and able to administer injections and snake-bite treatment.

2.26 Cleaning and Sterilization

1. Before being tested or put into use all buildings, tanks and other units constructed under this Contract shall be thoroughly cleaned so as to remove all dirt, grit and rubbish. Pipelines shall be washed out to ensure the removal of extraneous matter.
2. All tanks, channels, pipes, etc., containing treated or partially treated water shall be sterilized in accordance with the Specification. Workmen carrying out this work must wear clean rubber boots which have been disinfected. Strict precautions will be enforced to ensure that hygienic conditions prevail throughout the sterilizing operation. After cleaning and sterilization have been completed no person shall enter the sterile area without the specific and prior permission of the Engineer.
3. Where work is carried out in connection with the existing water supply system, the Contractor shall ensure that such work is carried out in hygienic conditions and that sterilization is carried out, all to the approval of the Engineer.
4. The Contractor shall arrange for the taking of swabs from all persons who will be engaged in carrying out or supervising sterilization operations to ensure that such persons are free from pathogenic organisms. All medical costs incurred in the taking and analysis of such

bacteriological tests shall be deemed to have been allowed for in the rates entered in the Bill of Quantities.

2.27 Inspection by the Engineer during the Defects Liability Period

1. The Engineer will give the Contractor due notice of his intention to carry out any inspection during the Defects Liability Period and the Contractor shall upon receipt of such notice arrange for a responsible representative to be present at the time and dates named by the Engineer. This representative shall render all necessary assistance and take note of all matters and things to which his attention is directed by the Engineer.

2.28 Attendance on Other Contractors

1. The Contractor shall maintain constant and careful liaison with other contractors on the sites to ensure the coordination of the respective progam of work.
2. Where others are responsible for erecting items of plant, building pipes through walls, etc. they will place the item to the correct line and level. The Contractor shall them cast the item in place.
3. The Engineer will do all possible to coordinate such works, and the Contractor shall carry out his building operations in the order required to prevent delays.
4. The Contractor shall be deemed to have included in his Tender for the co-ordination and programming of the Works with the works of such contractors and for any reasonable interference or delays which he may suffer thereby.

2.29 Photographs

1. No photographs of the Site, of the Works or any part thereof or anything therein shall be taken except with the permission in writing of the Employer and no such photographs shall be published or otherwise circulated without the like permission.

2. No such permission shall exempt the Contractor from complying with any statutory provisions in regard to the taking and publication of photographs.
3. Photographs showing the progress of the Works shall be taken by a competent photographer every month. Six prints from each of a minimum of ten approved negatives will be required every month. All negatives shall be numbered, retained on the Site and on completion of the works the negatives shall become the property of the Employer.

2.30 Official Visitors

1. The Contractor shall at all times when authorized by the Engineer give free and undisputed access and all facilities to any authorized employee of the Government or other authorized person wishing to view or inspect any part of the Site or Works or the materials therein.

2.31 Levels and Reference Points

1. The Contractor shall appoint and employ the necessary qualified and experienced staff to set out the work accurately, based on benchmarks and using the data shown on the drawings or as per the Engineers instruction.
2. Levels and Bench Marks shown on the Drawings to be used for the construction of the Works shall be confirmed by the Engineer in writing before any work commences. Before starting any work the contractor shall check the alignment of the bench marks in the presence of the engineers and shall notify the engineer of any error or misalignment which may discovered during such checking and if there is any corrected errors, the contractor shall certify his acceptance of the benchmarks to the engineer in written form. Any work carried out without the said written confirmation and subsequently found to be erroneous, shall be made good at the Contractor's expense.
3. The Contractor shall establish and locate all lines and levels and be responsible for the correct location of all works.
4. Where directed by the Engineer's Representative, the Contractor shall take such levels and dimensions as may be required prior to disturbance of the ground for the purpose of

measurement and these shall be agreed between the Contractor and the Engineer's Representative in writing before any of the surface is disturbed or covered up. Any work commenced without taking the said levels and dimensions shall be measured on the Engineer's reckoning of their values prior to disturbance. The Engineer's decision on this matter shall be final.

5. Bench marks shall where possible be preserved or else be relocated. Where benchmarks could be destroyed, they shall be accurately tied into permanent concrete reference points before work is commenced.

2.32 Contamination of Water Supplies

1. The Contractor shall comply with the following provisions to avoid contamination of existing or new potable water supplies on the Site:
   a) All personnel working on 'restricted operations' as defined by the Engineer, shall be medically accepted prior to commencing work on the said restricted operations, by having health checks carried out as specified in Clause 2.26.
   b) Strict discipline shall be maintained concerning personal hygiene.
   c) Vehicles, equipment, tools and protective clothing shall be kept clean and may require disinfection as directed by the Engineer.
   d) Should any employee contract any illness, looseness of bowels or gastric disorder, he must immediately cease work on 'restricted operations', avoid contact with other employees, undergo another health check when recovered and gain fresh approval before continuing work on 'restricted operations'.

2.33 Prevention of Obstructions, Pollution & Avoidance of Nuisance

The Contractor shall ensure at all times that the site and the approaches there to are not obstructed or made congested and that no nuisance is created due to the construction of the works which might affect the site or its environment.

2.34 Work in Adverse Weather

1. Working in adverse weather, shall only be permitted as directed by the Engineer. In this context "adverse weather" shall mean any weather conditions which, in the opinion of the Engineer, are such as to prevent the safe and efficient execution and completion of the works, or cause damage to the soil structure of agricultural land.
2. Working in adverse weather may be permitted by the Engineer only where adequate protective measures are undertaken and maintained by the Contractor.

2.35 Site Management and Safety

1. The Contractor shall be responsible for coordinating civil works site operations with the mechanical and electrical contractor or other sub-contractors to ensure the smooth operation of the Works and site safety.
2. The Contractor shall be responsible for the control of site safety.

2.36 Working Hours on Site

1. Subject to any provision to the contrary contained in the Contract, no work on the Site shall be executed during the night, or on locally recognized days of rest without providing the Engineer with a written request submitted at least 48 hours prior to the night or day in question. No such work shall commence without the permission in writing of the Engineer (which will not be unreasonably withheld) save when the work is unavoidable or absolutely necessary for the saving of life or property or for the safety of the Works in which case the Contractor shall immediately advise the Engineer's Representative.
2. Normal working hours on site shall be between 6.30 am and 6.00 pm. Monday to Saturday, as proposed by the Contractor and approved by the Engineer, and shall be in accordance with the Laws and Regulations of the Federal Democratic Republic of Ethiopia.
3. The Contractor shall be in attendance on site at all times when the mechanical and electrical contractor or other sub-contractors are working.

2.37 Demolition of Existing Structures

Where demolition of existing structures is indicated on the Drawings, these structures shall be demolished in their entirety, inclusive of any foundations, and all materials shall be removed from the Site. The ground at the site of any demolished structures shall be returned to their original level to the approval of the Engineer.

2.38 Shop Drawing

The Contractor shall enclose consultation with the engineer prepare all the Shops Drawing deemed necessary for the execution of the works and shall submit the same for approval to the Engineer well in advance to allow 30 days for engineer's checking & approval.

2.39 As - Built Drawings

1. The Contractor shall, upon completion of the Works and prior to the issuance of the Taking - Over Certificate, submit to the Engineer detailed as-built drawings showing all works constructed under this Contract this shall include, but not necessarily be limited to location plans, floor plans layouts, sections, elevations and details complete with dimensions, sizes, data references etc. Sufficient information shall be provided to adequately describe the works and all its components to the satisfaction of the Engineer.
2. Two prints of the as-built drawings shall be submitted to the Engineer for his review. Following the completion of any amendments as may be required and the subsequent approval in writing of the Engineer the Contractor shall submit one semi-original copy and two prints of each drawing.
3. The type of film, paper, size of the drawings, title block, lay-out, orientation and numbering shall all be to the approval of the Engineer.

SECTION 3

MATERIALS

3.1 Approval of Concrete Constituents

The Contractor shall submit to the Engineer full details of all materials which he proposes to use for making structural or non-structural concrete as defined in Clause 5.1. No concrete shall be placed in the Permanent Works until the Engineer has approved the materials of which it is composed. Approved materials shall not thereafter be altered or replaced by other materials without the consent of the Engineer.

Water for Concrete and Mortar

1. Water for mixing or curing of concrete or mortar shall not contain more than the following concentrations of impurities:

	Max PPM
• The sum of sulphates, alkali carbonates and bicarbonate	1000
• Chlorides	500
• Suspended solids	2000
• Seawater or brackish water shall not be used	2000

2. At the commencement of the Works the Contractor shall send a sample of the water proposed for concrete and mortar to an accredited laboratory capable of carrying out the full analysis of potable water in accordance with either the "Analysis of Raw, Potable and Waste Waters" published by the British Her Majesty's Stationery Office (HMSO) or "The Standard Method of Examination of Water and Waste Waters" published by the American Water Works Association (AWWA).
3. The results of the analysis shall be submitted to the Engineer. The sample of water sent for analysis shall be taken in the presence of the Engineer.

4. If the water selected comes from a reliable potable water source the Contractor shall obtain a copy of recent analysis from the Employer's Water Examination Laboratory which normally tests water from the source. If the Engineer considers the recent analysis satisfactory then the further tests required above need not be carried out.
5. If the source of water is changed it shall be tested as above. If the water contains over 80 per cent of the maximum concentrations of impurities properties given above it shall be re-tested at two monthly intervals.

3.3 Aggregates for Concrete

3.3.1 Aggregates to Conform

a) Aggregates for concrete shall conform to the requirements for fine and coarse aggregates in BS 882. Fine and coarse aggregates shall separately conform to the requirements set out in the following sub-clauses.

3.3.2 General Requirements

a) Aggregate shall be clean, hard, durable and frost resistant and shall not contain iron pyrites, iron oxides (other than magnetite), mica, shale, coal or other laminar, soft or porous materials.

3.3.3 Grading

(a) Fine aggregate shall conform to BS 882 Table 5, Zones C or M. In order to achieve an acceptable grading it may be necessary to blend materials from more than one source.

Table for BS grading requirement for fine aggregate.

Normal size of Sieve (mm)	**Percentage passing by weight**
10	100
4.75	90 - 100
2.36	85 - 100
1.18	55 - 90
0.6	25 - 60
0.3	10 - 30
0.15	2 - 10

(b) Coarse aggregate shall be supplied in the nominal sizes specified and shall be graded in accordance with BS 882 for single sized aggregates. A coarse aggregate shall be predominantly angular, rounded or irregular as defined in BS 812, Part 1.

Table for BS grading requirement for coarse aggregate

Nominal Size of Sieve	**Percentage Passing by Weight**

(mm)	40 - 5 mm	20 - 5 mm
50	100	-
40	95 - 100	100
20	30 - 70	95 - 100
16	-	-
10	10 - 35	25 - 55
4.75	0 - 5	0 - 10
2.36	-	-

3.3.4 Soundness

a) After 5 cycles of Test C4 set out in appendix C, aggregates shall not show a weight loss of more than 18 percent using magnesium sulfate.

3.3.5 Flakiness

a) Flakiness Index of coarse aggregates when tested in accordance with BS 812 shall be as set out hereunder and not as given in BS 882 Table 1.

i) For nominal 40 mm aggregate and above, not more than 40

ii) For nominal 20 mm aggregate and below, not more than 35

3.3.6 Shell Content

a) In addition to requirements of Bs 882, the content of hollow and flat shells such not be such as will reduce the 28 day strength below the minimum average strength required or reduce the average strength required or required or reduce the average 28 day strength by more than 5 per cent when tested in accordance with shells are compared with 10 cubes made of concrete with shells removed.

3.3.7 Testing Aggregates

a) Acceptance Testing

i) The Contractor shall deliver to the Engineer samples containing not less than 50 kg of any aggregate, which he proposes to use in the Permanent Works, and shall supply such further samples as the Engineer may require. Each sample shall be clearly labeled to show its origin and shall be accompanied by all the information in BS 882.

ii) Tests to determine compliance of the aggregates with all the requirements of this Specification shall be carried out by the Contractor in a laboratory acceptable to the Engineer. If the tested materials fail to comply with the Specification, further tests shall be made in the presence of the Contractor and the Engineer and acceptance of the material shall be based on such tests.

iii) The acceptance tests carried out by the Contractor shall generally be on three representative samples of fine and coarse aggregates taken in the presence of the Engineer. Total numbers of tests required for acceptance are as follows:

Test	**Fine Aggregates**	**Coarse Aggregates**
Water Absorption	-	3*
Flakiness Index	-	3*
Shell Content Determination	-	3*
Test for Shell Content (where required)	-	1
10% Fines Test or Aggregate Impact Value	-	3*
Grading	3*	3 on each nominal size
Chloride Content	3*	3*
Sulphate Content	3*	3*
Soundness	-	3*
Petrographic Examination	As required minimum 3	As required minimum 3

Test	**Fine Aggregates**	**Coarse Aggregates**
Clay, silt and dust determination	3	3
Organic impurities	3	3

* One test on each sample

iv) If at any time a significant physical or chemical change in the nature of the coarse or fine aggregate occurs, or a new source aggregate is used, the Engineer may direct that some or all of the acceptance testing is repeated.

b) Routine Testing

i) The Contractor shall carry out routine testing of aggregates for compliance with the Specification during the period in which concrete is being produced for the Permanent Works. The tests set out below shall be performed on aggregates from each separate source on the basis of one set of tests for each day on which aggregates are delivered to Site provided that no set of tests shall represent more than 250 tonnes of fine aggregate nor more than 500 tonnes of coarse aggregate, and provided also that the aggregates are of uniform quality. If the aggregate from any source is variable, the frequency of testing shall be as instructed by the Engineer.

- Grading BS 812
- Silt and clay content BS 812
- Moisture content BS 812
- Check on organic impurities Test C3 in Appendix C.

ii) In addition to the above routine tests, the Contractor shall carry out the following tests at the frequencies stated:

- Moisture content: As frequently as may be required in order to control the water content of the concrete as required by the Specification.

- Chloride content: As frequently as may be required to ensure that the proportion of chlorides in the aggregates does not exceed the limit stated in the Specification.

iv) The Contractor shall take account of the fact that when the chloride content is variable it may be necessary to test every load in order to prevent excessive amounts of chloride contaminating the concrete. For this purpose the Contractor shall use the rapid field test described in Appendix C (the Quantab test). In the event of disagreement regarding the results of the field test, the chloride content of the aggregate shall be determined in the laboratory as described in BS 812 (the Volhard test).

3.3.8 Delivery and Storage of Aggregates

a) Aggregates shall be delivered to Site in clean and suitable vehicles. Different types or sizes of aggregate shall not be delivered in one vehicle.

b) Each type or size of aggregate shall be stored in a separate bin or compartment having a base such that contamination of the aggregate is prevented. Dividing walls between bins shall be substantial and continuous so that no mixing of types or sizes occurs.

c) The storage of aggregates shall be arranged so that as far as possible rapid drying out in hot weather is prevented in order to avoid sudden fluctuations in water content. Storage of fine aggregates shall be arranged so that they can drain sufficiently before use in order to prevent fluctuations in water content of the concrete.

3.4 Cement

1. Cement for use in the permanent works shall be Ordinary Portland Cement of an approved type complying to approved standards.
2. Cement in bags shall be stored in a suitable weatherproof structure of which the interior shall be dry and well ventilated at all times. The floor shall be raised above the surrounding ground level and shall be so constructed that no moisture rises through it.
3. Each delivery of cement in bags shall be stacked together in one place separate from other deliveries. The bags shall be closely stacked but shall not be stacked against an outside wall. If pallets are used, they shall be constructed so that bags are not damaged during

handling and stacking. No stack of cement bags shall exceed 3 m in height. Different types of cement in bags shall be clearly distinguished by visible markings and shall be stored in separate stacks.

4. Cement from broken bags shall not be used in the Permanent Works.
5. Cement in bags shall be used in the order in which it is delivered.
6. Bulk cement shall be stored in weatherproof silos which shall bear a clear indication of the type of cement contained in them. Different types of cement shall not be mixed in the same silo.
7. The Contractor shall provide sufficient storage capacity on Site to ensure that his anticipated program of work is not interrupted due to lack of cement having due regard to factors outside the Contractor's control.
8. Cement which has become hardened or lumpy or fails to comply with the Specification in any way shall be removed from the Site.
9. All cement used in the Permanent Works shall be tested by the manufacturer or the Contractor in a laboratory acceptable to the Engineer. The tests shall be in accordance with Test C1 in Appendix C contained at the end of the Specification, and the Contractor shall supply two copies of each test certificate to the Engineer.
10. Cement which does not comply with the Specification shall not be used in the Permanent Works.
11. The Contractor shall keep full records of all data relevant to the manufacture, delivery, testing and use of all cement used in the Permanent Works and shall provide the Engineer with two copies thereof.

3.5 Admixtures for Concrete or Grout

3.5.1 Admixtures for Concrete

Admixtures shall not be used without the written approval of the consultant. The contractor shall submit samples of any admixtures he proposes to use to the consultant at least 30 days prior to the date of commencement of construction of the particular structure or portion of structure on

which he intends to use such admixture. Admixtures as stated below shall be added based on the consultant approval.

1. Water reducing admixture shall conform to BS55075 Part 1
2. Retarding admixture shall conform to BS 55075 Part 1
3. Super plasticizer admixture shall conform to BS - 55075 part 3

   All admixtures shall be non-chloride.

3.5.2 Air Entraining Agents

a) In addition to the general requirements, air entraining agents shall be capable of producing an air content in concrete mixes within the limits stated in the Specification or on the Drawings without any tendency to produce excessive air content in the event of prolonged mixing times.

b) The effect of a proposed air entraining agent shall be tested by the Contractor in trial mixes produced in the plant which he proposes to use for the Permanent Works.

c) Air entraining agents shall comply with BS 5075.

3.5.3 Workability Agents

a) Subject to the agreement of the Engineer, admixtures may be used by the Contractor to assist in meeting the requirements of the Specification or to aid the placing of concrete.

b) Workability agents shall not have any adverse effect on the properties of the concrete. If a reduction in strength of the concrete is caused, the Contractor shall counteract this by a reduction in water cement ratio or by an increase in cement content.

3.6 Mortar

1. Mortar shall be composed of fine aggregate as specified in Clause 3.3 and the type of cement as specified in Clause 3.5. The mix proportions shall be as stated on the Drawings or if not stated shall be one part of cement to three parts of fine aggregate by weight.
2. Small quantities of mortar may be hand mixed but for amounts over 0.5 m^3 a mechanical mixer shall be used.
3. The water content of the mortar shall be as low as possible consistent with the use for which it is required but in any case the water/cement ratio shall not be more than 0.5.

3.7 Reinforcement

1. Unless otherwise directed or shown on the Drawings, hot rolled high yield deformed reinforcement complying with BS 4449 shall be used throughout the works.
2. Where required, mild steel reinforcement and medium tensile steel reinforcement shall comply with BS4449. Cold twisted steel reinforcement shall comply with BS4461. Steel mesh fabric shall comply with BS4483 and hard drawn mild steel wire shall comply with BS 4482
3. All reinforcement shall be from an approved manufacturer and, if required by the Engineer, the Contractor shall submit a test certificate of the rolling. The Contractor, shall, when requested by the Engineer, provide sample pieces 1.0 meters long for testing.
4. Tying wire shall be 1.6 mm diameter soft annealed iron wire.
5. All reinforcement shall be free from scale, rust grease, paint or other substances likely to reduce to bond between the steel and the concrete.

3.8 Formwork

1. The formwork may be of seasoned, planed, tongued and grooved timber, plywood, blackboard, and tempered hardboard, steel or as specified on the Drawings.
2. All timber used for formwork shall be sound wood, well-seasoned and free from loose knots, shakes, large checks, warping and other defects. Before use on the work, it shall be properly stacked and protected from injury from any source. Any timber which becomes badly warped or cracked, prior to the placing of concrete shall be rejected. All formwork for outside surfaces above final ground level shall be either tongued and grooved or provided with a suitable lining to produce a smooth surface finish.

3.9 Contraction and Expansion Joints

3.9.1 Contraction Joints

The contraction joints between the various parts of the structures shall be of the keyed joint type or plain but joints as shown on the Drawings. Where required, the joints shall be provided with PVC water stops to prevent seepage, as specified in Clause 41.32. One face of each joint is to receive one coat of bituminous primer and two coats of approved bituminous paint. These coats shall be applied when the surfaces are dry and no further coat shall be applied until the former coat is dry.

The whole of the concrete face shall be painted, but special care shall be taken that no paint remains on the water stop.

Care shall be taken to ensure that the joint surfaces are truly vertical and plane, and to this end all shuttering shall be rigidly supported.

3.9.2 Expansion Joints

Expansion Joints where shown on the Drawings shall be constructed by placing a rubber water stop between the parts to be joined and forming a gap by inserting a suitable premoulded joint filler. On the exposed sides of the joint a groove shall be formed and filled with joint sealing compound.

The joint sealing compound shall be of the two-component, polysulfide based type, and of approved make. It shall be suitable to withstand tropical climatic conditions without deteriorating. The manufacturer's instructions as to preparation and cleaning of caulking grooves and mixing and placing of joint sealer shall be strictly adhered to. Due regaard shall be given before use of the sealing compound that its shelf life has not been exceeded.

Sealing compounds of suitable viscosity shall be used on horizontal and vertical surfaces respectively.

3.10 Water Stops

1. All references to water stops include grout stops.
2. Water stops shall be of the material and form shown on the Drawings and as detailed in the Specification. No water stop material shall be brought onto site until the Contractor has submitted full details of the materials he proposes to use, including samples, and these have been approved by the Engineer. All samples shall be of adequate length for testing.

Test results from an independent laboratory approved by the Engineer will be accepted as an alternative to tests arranged by the Engineer.

3. Water stops shall be made of materials which are resistant to chlorides, sulphates, or other deleterious substances which may be present in the environment of the Permanent Works.
4. Rubber water stops may be of natural or synthetic rubber and shall have an elongation at breaking stress of at least 500 per cent at 25°C and shall be capable of accommodating a transverse movement of at least 50 mm.
5. Polyvinyl chloride (PVC) water stops shall be extruded from an unfilled plasticised PVC polymer or copolymer which does not contain any reclaimed or scrap PVC. PVC water stops shall have an elongation at breaking stress of at least 225 per cent at 25°C and shall be capable of accommodating a transverse movement of at least 10 mm.
6. Low modulus water stops shall be of rubber or PVC as described above but shall have an elongation of at least 200 percent at 25°C under a tensile stress of 6 N/mm^2 and shall be capable of accommodating a transverse movement of at least 50 mm.
7. Water stops shall be supplied in lengths as long as possible consistent with ease of handling and construction requirements.
8. Water stop material shall be stored carefully on site to avoid damage and contamination with oil, grease, or other pollutants. Rubber and plastic water stops shall be stored in cool well ventilated places away from direct sunlight.
9. Rubber and plastic water stops which are embedded in one side of a joint more than one month before the scheduled date of placing concrete on the other side, shall be protected from the sun.
10. Water stops shall be firmly fixed in the formwork so that they cannot be displaced during concrete placing and shall be completely free of all dirt, grease. oil, etc., before placing concrete.
11. Concrete shall be placed carefully round water stops so as to avoid distortion or displacement and shall be fully compacted. Where water stops lie in a horizontal or nearly horizontal plane the Contractor shall ensure that no voids are left on the underside of the water stops.

12. Formwork round water stops shall be carefully removed to avoid damage. If waterstops suffer any damage which cannot be properly repaired insitu the Engineer may require a section of concrete to be removed and the water stop replaced.

3.11 Marker Posts

1. Precast concrete marker posts shall be set in concrete and fixed near valves, fire hydrants, washouts etc, changes in direction of the mains and where directed by the Engineer. The posts shall be as detailed on the Drawings or as per the Engineer's order.

SECTION 4

EXCAVATION, BACKFILLING AND RESTORATION

4.1 Clearance of Ground

1. The Contractor shall clear the ground on or below which the Works are to be erected by removing vegetation and all superficial obstructions. The combustible material cleared may be disposed of by strictly controlled burning which shall be approved in each instance by the Engineer.
2. All trees, bushes and hedges are to be removed within a distance of 2 m from the centre-line of pipelines and for a distance of 3 m in plan from any foundations. Roots are to be killed or removed within this width.
3. Trees, bushes and hedges at the Site shall not be cut down, damaged or destroyed without the approval of the Engineer. Trees shall be defined as having a girth exceeding 500 mm measured 600 mm above ground level except where a tree has buttresses when the measurement shall be taken immediately above the buttresses.

4.2 Agreement of Existing Ground Levels

1. Prior to the start of any earthworks or excavation, but after site clearance, if any, the levels of the existing ground shall be surveyed by the Contractor and agreed between the Contractor and the Engineer. If the Contractor fails to take the requisite levels the ground levels shown on the drawings or determined by the Engineer shall be taken as correct.
2. No allowance will be made for normal bulking or shrinking of the soil and the Contractor shall make allowance for this in his rates.

4.3 Classification of Excavation

1. For purposes of measurement, excavation is classified as follows:

i) 'Soft Rock' shall mean weathered or disintegrated materials which can be removed or excavated using excavators or shovels, or hand picks or tractor drawn tines or rippers for breaking up the materials.

ii) Hard Rock shall mean material of geological strata requiring the use of wedges, prismatic tools or drilling or blasting with a power operated hand tool for the removal of boulderss, pieces or concrete or masonry exceed 1.0 m^3 in volume.

iii) Boulders shall mean insolated volume of hard rock less than 1.0 m^3 in ordinary soil or soft rock or above ground.

iv) Common or ordinary shall mean material yielding to ordinary excavation machinery or pick axes which will be classified as bulk, pit continuous trench excavation.

4.4 Blasting

1. The Contractor shall keep in his office at the Site copies of State Laws applying to the transport, storage and use of explosives and shall supply one copy of each State Law to the Engineer. The Contractor shall also submit to the Engineer a copy of any instructions or notices which the Contractor may issue to his staff or workmen or post about the Site in compliance with such State Laws.
2. The Contractor shall submit to the Engineer details of the explosives which he proposes to use and of his proposals for the storage and transport of explosives to the Sites.
3. Explosives shall be used in accordance with the recommendations of the BS 5607.
4. The Contractor shall use explosives for blasting in connection with the work only at such times and places and in such a manner as the Engineer may approve but such approval shall not relieve the Contractor from his responsibility for injury, loss, inconvenience and annoyance to persons, damage to the work and adjoining structures, consequent on the use of such explosives. The Contractor shall be entirely liable for any accident which may occur and shall hold the Employer harmless and indemnified from all claims arising from such. Where loss, inconvenience, injury or accident is likely to be caused to persons, animals, works, property, places or objects the Engineer shall have power to regulate or

prohibit the blasting and in the event of such regulation or prohibition the Contractor shall have no claim against the Employer.

5. The Contractor shall give warning each time of his intention to blast and shall station men on the roads and elsewhere with flags, horns and whistles and prevent persons, animals and traffic going into or remaining within the danger zone. He shall arrange for control of traffic on the main roads by the police during all blasting operations within 400m of such main roads.
6. The Contractor's supervisor in charge of blasting operations shall have a valid licence for all types of blasting required including restricted blasting, a copy of which shall be made available to the Engineer.
7. The Contractor shall provide proper buildings in suitable positions for the storage of explosives to the satisfaction of the Engineer and the relevant Authority. The Contractor shall take all possible precautions and comply with all State Laws or other regulations governing the handling and use of explosives including the display on the site of warning notices explaining the procedure to be used in blasting operations, such notices to be displayed in all languages normally spoken by the personnel working on the Site.
8. In carrying out blasting the Contractor shall drill holes to the extent approved and in such number, position and direction and to such lengths and with loading of explosives of such quantity and power and means of detonating as will ensure that the excavation is taken out as neatly as possible to the required profile without shattering the rock remaining or causing injury to concrete or fill already deposited in the vicinity.
9. In certain areas it is necessary to restrict blasting in order to protect installations of major significance as follows:
    a) The Contractor shall, whenever he wishes to blast within 400m of any public road, overhead power line or telephone line, draw this to the attention of the relevant authority concerned and ensure that all conditions imposed by them including attendance by the representatives of such authority are met. In all such cases, he will be required to provide cover to the area to be blasted, to the approval of the Engineer, to prevent damage to these services by flying debris.
    b) The Contractor shall ensure, by limiting the amount of charge/delay or by the use of controlled detonations used at any blasting site, that the peak particle velocity

at any existing building, structure or service, does not exceed 50 mm/sec. The Contractor shall provide a suitable vibrometer and whenever called upon to do so by the Engineer, demonstrate by the use of the vibrometer that the charges he proposes to use comply with this Specification.

10. Compliance with the restrictions will not, however, limit the Contractor's liability in the event of any damage to any existing building, structure or services.
11. Notwithstanding any of the above, the Contractor shall cease blasting and continue to excavate in rock by barring, wedging or other approved methods, whenever called upon to do so by the Engineer.
12. If firing is done electrically, all precautions shall be taken to prevent premature explosions. All men other than the responsible foreman and one skilled man shall be withdrawn to a safe distance before firing wires are connected to the firing cable. The connection of the firing cable to the firing battery shall be the last operation. No charging or firing will be permitted when there are electrical storms or thundery conditions at or near the Site, when the time delay between the flash of lightning and the thunder clap is less than 10 seconds.
13. After blasting no man shall approach the area until it has been examined by the foreman or other responsible person and in the case of misfires the proper precautions shall be taken.
14. The Contractor shall be deemed to have included in his rates for items covering excavation for the supply of all explosives, transport, storage, supervision and compliance with the conditions and restrictions set out above.

4.5 Excavated Material

1. Excavated material approved by the Engineer for use as backfill shall be deposited in spoil heaps confined to areas approved by the Engineer.
2. Top soil shall be stored separately from the main excavated material and on no account disposed of without the approval of the Engineer.

3. The Contractor shall include in his excavation rates for removing to tip all surplus excavated material, rubbish and waste matter and for providing tips and leaving them with an acceptable appearance, all to the approval of the Engineer.

4.6 Timbering and Dewatering of Excavations

1. The Contractor shall carry out timbering in accordance with the recommendations in BS 5031.
2. All open excavation shall be securely timbered with suitable timber (or alternative form of sheeting other than timber) as may be required and whenever necessary to the satisfaction of the Engineer at the Contractor's expense. Timber shall not be left in the excavations as they are being filled up unless authorised by the Engineer.
3. Every precaution shall be taken by the Contractor against slips and falls, and the like in the excavations, but if any slips or falls should occur the Contractor shall at once make good the same including all surface restoration and reinstatement, all at his own cost. If any such fall or slip disturbs or weakens any foundation or support to the Works or adjacent buildings, pipes, etc., or causes a space to exist outside the new work itself the Contractor shall execute such additional works as the Engineer may require in consequence thereof and fill up the space so caused, with concrete if necessary, as the Engineer may direct, all at the Contractor's own expense.

4 All excavation shall be kept free from water until construction work is complete and for such time as the Engineer considers necessary to safeguard the permanent work all at the Contractor's own expense. Trenches for pipework are to be kept dry and free of debris until final backfilling.

5. The Contractor shall be deemed to have included in his rates for excavation for the supply and operation of all pumps and the construction of any sumps or temporary drains necessary. Should any damage be caused by prolonged or excessive pumping, making good shall be carried out by the Contractor at his own cost and to the Engineer's approval.
6. The Contractor shall comply with all instructions of the Engineer regarding the supporting of the sides and dewatering of trenches or pits but shall not be relieved of his

responsibilities under the Contract because no objection has been raised to the condition of the work.

4.7 Excavation

4.7.1 Trench Excavation

1. The minimum width of pipe trench shall be as indicated on the Drawings. This dimension will be used for measurement of the work and no separate measurement will be taken or allowed for over break. The Contractor shall ensure that at any point the width of the pipe trench is sufficient to permit the pipe to be laid with banks nearly vertical as practical and bedding to be placed and compacted around the pipe to the Engineer's satisfaction.
2. Each section of trench shall, where possible, have a bed of uniform gradient. Trench formation shall normally be in undisturbed ground, but where, in the opinion of the Engineer, the formation is unsuitable for bearing, extra excavation shall be carried out under the direction of the Engineer and the level made up again with selected fill material carefully compacted, or with Class 20 concrete. Such additional excavation and filling shall be paid for separately provided that the unsuitability is not due to the Contractor's method of working in which case the Contractor shall carry out the work at his own expense.
3. Whenever wet or otherwise unstable soil is encountered in the trench bottom and in capable of properly supporting the pipe as determined by the Engineer, such soil shall be removed to the depth required and the trench back filled to the proper grade imported material as approved by the Engineer.
4. All pipes shall have a minimum cover measured from the top of the pipe to the ground surface as follows:-
   a) 0.8 for pipes up to DN/OD 400 mm, laid under open areas.
   b) 11.0 m where pipes of any diameter laid under roads or road verges and for all pipes of DN 450 mm diameter and above, irrespective of location.
5. Where for any reason the required minimum cover cannot be achieved then the pipe shall be surrounded with Class 20 concrete in accordance with the details shown on the Drawings.

6. No greater length of trench shall be opened at one time than is approved by the Engineer. If there is a danger of erosion of trenches, the period between excavation of the trench, the pipe laying operation and subsequent backfilling shall be kept to a minimum.
7. If at any time any trench or excavation becomes dangerous, the Engineer shall be at liberty to call upon the Contractor to restore it to a proper condition at three hours notice and, should the Contractor fail to carry out the work, have it done at the Contractor's expense.
8. Excavated material approved by the Engineer for use as backfill shall be stockpiled alongside or near the trenches. All surplus material shall be removed to tip.
9. The Contractor shall in accordance with Clause 38 of the Conditions of Contract give due notice to the Engineer whenever the trench invert is about to be ready for examination and no further work shall proceed thereon until the Engineer's approval is given.
10. The use of trench digging machinery will not be permitted except where its operation will cause damage to trees, buildings, or existing structures above or below the ground. At such locations hand methods shall be employed to avoid such damage machinery, trucks, etc. will only allowed to move on the temporary access road only in a longitudinal direction the equipment may only leave the said road at place which are especially provided therefore.

4.7.2 Structure Excavation

Excavation for structures shall be to width and depth necessary to provide adequate space for structural foundation, bracing and supporting formwork, pumping and draining, and if required over excavation of unsuitable material, over excavation required because of un-satisfactory soil conditions resulting from lack of drainage or dewatering equipment will be the responsibility of the contractor.

4.7.3 Hand Excavation

It shall be utilized in restricted casements and in those locations where machine excavation is not possible or particle due to the proximity of the structures or underground utilities. The case of hand excavation where necessary, if any, shall be deemed to be included in the price tendered for common trench excavation and backfill.

4.8 Preparation, Inspection and Blinding of Foundations

1. Where stated on the Drawings or elsewhere in the Specification, the excavation shall be carried out as described and the Final Surface treated as specified.
2. The faces of excavations shall be clean and trimmed to the required lines and levels. Any parts of the formation inconsistent with the nature and texture of the main formation shall be removed if authorized by the Engineer, and the voids so formed filled with a material and in a manner approved by the Engineer. Such extra excavation including filling will be paid for by the Employer provided it is not caused by any action or negligence by the Contractor.
3. Where the Final Surface is damaged or allowed to deteriorate through instructions not being complied with, the cost of the re-excavation to a firm base and making up with Grade C20 lean mix concrete shall be borne by the Contractor.
4. If any slips or falls occur, the Contractor shall immediately make good the same including all surface restoration, all at his own expense.
5. The Contractor shall stop excavation at a minimum depth of 150mm above any Final Surface to be blinded. The final 150mm excavation shall not be carried out until the Contractor is ready to protect the Final Surface with blinding.
6. The Contractor shall not excavate below the formation level or beyond any exposed faces shown on the Drawings. Any over-excavation shall be backfilled with Class B15 lean mix concrete at the Contractor's expense.
7. The Contractor shall in accordance with Clause 38 of the Conditions of Contract give due notice to the Engineer whenever any such work or foundation is about to be ready for examination and no further work shall proceed thereon until the Engineer's approval is given.
8. The Contractor shall at all times afford protection to any exposed formation to obviate deterioration and, where applicable, blinding concrete shall be laid immediately following the Engineer's approval of the formation.

9. Settlement or washing that occurs in graded or backfilled areas prior to acceptance, of the work shall be repaired and regraded to the required elevations and slopes at no additional cost to the Employer

4.9 Foundations and Thrust Blocks Cast Against Existing Ground

1. Where shown on the Drawings or directed by the Engineer that concrete shall be cast against the existing ground, the excavation shall be neatly excavated to the shape required. Where the foundation is inadvertently over-excavated, the space between the foundation and the soil face shall be backfilled with Class B15 concrete or as directed by the Engineer.

4.10 Fill

1. All filling directed by the Engineer shall consist of selected granular material uplifted, placed and compacted in layers not exceeding 250 mm thick, watered if necessary to ensure adequate compaction, all to the approval of the Engineer. No filling shall proceed without the approval of the Engineer.
2. Where in the opinion of the Engineer insufficient excavated material suitable for backfilling exists within 1 km of the place where the fill is required the Contractor shall if directed by the Engineer import suitable material either from borrow pits or from stockpiles. Items are included in the Bill of Quantities for the import of such material. Payment will only be made under these items for imported fill from borrow pits and from stockpiles more than 1 km from the place of filling. The volume to be measured shall be the volume of compacted fill in place.

4.11 Backfilling of Trenches

1. The pipe zone is defined as that portion of the trench between the bottom level of the pipe bedding and a level 150 mm above the top of the installed pipe. Bedding of the pipe and backfill of the trench within the pipe zone shall be carried out by selected backfill material and shall be placed by hand to a minimum depth over the pipe of 300 mm. This material shall be thoroughly compacted using hand tempers in lifts, each having a maximum compacted depth of 150 mm.
2. Materials with high swelling characteristics or any other deleterious properties shall not be used unless specifically directed by the Engineer. Each layer shall be separately compacted using suitable rammers. All backfilling shall be completed as soon as possible after pipes have been tested and approved.
3. Under road crossings, the backfilling to pipes shall be brought up in 150 mm layers, and compacted to a density not less than 95% PROCTER.
4. Pipes crossing under roads under construction should be excavated and the pipes laid and backfilled after completion of the road earth works if the road at that location is in cut. In all cases, pipes should be laid and backfilled in advance of road subgrade processing operations.
5. Where in the opinion of the Engineer insufficient excavated material suitable for use as fill or bedding exists within 1 km of the place where it is required, the Contractor shall if directed by the Engineer import suitable material either from stock piles or from borrow pits.
6. Items are included in the Bill of Quantities for the import of suitable material. Payment will only be made under these items for fill or bedding material imported from borrow pits and stock piles situated more than 1 km from the place of filling. Payment will be measured by the volume of compacted fill or bedding material in place, multiplied by the distance (to the nearest 0.5 km) in excess of 1 km that it has been transported.
7. Rates for excavation and backfilling of pipe trenches shall include for removal of surplus material to disposal areas within a radius 2 km, spreading and levelling of the

spoil, and reinstatement of access tracks, verges, storm drains and fences, all to the satisfaction of the Engineer.

8. In order that consolidation of backfill is not hampered, trench water, if present, shall be removed prior to commencement of backfilling.

   To prevent damage to installed pipe, backfill shall be placed in the trench by rolling down a slope and not be pushing it over the edge of the trench and allowing it to drop vertically. Every effort shall be made to plan the backfilling operation such that exposure of backfill material to wet weather is kept to a minimum. The trench shall be backfilled as close to the pipe laying operation as conditions permit and trench excavation shall not be left open overnight without the writer permission of the Engineer.

9. Materials and method employed in backfilling trenches above the pipe zone shall depend on the location of the trench with respect to traveled and untraveled surface, and in particular on the type of material existing on the surface in which the trench is excavated. Traveled surfaces are graveled or paved roadways, lanes, driveways, parking areas, road shoulders, walkways, or other graveled or paved surfaces over which vehicular or pedestrian traffic normally travels.

   Subject to provisions contained elsewhere herein backfill above the pipe zone and surface restoration of trenches shall be carried out in accordance with the following paragraphs.

4.12 Untraveled Surface

In untraveled surfaces, unless otherwise specified, trench backfill above the pipe zone shall be native backfill material. Backfill may initially be built up to a height above original ground level equal to 110% of the trench depth and allowed to settle. Prior to acceptance, however, the trench surface shall be restored to its original level and to a condition which at least is equivalent to the existed prior to construction unless the approval of the Engineer is given to leave trench surfaces in a bermed condition.

4.13 Gravel Traveled Surface

In travelled surfaces which exist ass gravel surfaces, trench backfill shall be mechanically compacted native backfill material to a level 300 mm below finished surface grade. The remainder of the trench shall be backfilled with 300 mm of compacted road base gravel.

4.14 Paved Traveled Surface

When trenches have been excavated in existing paved surfaces which are to be re-paved, trench backfill shall be mechanically compacted native backfill material to a level 350 mm below finished surface grade. The remainder of the trench shall be backfilled with 300 mm of compacted road base gravel and finished with a minimum thickness of 50 mm of compacted hot-mix asphalt.

If the edges of the cut pavement have become ragged as result of the construction operation, pavement shall be re-cut to form a straight line and the base compacted prior to placing new pavement. The edges of the existing pavement shall be thoroughly cleaned and coated with an approved steel-wheeled roller having a minimum weight of 7.3 ton.

4.15 Reinstatement

1. The Contractor shall be responsible for the temporary and permanent reinstatement of all roads, fields, paths, gardens, verges and the like, whether public or private, which are affected by his operations.
2. Immediately backfilling of trenches has been completed, temporary reinstatement of the ground shall take place.
3. When in the opinion of the Engineer a suitable period has elapsed after temporary reinstatement has been completed for there to be no further settlement, he shall allow the Contractor to carry out the permanent reinstatement. This shall not in any way relieve the Contractor of his responsibility for reinstatement and, should any further unforeseen settlement take place, the Contractor will be required to make good the reinstatement at his own expense.

4. Permanent reinstatement means that the ground surface shall be restored to its original form and condition.
5. Any diverted water courses shall be reinstated in their former positions and topsoil shall be spread where the ground has been stripped. The Contractor shall be deemed to have included in the rates entered in the Bill of Quantities for the full cost of such reinstatement.

4.16 Top soiling and Grassing

1. Topsoil for planting grass shall be selected topsoil from approved stockpiles of excavated materials or from stripping from borrow areas or from other approved sources.
2. The materials shall contain the most fertile loam available and shall be free from excessive quantities of roots, weeds, sticks, stones or other objectionable material.
3. Areas to receive the topsoil shall be brought to within 150 mm of the prescribed final cross sections and finished ground levels at all points and finished smoothly and uniformly before topsoil is applied.
4. Topsoil shall be evenly placed and spread over the graded areas in one layer.
5. The Contractor shall allow for a temporary sprinkler irrigation system to the Engineer's approval and shall irrigate the newly planted grass to ensure germination and establishment of plants.
6. The Contractor shall repair at his own expense any damage to the slopes or any part of the Works caused by excessive or irregular application of irrigation water.
7. When the topsoil has been placed on the areas to be planted with grass, levelled and compacted to finished grade it shall be brought to a friable condition by harrowing or other means to a maximum depth of 100 mm. All lumps and clods shall be thoroughly broken up.
8. All grass shall be of the creeping type. Approved grass sprigs shall be planted at 200 mm centres both ways on all areas designated by the Engineer. The grass areas shall be watered and maintained until a full grass cover has been established.

4.17 Hardcore

1. Hardcore shall consist of broken rock, concrete or other approved hard material, clean and free from extraneous matter, having a maximum particle size of 100 mm. It shall be spread and leveled, watered and compacted, and then blinded with a layer of fine material of grading 3mm to dust, watered and compacted all to the Engineer's approval.

4.18 Pitching

1. Stone for pitching shall consist of sound under composed rock.
2. The stone as dressed shall be roughly cubical in shape with minimum dimensions of 150 mm x 150 mm x 150 mm for a nominal thickness of 150 mm pitching or 150 mm x 150 mm x 200 mm for a nominal thickness of 200 mm pitching.
3. Hard stone boulders may be used for grouted pitching only but in this case the size shall be 300 mm minimum diameter for a nominal thickness of 200 mm pitching.
4. For dry pitching the surface to receive the pitching shall be compacted and trimmed to slope covered with a 100 mm thick layer of compacted gravel well graded from 19 mm to 5 mm and the stone hand laid, interlocked and rammed into the gravel to give an even finished surface. Fill material shall then be rammed into the interstices.
5. Grouted pitching shall be constructed as for dry pitching except that the interstices of the pitching shall not be filled with fill material, but shall be choked with large rock spalls. The pitching shall be thoroughly soaked with water, and cement mortar shall be worked into the interstices and smoothed off flush with the pitched face.
6. When dry pitching is specified, the Engineer may accept a grouted boulder pitched surface in lieu.
7. The rates for pitching shall include for compaction and trimming of the undersurface, providing and laying stone and gravel, providing and filling interstices with fill material or spalls and mortar, water, and any additional compaction of the filling behind the pitching.

4.19 Trial Pits

1. The Contractor shall excavate, maintain and afterwards refill at the rates in the Bill of Quantities any trial pits ordered by the Engineer. The cost of trial pits required by the Contractor shall be at the Contractor's expense.
2. The sides of the pits shall, where deemed necessary by the Engineer for safety purposes, be supported by sheeting or boarding with adequate framing and a ladder shall be provided for inspection purposes, the costs of which shall be deemed to be included in the Contractor's excavation rates for trial pits.

SECTION 5

CONCRETE FINISHES AND FORMWORK

5.1 Definitions

1. Structural concrete is any class of concrete which is used in reinforced, pre-stressed or un-reinforced concrete construction, which is subject to stress and which is required to comply with other Clauses of the Specification.
2. Non-structural concrete is composed of materials complying with the Specification but for which no strength requirements are specified and which is used only for filling voids and similar purposes where it is subjected to significant stress.
3. A formed surface is a face which has been cast against formwork. A free surface is a horizontal or nearly horizontal surface produced by screeding or troweling to the level and finish required. A pour refers to the operation of placing concrete into any mold, bay or formwork, etc., and also to the volume which has to be filled. Pours in vertical succession are also referred to as lifts.
4. Water/cement ratio is the ratio by weight of the free water in the mix divided by the weight of cement in the mix. Free water is the water in the mix including water absorbed by the aggregate.
5. Forms, formwork or shuttering shall mean all temporary molds forming the concrete to the required shape together with any special lining that may be required to produce the concrete finish specified.
6. False work or centering shall mean the furnishing, placing and removal of all temporary construction such as framing, props and struts required for the support of forms.

5.2 Standard Specifications

All workmanship materials, tests and performance in connection with reinforced concrete shall, unless otherwise stated in this specification, be in conformity with the following standard specifications.

BS 8110	Structural use of Concrete
	Part 1: Code of practice for design and construction

	Part 2: Code of practice for special circumstances
BS 8007	Design of concrete structures for retaining aqueous liquids
BS 5328	Methods for specifying concrete, including ready-mixed concrete
BS 6073	Precast concrete masonry units.

The specification shall apply to concrete prepared on site as well as ready mixed concrete and small precast concrete elements. It is based on CP110: 1972 Part I in general, and on BS5337: 1976 in respect of exposure of concrete to water and moisture.

The standards and Codes of Practice, detailed below are by reference made part of this Specification.

ESCP 2: Part I	Structural use of Concrete
ES C.D3.201	Normal Concrete Aggregates
ES C.D5.201	Portland Cement General Requirements
ES C.D8.490	Portland Cement Methods of Sampling & Testing
BS	Portland cement (ordinary and rapid hardening)
BS 410	Test sieves
BS 812	Methods for sampling and testing of mineral aggregates, sands and filters
BS 882	Aggregates from natural sources for concrete
BS 1305	Batch type concrete mixers
BS 1370	Low heat Portland cement
BS 1881	Guide to use of non-destructive methods of test for hardened concrete
BS 3148	Tests for water for making concrete
BS 4449	Carbon steel bars for the reinforcement of concrete
BS 4466	Bending dimensions and scheduling of bars for the reinforcement of concrete
BS 4482	Steel wire for the reinforcement of concrete
BS 4483	Steel fabric for the reinforcement of concrete
BS 4550	Methods for testing cement
BS 5075	Concrete admixtures
BS 5135	Metal-arc welding of carbon and carbon manganese steel

BS 8007	Code of practice for the design of concrete structures for retaining aqueous liquids
BS 5606	Code of practice for Accuracy in Building
BS 4027	Sulphate Resisting Portland Cement
BS 8110	Structural use of concrete – parts 1-3
ASTM standard C309	Liquid membrane forming compound for curing concrete
ASTM standard C260	Air entraining admixtures for concrete

In case of discrepancy or contradiction, the requirements of this specification shall rule over any standard.

3.1.2 CLASSIFICATION OF CONCRETE

3.1.2.1 *Normal Concrete*

All normal concrete (i.e., other than mass concrete as specified below) to be used in reinforced and plain structure is classified in the contract documents according to required strength grade as per Table 1 and to (exposure) class as per Table 2.

Table 1: Grades of Concrete and Strength Requirements

Grade	Characteristic	Cube Strength at 28 days, in N/mm2		
	Strength	Work Cube [1]		Trial Mix [1]
	N/mm2	Average	Each Individual	Average
10	10	12.3	8.5	
15	15	20.0	12.8	21.5
20	20	27.5	17.0	31.5
25	25	32.5	21.3	36.5
30	30	37.5	25.5	41.5
40	40	47.5	34.0	51.5
50	50	57.5	42.5	61.5

[1] Note: Concrete may be accepted the basis of 7 days cube strength, provided the average strength is at least 70% of the required 28 days strength

Table 2: Minimum Cement Content (kg/m3) Required for Classes of Exposure

		Reinforced Concrete			Plain Concrete	

Class					Max.					Max.
					Free					Free
	Max. Size of Aggregate, mm				Water	Max. Size of Aggregate, mm				Water
	40	20	14	10	Cement	40	20	14	10	Cement
					Ratio					Ratio
E	320	360	390	410	0.45	270	310	330	360	0.50
Severe	(290)	(330)	(350)	(370)		(240)	(280)	(300)	(320)	
F	260	290	320	340	0.55	220	250	280	300	0.60
Moderate	(240)	(260)	(290)	(310)		(200)	(230)	(250)	(270)	
G	220	250	270	290	0.65	200	220	250	270	0.70
Mild	(200)	(230)	(250)	(260)		(180)	(200)	(220)	(240)	

Notes: The minimum cement content may be reduced, as given in brackets when:

1. Trial mixes have verified that a concrete with a maximum free water cement ratio not greater than that given for the particular concrete can be consistently produced ant that it is suitable for the conditions of transporting placing and compaction.
2. The max. Free water/cement ratio is strictly controlled by a site laboratory.

3.1.2.2 *(Void)*

5.3 Concrete

5.3.1 Quality Control of Concrete Production (150 mm cubes)

a) for each class of concrete in production at each plant for use in the Permanent Work, samples of concrete shall be taken at the point of mixing or of deposition as instructed by the Engineer and in the presence of a representative of the Engineer, all in accordance with the sampling procedures described in BS 1881.

b) The slump of each sample measured in accordance with Clause 5.6 shall be determined at the time of sampling.

c) Samples shall be taken on the basis of one for each 20 m^3 of concrete placed but in any case not less than one sample per day or one sample for each pour of concrete placed, whichever is the more frequent.

d) Test cubes shall be cast from each sample, cured and tested as specified in Clause 5.4.

e) Test cubes shall be tested in accordance with Clause 5.5.

f) The density of all the cubes shall be determined before the cubes are crushed.

5.3.2 Failure to Comply with Requirements

a) The Contractor shall take any action instructed by the Engineer to remedy concrete, which fails to comply with the Specification. Such action may include but is not necessarily confined to the following.

i) Adjusting the mix proportions until the concrete again complies with the Specification

ii) Cutting test cores from the failed concrete and testing in accordance with BS 1881.

iii) Carrying out additional works to overcome the effect of the failed concrete.

iv) Removing the failed concrete

v) Increasing the frequency of sampling until control is again established.

5.4 Concrete Mixes

The classes of structural concrete to be used in the Permanent Works shall be those shown on the Drawings. The classes are designated in Table 5.4.1

1. Concrete for water retaining structures shall have maximum water/cement ratios as shown in accordance with the recommendations laid down in Section six of BS 8007:1987.
2. Concrete for other structures shall have maximum water/cement ratios as shown in Table 5.4.1 or on the Drawings.
4. The coarse aggregate maximum size shall be as shown in Table 5.4.1 or on the Drawings.
5. Frequency of sampling shall be in accordance with Table 7 of BS 5328.
6. Concrete mixes shall be designed mixes and shall generally be in accordance with Section 3 of BS 5328, and as specified in the sub-clauses below.
7. The Contractor shall be responsible for sampling, curing and testing of concrete.
8. Design of Proposed Mixes

a) The Contractor shall submit full details of all the mixes he proposes to use of the Engineer for his approval before proceeding with their use for the Permanent Works.

b) The Contractor shall design the mixes, which he proposes to use in the Permanent Works to achieve acceptable workability and resistance to segregation during handling and placing. Mixes shall also comply with the following requirement:

i) The aggregate portion shall be well graded from the nominal maximum size of stone down to the 150-micron size.

ii) The cement contents shall be within the limits shown in Table 5.4.1 unless a higher cement content is required to meet the strength requirement.

iii) The water/cement ratio shall be the minimum consistent with adequate workability but in any case not greater than that shown in Table 5.4.1 taking due account of any water contained in the aggregates. The Contractor shall take into account that this requirement may need the inclusion of a workability agent in the mix.

iv) The workability shall be consistent with ease of placing and proper compaction having regard to the presence of reinforcement and embedded items.

v) The crushing strength at 28 days shall be determined in accordance with Clause 5.5.

vi) The drying shrinkage determined in accordance with BS 1881 shall not be greater than 0.05 percent

vii) Blinding concrete shall be Class C15 for water retaining structures and C10 for other structures unless otherwise indicated on the Drawings or in the Specification.

9. Based on the results of the tests on the trial mixes, the Contractor shall submit full details of his proposals for mix design to the Engineer, including the type and source of each ingredient, the proposed proportions of each mix and the results on the tests on the trial mixes.

10. If the Engineer does not agree to a proposed concrete mix for any reason, the Contractor shall amend his proposals and carry out further trial mixes. No mix shall be used in the Permanent works without the written consent of the Engineer.

Table 5.4.1

Specified requirements of concrete mixes to be used, Clause 5.4 refers

	Mix descriptions used in Bill of Quantities

	C10	C15	C20	C25	C30	C35
Type of Mix. Designed	D	D	D	D	D	D
Type of Cement : BS No.	12	12	12	12	12	12
Types of Aggregate Coarse BS No.	882	882	882	882	882	882
Fine BS No.	882	882	882	882	882	882
Nominal Aggregate:						
Maximum Size (mm)	40	40	40	20	20	20
Grade	C10	C15	C20	C25	C30	C35
Minimum Cement Content (kg/m^3)	200	200	240	300	325	325
Sampling Rage (m^3/sample)	50	50	50	155	15	15
Workability/Slump (mm)	40/75	40/75	40/75	40/75	40/75	40/75
VB (s)	-	-	-	-	-	-
Compacting factor	-	-	-	-	-	-
Maximum free water/cement ratio	0.6	0.6	0.55	0.55	0.55	0.55
Maximum cement content (kg/m^3)	-	-	-	-	360	360
Special cement	-	-	-	-	-	-
Special aggregate Coarse:	-	-	-	-	-	-
Fine	-	-	-	-	-	-
Admixtures Specified						
Prohibited	All admixtures unless approved by the Engineer					
Amount						
Air content	0%	0%	0%	0%	0%	0%
Temperature of concrete (°C)						
Maximum	30	30	30	30	30	30
Minimum	5	5	5	5	5	5
Density of concrete						
(kg/m^3) Maximum						
Minimum	2350	2350	2350	2350	2350	2350
Additional requirements	Grades C30 and C35 designed to retain aqueous liquids					

5.5 Trial Mixes

1. For each mix of concrete the Contractor shall in the presence of a representative of the Engineer prepare three separate batches of batches of concrete using the materials which have been approved for use in the Permanent Works and the mixing plant which he proposes to use for the Permanent Works.
2. Six 150 mm test cubes shall be cast from each batch.
3. The making, curing and testing of all test cubes shall comply with the requirements of BS 1881. The slump of the concrete measured in accordance with BS 1881 shall be recorded or at least one (1) slump test shall bee taken for each strength test.
4. Three cubes from each batch shall be tested for compressive strength at seven days and the remaining three at 28 days.
5. The density of all the cubes shall be determined before the cubes are crushed.
6. If the 28-day strength as determined by this Clause is less than the minimum average strength specified, then the mix shall be adjusted in order to comply. If adjustment of aggregate proportions does not increase the strength, the Contractor shall seek approval from the Engineer to reduce the water cement ratio.
7. If it is necessary to increase the workability, the use of a plasticity additive may be considered by the Engineer but shall not necessarily be accepted. An increase in cement content will not normally be acceptable.
8. The average strength of the three cubes crushed at 28 days shall be referred to as one test result.
9. The average strength of the three cubes crushed at 28 days cubes accepted by the Engineer shall be referred to thereafter as the "final trial mix strength".
10. The Contractor shall carry out tests to determine the drying shrinkage of the concrete,

5.6 Workability

1. The slump for conventionally placed concrete, measured in accordance with BS 1881, shall be 50 mm ± 25 mm.

5.7 Transporting, Placing and Compacting

1. Concrete shall not be placed in any part of the Permanent Works until the Engineer's consent has been given in writing, and the Contractor shall give the Engineer at least 18 hours' notice of his intention to place concrete.
2. The time elapsing between mixing and placing a batch of concrete shall be as short as practicable and in any case no longer than will permit completion of placing and compaction before the onset of initial set. If the placing of any batch of concrete is delayed beyond this period, the concrete shall not be placed in the Permanent Works.
3. If concrete placing is not commenced within 24 hours of the Engineer's consent, the Contractor shall again request written consent as specified above
4. Excavated surfaces on which concrete is to be deposited shall be prepared as set out in Section 3 of the Specification.
5. Existing concrete surfaces shall be prepared as set out in the relevant clauses. Before deposition of further concrete they shall be clean, hard and sound and if required by the Engineer shall be wet but without any freestanding water.
6. Any flow of water into an excavation shall be diverted through proper side drains to a sump, or be removed by other suitable methods which will avoid washing away the freshly deposited concrete or any of its constituents. When they are no longer required any under drains constructed for this purpose shall be completely grouted up or dealt with by a method agreed by the Engineer.
7. The concrete shall be deposited as nearly as possible in its final position. It shall be placed so as to avoid segregation of the concrete and displacement of the reinforcement, other embedded items, or formwork. It shall be brought up in layers approximately parallel to the construction joint planes and not exceeding 500 mm in compacted thickness unless otherwise permitted or directed by the Engineer, but the layers shall not be less than four times the maximum nominal size of aggregate in thickness.
8. Layers shall not be placed so that they form feather edges nor shall they be placed on a previous layer which has taken its initial set. In order to comply with this requirement, a layer may be started before completion of the preceding layer.
9. All work shall be completed on each batch of concrete before its initial set commences and thereafter the concrete shall not be disturbed before it has set hard. No concrete that

has partially hardened during transit shall be used in the Permanent Works and the transport of concrete from the mixer to the point of placing shall be such that this requirement can be complied with.

10. Concrete shall not be placed during rain which is sufficiently heavy or prolonged to wash mortar from coarse aggregate on the exposed faces of fresh concrete. Means shall be provided to remove any water accumulating on the surface of the placed concrete. Concrete shall not be deposited into such accumulations of water.
11. In drying weather, covers shall be provided for all fresh concrete surfaces which are not being worked on. Water shall not be added to concrete for any reason.
12. When concrete is discharged above its place of final deposition, segregation shall be prevented by the use of chutes, down pipes, trunking, baffles or other appropriate devices.
13. Forms for walls, columns and other thin sections of significant height shall be provided with openings or other devices that will permit the concrete to be placed in a manner that will prevent segregation and accumulations of hardened concrete on the formwork or reinforcement above the level of the placed concrete.
14. If concrete placing is interrupted for any reason and the duration of the interruption cannot be forecast or is likely to be prolonged, the Contractor shall immediately take the necessary action to form a construction joint so as to eliminate as far as possible feather edges and sloping top surfaces and shall thoroughly compact the concrete already placed in accordance with the Specification. All work on the concrete shall be completed while it is still plastic and it shall not thereafter be disturbed until it is hard enough to resist damage.
15. Equipment and materials to comply with this requirement shall be readily available at all times during concrete placing.
16. Before concreting is resumed after such an interruption the Contractor shall cut out and remove all damaged or un-compacted concrete, feather edges or any other undesirable features and shall leave a clean sound surface against which the fresh concrete may be placed.
17. If it becomes possible to resume concrete placing without contravening the Specification and the Engineer consents to a resumption, the new concrete shall be thoroughly worked in and compacted against the existing concrete so as to eliminate any cold joints.
18. Unless otherwise agreed by the Engineer, pours shall not be more than two metres high and shall as far as possible have a uniform thickness over the plan area of the pour.

Concrete shall be placed to the full planned height of all pours except in the event of an interruption to placing in which case action shall be taken as specified.

19. The Contractor shall plan the dimensions of pours in such a way that thermal or shrinkage stresses are minimized.
20. The Contractor shall arrange that as far as possible the intervals between placing successive lifts of concrete in one section of the Permanent Works are of equal duration. This duration shall normally be not less than three nor more than seven days under temperate weather conditions unless otherwise agreed or instructed by the Engineer.
21. Where required by the Engineer to limit the opening of construction joints due to shrinkage, concrete shall not be placed against adjacent concrete which is less than 21 days old.
22. If concrete has to be placed against recently cast concrete within a period of less than 21 days, the pour shall be carried out as early as possible after the adjacent pour but precautions shall be taken to minimize shrinkage. The methods described in Clause 5.8 can be used to that effect. However the Contractor shall submit for approval a proposed method and program for placing of concrete.
23. When the Drawings call for contraction gaps in concrete these shall be of the widths and in the locations shown on the Drawings.
24. The concrete shall be fully compacted throughout the full extent of the placed layer. It shall be thoroughly worked against the formwork and around any reinforcement and other embedded items, without displacing them. Particular care shall be taken at arrises and other confined spaces. Successive layers of the same pour shall be thoroughly worked together.
25. Concrete shall be compacted with the assistance of mechanical immersion vibrators, unless the Engineer agrees to another method.
26. Immersion vibrators shall operate at a frequency of between 7,000 and 10,000 cycles per minute. The Contractor shall ensure that vibrators are operated at pressures and voltages not less than those recommended by the manufacturer in order that the compactive effort is not reduced.
27. A sufficient number of vibrators shall be operated to enable the entire quantity of concrete being placed to be vibrated for the necessary period and, in addition, stand-by vibrators shall be available for instant use at each place where concrete is being placed.

28. Vibration shall be continued at each point until the concrete ceases to contract, a thin layer of mortar has appeared on the surface and air bubbles have ceased to appear. Vibrators shall not be used to move concrete laterally and shall be withdrawn slowly to prevent the formation of voids.
29. Vibration shall not be applied by way of reinforcement nor shall vibrators be allowed to touch reinforcement or other embedded items. The vibrators shall be inserted vertically into the concrete to penetrate the layer underneath at regular spacing which shall not exceed the distance from the vibrator over which vibration is visibly effective.

5.8 Curing

1. Concrete shall be protected during the first stage of hardening from loss of moisture and from the development of temperature differentials within the concrete sufficient to cause cracking. The methods used for curing shall not cause damage of any kind to the concrete.
2. Curing shall be continued for as long as may be necessary to achieve the above objectives but in any case for at least ten days or until the concrete is covered by later construction whichever is the shorter period.
3. The curing process shall commence as soon as the concrete is hard enough to resist damage from the process, and in the case of large areas or continuous pours shall commence on the completed section of the pour before the rest of the pour is finished.
4. Exposed concrete surfaces shall be closely covered with impermeable sheeting, properly secured to prevent its removal by wind and the development of air spaces beneath it. Joints in the sheeting shall be lapped by at least 300 mm.
5. If for some reason it is not possible to use impermeable sheeting, the Contractor shall keep the exposed surfaces continuously wet by means of a water spray or by covering with a water adsorbent material which is kept wet, unless this method conflicts with the other sub-clauses of this Clause.
6. Water used for curing shall be of the same quality as that used for mixing as stated in Clause 3.2.1.
7. If instructed by the Engineer, the Contractor shall, in addition to the curing provisions set out above provide a suitable form of shading to prevent the direct rays of the sun reaching the concrete surfaces for at least the first four days of the curing period.

8. Freshly placed concrete shall be protected from rainfall and from water running over the surface until it is sufficiently hard to resist damage from this cause.
9. No traffic shall be allowed on any concrete surface until such time as it is hard enough to resist damage by such traffic.
10. Concrete placed in the Permanent Works shall not be subjected to any structural loading until it has attained at least its minimum average strength as defined in Clause 5.3.

5.9 Records of Concreting

1. Records, in a form agreed by the Engineer, shall be kept by the Contractor of the details of every pour of concrete placed in the Permanent Works. These records shall include class of concrete, location of pour, date of pour, ambient temperature and concrete temperature at time of placing, moisture contents of aggregates, details of mixes, batch numbers, cement batch number, results of all tests undertaken, location of test cube sample points and details of any cores taken.
2. The Contractor shall supply to the Engineer four copies of these records each week covering work carried out the preceding week. In addition he shall supply to the Engineer monthly histograms of all 28 day cube strengths together with accumulative and monthly standard deviations and any other information which the Engineer may require concerning the concrete placed in the Permanent Works.

5.10 Cutting, Bending and Fixing of Reinforcement

1. The Contractor shall be responsible for preparing all bending schedules in compliance with BS 4466 (Bending dimensions and scheduling of reinforcement for concrete) and the checking of those provided from the following information that will be given on the construction drawings:
    - Required bar diameter
    - Required steel specification
    - Bar locations and plan area covered
    - Bar spacing
    - Bar cover

- Required lap length

2. The Contractor shall be responsible for determining:
    - Required number of bars
    - Required shape code
    - Required bending dimensions
    - Overall length of each bar
3. Reinforcement shown on the drawings will be that required for structural purposes only. The Contractor shall be responsible for designing all reinforcement necessary for positioning and supporting structural reinforcement (chairs, spacing bars and the like).
4. All bars shall be hot rolled deformed, unless otherwise permitted by the Engineer. Bar reinforcement shall be bundled and each bundle of steel shall be tagged with identifying tags, showing the size and mark of the bar. The bundles shall be stacked clear of the ground in easily accessible positions that do not in any way hinder the progress of work and shall be kept clean.
5. When placed in the work reinforcement shall be free from coatings or dirt, detrimental scale, paint, oil or other foreign substances. When steel has on its surface rust, loose scale and dust which is easily removable, it may be cleaned by a method approved by the Engineer.
6. All reinforcing bars, ties, links and fabric shall be fixed in the positions shown on the Drawings within the tolerances specified in BS 4466. In no case shall the cover specified on the Drawings be increased by more than 5 millimetres.
7. Displacement of reinforcement beyond the specified tolerance shall be prevented by supporting the bars sufficiently and securely fixing them together at intersections where necessary.
8. The ends of all tying wires shall be turned into the body of the concrete and not allowed to project towards the surfaces of the concrete.
9. Spacers shall be used to maintain the cover to all steel and shall be made of dense cement mortar of one part cement and two parts sand.
10. Spacers shall be rectangular in section and the flat sides shall bear against the formwork and the steel. Wire cast into the blocks to fix them to the reinforcement shall be 1.6 millimeters diameter soft annealed iron. The Engineer may approve the use of spacers made of other materials. Spacers shall not be used on the wet face of water retaining or

water excluding structures. Chairs, stools, etc. shall be used to maintain clearance between two or more layers of reinforcement.

11. The fixing of reinforcement shall be checked before and during concreting, and particular attention shall be given to the position of top steel in cantilever sections. During concrete placing a competent steel fixer shall be in attendance to adjust and correct the position of any reinforcement which may be displaced.
12. All reinforcement shall be provided in full lengths as indicated on the Drawings. Splicing of bars, except where shown on the Drawings, shall not be permitted without the written approval of the Engineer. Splices shall be staggered as far as possible. Bar reinforcement shall not be welded without the Engineer's written permission.
13. In lapped splices, the bars shall be placed in contact and wired together in such manner as to maintain a clearance between bars of not less than 50 millimetres.
14. Mesh or mar reinforcement shall overlap sufficiently to maintain a uniform strength and shall be securely fastened at ends and edges. The edge lap shall not be less than 40 diameters of the mesh reinforcement bar or two mesh widths whichever is greater.
15. Bars shall be moved ass necessary to avoid interference with other reinforcing steel, conduits or embedded items. If bars are moved a distance more than one bar diameter, the resulting arrangement of bars including additional bars necessary to meet structural requirements must be approved before concrete is placed.

5.11 Construction Joints

Where a kicker is used a rebate of not less than 5 mm and not greater than 10 mm shall be allowed on the inside face of the wall.

2. Whenever concrete is to be bonded to other concrete which has hardened, the surface of contact between the sections shall be deemed a construction joint.
3. Where construction joints are shown on the Drawings, the Contractor shall form such joints in those positions. The location of joints which the Contractor requires to make for the purpose of construction shall be subject to the agreement of the Engineer and details shall be submitted with the program of Works required by the Conditions of Contract. The exact location of all construction joints shall be submitted to the Engineer at least 28 days prior to the start of construction of the relevant part of the works.

Construction joints shall be in vertical or horizontal plans except in sloping slabs where they shall be normal to the exposed surface or elsewhere the Drawings require a different arrangement.

4. Construction joints shall be so arranged as to reduce to a minimum the effects of shrinking in the concrete after placing, and shall be placed in the most advantageous positions with regard to stresses in the structures and the desirability of staggering joints.
5. Feather edges of concrete at joints shall be avoided and any feather edges which may have formed where reinforcing bars project through a joint shall be cut back until sound concrete has been reached.
6. The intersections of horizontal or near horizontal joints and exposed faces of concrete shall appear as straight lines produced by use of a guide strip fixed to the formwork at the top of the concrete lift, or by other means acceptable to the Engineer.
7. Construction joints formed as free surfaces shall not exceed a slope of 20 per cent from the horizontal.
8. The surface of the fresh concrete in horizontal or near horizontal joints shall be thoroughly cleaned and roughened by means of high pressure water and air jets when the concrete is hard enough to withstand the treatment without the leaching of cement. The surface of vertical joints shall be similar treated if circumstances permit the removal of formwork at a suitable time.
9. Where concrete has become too hard for the above treatment to be successful, the surface whether formed or free is to be thoroughly scrabbled by mechanical means or wet sand blasted and then washed with clean water. The indentations produced by scrabbling shall be not less than 10 mm deep and shall not extend closer than 40 mm to a finished face.
10. If instructed by the Engineer the surface of the concrete shall be thoroughly brushed with a thin layer of mortar complying with Clause 3.7, all as set out in Clause 5.7 immediately prior to the deposition of fresh concrete. The mortar shall be kept just ahead of the fresh concrete being placed and the fresh layer of concrete shall be thoroughly and systematically vibrated to full depth to ensure complete bond with the adjacent layer.
11. No mortar or concrete may be placed in position on or against a construction joint until the joint has been inspected and passed by the Engineer.
12. Expansion and contraction joints are discontinuities in concrete designed to allow for thermal or other movements in the concrete.

13. Expansion joints are formed with a gap between the concrete faces to permit subsequent expansion of the concrete. Construction joints are formed to permit initial contraction of the concrete and may include provision for subsequent filling.
14. Expansion and contraction joints shall be formed in the positions and in accordance with the details shown on the Drawings or elsewhere in the Specification.

5.12 Surface Finishes Produced Without Formwork

5.12.1 Classes of Finish

Horizontal or nearly horizontal surfaces which are not cast formwork shall be finished to the class shown on the Drawings and defined hereunder:

a) U1 Finish

i) All surfaces on which no higher class is called for on the Drawings or instructed by the Engineer shall be given a U1 finish.

ii) The concrete shall be leveled and screened to produce a uniform plain or ridge surface, surplus concrete being struck off by a straightedge immediately after compaction.

b) U2 Finish

i) The surface shall first be treated as a Class U1 finish and after the concrete has hardened sufficiently, it shall be floated by hand or machine sufficient only to produce a uniform surface free from screed marks.

c) U3 Finish

i) This is hard trowelled surface for use where resistance or appearance is important, or which is subject to high velocity water flow. The surface shall be floated as for a U2 finish but to the tolerance stated below. When the moisture film has disappeared and the concrete has hardened sufficiently to prevent laitance from being worked to the surface, it shall be steel-trowelled under firm pressure to produce a dense, smooth uniform surface free from trowel marks.

5.12.2 Tolerances

a) The permissible tolerances on free surfaces shall not exceed the values given in Table 5.12.1

Table 5.12.1

Surface Tolerances (without use of formwork)

Class of Finish	Tolerance in mm		
	A	B	C
U1	Not applicable	10	+ 20 or - 10
U2	Nil	10	+ 20 or - 10
U3	Nil	5	+ 12.5 or - 7.5

Notes: The tolerances A, B and C given in the Table are defined as follows:

- A is the maximum allowed value of any sudden change of level in the surface
- B is the maximum allowed value of a gradual irregularity of the surface as indicated by the gap between the surface and a three metre long straightedge or correctly shaped template placed on the surface.
- C is the maximum allowed value of the difference in level or position between a straightedge or correctly shaped template placed on the surface and the specified level or position of that surface.

b) Where dimensional tolerances are given on the Drawings or elsewhere in the Specification they shall take precedence over those given in Table 5.12.1.

5.13 Surface Finishes Produced With Formwork

5.13.1 Classes of Finish

The surface finish to be achieved on formed concrete surfaces shall be as shown on the Drawings and defined hereunder:

a) Class F1 Finish

i) This finish is for surfaces against which backfill or further concrete will be placed. Formwork may be sawn boards, sheet metal or any other suitable material which will prevent the loss of fine material from the concrete being placed.

b) Class F2 Finish

i) This finish is for surfaces which are permanently exposed to view but where the highest standard of finish is not required. Forms to provide a Class F2 finish shall be faced with wrought thicknesses tongued and grooved boards with square edges arranged in a uniform pattern and close jointed or with suitable sheet material. The thickness of boards or sheets shall be such that there shall be no visible deflection under the pressure exerted by the concrete placed against them. Joints between boards or panels shall be horizontal and vertical unless otherwise directed. This finish shall be such as to require no general filling of surface pitting, but fins, surface discoloration and other minor defects shall be remedied by methods agreed by the Engineer.

c) Class F3 Finish

i) This finish is for surfaces which will be in contact with water and for surfaces prominently exposed to view where good appearance is of special importance. To achieve this finish, which shall be free of board marks, the formwork shall be faced with plywood complying with B.S. 1088 or equivalent material in large sheets. The sheets shall be arranged in an approved uniform pattern. Wherever possible, joints between sheets shall be arranged to coincide with architectural features or changes in direction of the surface. All joints between panels shall be vertical and horizontal unless otherwise directed. Suitable joints shall be provided between sheets to maintain accurate alignment in the plane of the sheets. Unfaced wrought boarding or standard steel panels will not be permitted for Class F3 finish. The Contractor shall ensure that the surface is protected from rust marks, spillages and stains of all kinds.

5.13.2 Curved Surfaces

a) For curved surfaces where F2, or F3 finishes are called for, the formwork face shall be built up of splines cut to make a tight surface which shall then be dressed to produce the required finish.

b) Alternatively single curvature surfaces may be faced with plastic or plywood linings attached to the backing with adhesive or with escutcheon pins driven flush. Linings shall not bulge, wrinkle or otherwise deform when subjected to temperature and moisture changes.

5.13.3 Tolerances

a) All parts of formed concrete surfaces shall be in the positions shown on the Drawings within the tolerances set out in Table 5.13.1.

Table 5.13.1

Tolerances Using Formwork

Class of Finish	**Tolerances in mm**		
	A	**B**	**C**
F1	10	10	+25 to – 10
F2	5	10	+25 to - 15
F3	2	5	+10 to - 10

Note 1: The tolerances A, B and C given in the Table are defined as follows:

- A is an abrupt irregularity in the surface due to misaligned formwork or defects in the face or the formwork.
- B is a gradual deviation from a plane surface as indicated by a straightedge 3m long. In the case of curved surfaces the straightedge shall be replaced by a correctly shaped template.
- C is the amount by which the whole or part of a concrete face is displaced from the correct position shown on the Drawings.

Note 2: All abrupt irregularities on Class F2 and F3 finishes shall be eliminated by grinding to achieve a transition of 1 in 50 between adjacent surfaces.

b) In cases where the Drawings or elsewhere in the Specification call for tolerances other than those given in Table 5.10.1, they shall take precedence.

5.14 Tolerances for Concrete Surfaces

1. Concrete surfaces in the Permanent Works shall not vary by more than the permissible amounts shown in Table 5.14.1.

Table 5.14.1

Tolerances for Concrete Surfaces, Clause 5.14 refers

Type of Structure	Dimension Measured	Tolerance (mm)			
		Finish Produced with Formwork		Finish Produced without Formwork	
		Rough (F1)	Fair/Fair worked (F2 or F3)	Screened	Wood/ Steelfloat
Buried Concrete	Position	± 25	-	± 25	-
	Alignment	± 15	-	± 15	-
	Height up to 5 m	± 25	-	± 15	-
	Thickness	± 10	-	± 10	-
	Straightness in 5 m	± 15	-	± 10	-
	Plumb per m: Limit	-	-	-	-
	Step Displacement	10	-	10	-
Ordinary Exposed Concrete	Position	± 20	± 20	± 10	± 10
	Alignment	± 10	± 10	± 10	± 3
	Height up to 5 m	± 10	± 10	-	-
	Thickness	± 10	± 5	± 5	± 5
	Straightness in 5 m	± 15	± 10	± 10	± 10
	Plumb per m :Limit	-		-	-
	Step Displacement	5	3	5	0
Exposed ** Concrete (Where mechanical plant is to be installed), Pre-cast Concrete Screeds	Position Alignment Height up to 5 m Thickness Straightness in 5 m Plumb per m: Limit Step Displacement	± 5 ± 5 ± 10 ± 10 ± 5 - 3	± 5 ± 3 ± 5 ± 5 ± 3 - 2	± 3 ± 3 - ± 5 ± 5 - 3	± 3 ± 2 - ± 5 ± 3 - 0
Measuring Devices (Flumes, Weirs etc.)	Position Alignment Straightness in 5 m Plumb per m: Limit	- - - -	± 3 ± 3 ± 2 -	- - - -	± 3 ± 3 ± 3 -

	Step Displacement	-	0	-	0

NOTES:- ** This group is intended to be used where mechanical plant bears directly on the concrete. Where plant is mounted on grouted bed shims and the like, work shall be constructed within the tolerances specified for Ordinary Exposed Concrete

5.15 Mixing Concrete

1. Before any equipment for batching, mixing, transporting, placing, compacting and finishing concrete is ordered or delivered to Site, the Contractor shall submit to the Engineer full details including drawings of all the equipment which he proposes to use and the arrangements he proposes to make.
2. Concrete for the Permanent Works shall be batched and mixed in one or more central units unless the Engineer agrees to some other arrangement.
3. Batching and mixing equipment shall be modern efficient equipment complying with the requirements of BS 1305 and capable of producing a uniform distribution of the ingredients throughout the mass. Truck mixers shall not be used unless the Engineer agrees otherwise, in which case they shall comply with the requirements of BS 4251. If the equipment proposed by the Contractor does not fall within the scope of BS 1305, it shall have been tested in accordance with BS 3963 and shall have a mixing performance within the limits of Table 6 of BSS 1305.
4. Unless the Engineer agrees otherwise, each mixing unit shall be tested for mix variability as set out in Test C7 in Appendix C before it is used to mix concrete for the Permanent Works.
5. All mixing operations shall be under the control of an experienced supervisor.
6. The aggregate storage bins shall be provided with drainage facilities arranged so that drainage water is not discharged to the weigh hoppers. Each bin shall be drawn down at least once per week and any accumulations of mud or silt removed.
7. Cement and aggregates shall be batched by weight. Water may be measured by weight or volume.
8. The weight and water dispensing mechanisms shall be maintained in good order. Their accuracy shall be maintained within the tolerance described in BS 1305 and checked against accurate weights and volumes when required by the Engineer.

9. The Weight of cement and off each size of aggregate indicated by the mechanisms employed shall be within a tolerance of plus or minus two percent of the respective weights per batch agreed by the Engineer.
10. Test shall be made by the Contractor at the intervals to be determined by the Engineer and shall be carried out in his presence. For the purpose of carrying out these tests, there shall be easy access for personnel to the weight hoppers. The Contractor shall provide the Engineer with copies of the complete results of all check tests and shall made any adjustments, repairs or replacements necessary to ensure satisfactory performance.
11. The nominal drum or pan capacity of the mixer shall not be exceeded. The turning speed and the mixing time shall be as recommended by the manufacturer, but in addition, when water is the last ingredient to be added, mixing shall continue for at least one minute after all the water has been added to the drum or pan.
12. If the Engineer has reason to doubt the adequacy of the mixing, he may order a variability test as set out in Test C7 in Appendix C and the Contractor shall forthwith carrying out such test, the results of which shall comply with the requirements shown in Appendix C.
13. The blades of pan mixers shall be maintained within the tolerances specified by the manufacturer of the mixer and the blades shall be replaced when it is no longer possible to maintain the tolerances by adjustment.
14. Mixers shall be fitted with an automatic recorder registering the number of batches discharged.
15. The water to be added to the mix shall be reduced by the amount of free water contained in the coarse and fine aggregates. This amount shall be determined by the Contractor by a method agreed by the Engineer immediately before mixing begins each day and thereafter as the Engineer directs. When the correct quantity of water, determined as set out in the Specification, has been added to the mix, no further water shall be added, either during mixing or subsequently.
16. After mixing for the required time, each batch shall be discharged completely from the mixer before any materials for the succeeding batch are introduced.
17. Mixers which have been out of use for more than 30 minutes shall be thoroughly cleaned before any fresh concrete is mixed.

18. The mixing shall continue until there is a uniform distribution of the materials and the mass is uniform in a colour and consistency, butt in no case shall the mixing be less than 1 minute for batches of up to 0.50 m^3 and 1½ minutes for larger batches after ingredients including the full amount of water are in the mixer. The engineer may permit, subject to preliminary tests, to reduce the above mixing times for high speed pan type mixers by half a minute. In addition to that the engineer has the right to increase the above minimum mixing time when the charging and mixing operations fail to produce a concrete batch through out which the ingredients are uniformly distributed and the consistency is uniform. The concrete shall also be uniform from batch to batch, except where changes in compassion & consistency are required.
19. Mixers shall be cleaned out before changing to another type of cement.

5.16 Formwork

1. All forms shall be of wood or metal and shall be built grout-tight and of sufficient rigidity to prevent distortion due to the pressure of the concrete and other loads incidental to the construction operations. Forms shall be constructed and maintained so as to prevent warping and the openings of joints due to shrinkage of the timber.
2. The forms shall be substantial and unyielding and shall be so designed that the finished concrete will conform to the proper dimensions and contours. The design of the forms shall take into account the effect of vibration of concrete as it is placed.
3. All formwork shall, unless otherwise directed, be provided with 25 mm by 25 mm angle fillets so as to form splays on internal and external angles.
4. A grout check formed from 25 millimetres square hardwood timber shall be incorporated in the formwork to provide a clean, level, horizontal joint on exposed concrete surfaces at the top of each lift.
5. All joints in the formwork shall be either horizontal or vertical. End formwork shall be square across the mass of concrete.

6. Where concrete is to be deposited to a slope steeper than 20 degrees to the horizontal, top formwork shall be used to enable the concrete to be properly compacted unless the Engineer agrees otherwise.
7. Openings for the inspection and cleaning of the inside of formwork for walls, piers and columns shall be formed in such a way that they can be closed conveniently before commencing to place concrete.

8. Form clamps, tie bolts and anchors shall be used to fasten forms. The use of wire ties to hold forms in position during placing of concrete will not be permitted. Tie bolts and clamps shall be positive in action and of sufficient strength and number to prevent spreading or springing of the forms. They shall be of such type that no metal part shall be left within the specified concrete cover. For water retaining sections, methods of fixing the forms which result in holes through the concrete section when the formwork is removed shall not be used and built-in wall ties shall be fitted with water baffles.
9. All forms for outside surfaces shall be constructed with stiff wales at right angles to the studs and all form clamps shall extend through and fasten such wales.
10. The shape, strength, rigidity, grout tightness and surface smoothness of forms which are re-used shall be maintained at all times. Any warped, bulged or otherwise damaged timber shall be replaced. Forms which are unsatisfactory shall not be re-used. If the surface finish on the formed concrete deteriorates as a result of deterioration of the faces of the forms, the Engineer shall instruct that forms be resurfaced, or discarded.
11. All forms shall be treated with approved mould or similar oil or be soaked with water immediately before placing concrete to prevent adherence of concrete. Any materials which adhere to or discolour concrete shall not be used.
12. All forms shall be set and maintained true to the line designated until the concrete is sufficiently hardened. Forms shall remain in place for periods which shall be as specified in relevant clause. When forms appear to be unsatisfactory in any way, either before or during the placing of concrete, the Engineer shall order the work stopped until the defects have been corrected.

13. All formwork shall be approved by the Engineer before concrete is placed within it. The Contractor shall, if required by the Engineer, provide copies of calculations of the strength and stability of the formwork and falsework. Notwithstanding the Engineer's approval of these calculations, the Contractor shall be held responsible for the safety and adequancy of formwork.

5.17 False work and Centering

1. Detailed plans for a false work or centering shall be supplied by the Contractor to the Engineer at least 14 days in advance of the time the Contractor begins construction of the falsework. Notwithstanding the approval of the Engineer of any designs for falsework submitted by the Contractor, the Contractor shall be solely responsible for the strength, safety and adequancy of the falsework or centering.
2. All falsework shall be designed and constructed to provide the necessary rigidity and to support the loads from the weight of green concrete and shuttering and incidental construction loads.
3. Falsework or centering shall be founded upon a solid footing safe against undermining and protected from softening. Falsework which cannot be founded on satisfactory footings shall be supported on piling which shall be spaced, driven and removed in a manner approved by the Engineer. The engineer may require the Contractor to employ screw jacks, or hard wood wedges to take up any settlement in the formwork either before or during the placing of concrete.
4. Falsework shall be set to give the finished structure the required grade and camber shown on the Drawings.

5.18 Forms for Joints

1. Where permanent or temporary joints are to be made in horizontal or inclined members, stout stopping off boards shall be securely fixed across the mould to form a water-tight joint. The form of the permanent joint shall be as shown on the Drawings.

2. Where reinforcement or waterstops pass through the face of a joint the stopping off board shall be drilled so that the bars or waterstop can pass through, or the board shall be made in sections with a half round indentaion in the joint faces for each bar so that when placed the board is neat and accurate fit and no grout leaks from the concrete through the bar holes, joints or around the water stop.

5.19 Release Agents

1. Only approved chemical release agents, mould creams (emulsions of water in oil) or oils containing a proportion of surfactant not exceeding 2 per cent will be permitted. Water soluble emulsions and oils without surfactant shall not be used. Oil based release agents shall be applied at a rate of 7 square metres per litre one day in advance of concreting, preferably by spray or roller. Chemical release agents shall be applied in accordance with the manufacturer's recommendations.
2. New timber face work shall be given three coats of release agent before use on the work to ensure uniformity of porosity on the surface.
3. On no account shall the release agent come into contact with the reinforcement.
4. Forms to surfaces to be plastered or rendered shall not be so treated, but shall be thoroughly wetted about half an hour before concreting.

5.20 Removal of Formwork

1. Formwork shall be carefully removed without shock or disturbance to the concrete. No formwork shall be removed until the concrete has gained sufficient strength to withstand safely any stresses to which it may thereby be subjected.
2. The minimum periods which shall elapse between completion of placing concrete and removal of forms are as follows and apply to ambient temperatures higher than 10^0C:
   - Beam sides, walls and columns - 1 to 2 days
   - Slab soffits - props remain undisturbed - 7 days
   - Beam soffits - props remain undisturbed- 7 days
   - Removal of slab props - 14 days

· Removal of beam props - 21 days

3. At lower temperatures or if cements other than Odinary Portland are involved, the Engineer may instruct longer periods.
4. Compliance with these requirements shall not relieve the Contractor of his obligation to delay removal of formwork until such removal can be completed without damage to the concrete.

5.21 Grouting of Pockets and Holes and Underpinning of Baseplates

1. Pockets and holding-down bolt holes shall be thoroughly cleaned out using a compressed air water jet. Holes drilled by a diamond bit shall be roughened. The pockets and holes shall be filled with grout consisting of cement and clean fresh water mixed in proportion of two parts by weight of cement to one part by weight of water. The pouring of liquid grout shall cease as soon as each hole is filled and any excess grout on the surface of the concrete foundation shall be completely removed and the surface dried off before the following operations detailed in the other sub-clauses proceed.
2. The space between the top surface of foundation concrete and the underside of baseplates shall be filled with a special mortar made up in the following proportions:
   a) Portland cement..... 50 kg
   b) Fine aggregate..... 50 kg
   c) An additive acceptable to the Engineer to counteract shrinkage in proportions recommended by the manufacturer.
3. The special mortar shall then be mixed with the lowest water-cement ratio which will result in a consistency of mix of sufficient workability to enable maximum compaction to be achieved.
4. The special mortar shall then be well rammed in horizontally below the baseplate and from one edge only until it is extruded from the other three sides. The mortar which has extruded shall then be rammed back to ensure complete support without voids.

5.22 Remedial Work to Defective Surfaces

1. If on stripping any formwork the concrete surface is found to be defective in any way, the Contractor shall make no attempt to remedy such defects prior to the Engineer's inspection and the receipt of any instructions which the Engineer may give.
2. Defective surfaces shall not be made good by plastering nor by sealing with Vandex or any other sealing compound.
3. Areas of honeycombing which the Engineer agrees may be repaired shall be cut back to sound concrete or to 75mm whichever is the greater distance. In the case of reinforced concrete the area shall be cut back to at least 25mm clear distance behind the reinforcement or to 75mm, whichever is the greater distance. The cavity shall have sides at right angles to the face of the concrete. After cleaning out with water and compressed air, a thin layer of cement grout shall be brushed on to the concrete surfaces in the cavity and it shall then be filled immediately with concrete of the same class as the main body and well vibrated/compacted with the provision of a lip to enable concrete to be placed. The form shall be filled to a point above the top edge of the cavity.
4. After seven days the lip of concrete shall be broken off and the surface ground smooth.
5. Surface irregularities which are outside the limits of tolerance set out in Clause 5.13 shall be ground down in the manner and to the extent instructed by the Engineer.
6. Defects other than those mentioned above shall be dealt with as instructed by the Engineer.

5.23 Remedial Work to Existing Structures

1. Where shown on the Drawings or instructed by the Engineer, surfaces to existing structures shall be sealed with Vandex or similar approved in accordance with the manufacturer's recommendations. For water-retaining structures, two coats shall be applied and in the case of other structures, only one coat shall be applied.

5.24 Hand Mixed Concrete

1. Concrete for structural purposes shall not be mixed by hand. Where non-structural concrete is required, hand mixing may be carried out subject to the agreement of the Engineer.
2. The mixing shall be done on a hard impermeable surface. The materials shall be turned over not less than three times dry, water shall then be sprayed on and the materials again turned over not less than three times in a wet condition and worked together until a mixture of uniform consistency is obtained.
3. For hand mixed concrete the specified quantities of cement shall be increased by 10% and not more than 0.5 cubic metre shall be mixed at one time. During windy weather efficient precautions shall be taken to prevent cement from being blown away during the process of gauging and mixing.

5.25 Non-Structural Concrete

1. Non-structural concrete (NS concrete) shall be used for non-structural purposes where shown on the Drawings.
2. NS concrete shall be composed of aggregates complying with all-in aggregate within the grading limits of Table 3 off BS 882, Clause 3.3 and the type of cements specified in Clause 3.5 or on the Drawings.
3. The weight of cement mixed with 0.3 cubic metres of combined or all-in aggregate shall not be less than 50 kg. The mix shall be proportioned by weight or by volume. The maximum aggregate size shall be 40 mm nominal.
4. The concrete shall be mixed by machine or by hand to a uniform colour and consistency before placing. The quantity of water shall not exceed that required to produce a concrete with sufficient workability to be placed and compacted where required.
5. The concrete shall be compacted by hand or by mechanical vibration.

5.26 Protection of Buried Concrete

5.26.1 Materials

a) Plastic sheeting where shown shall be polythene sheeting 250 microns minimum thickness (except where otherwise specified) to BS 743 to the approval of the Engineer. The Contractor shall provide suitable samples for approval before any concreting works shall begin.

b) All joints in the plastic meeting shall be made with an approved polythene based adhesive tape. This tape shall also be used where tailoring of the sheeting to complicated shapers is necessary, e.g. gullies, pipe ducts, etc.

c) Bitumen coating shall consist of one priming coat and one finishing coat of an approved bitumen based high build asbestos filled liquid coating.

5.26.2 Concrete in Contact with Ground

a) Where directed by the Engineer or shown on the Drawings concrete work which will placed directly against rock or soil or which will subsequently have backfill placed against it will be protected in the following way from the aggressive action of salts contained in rock, soil or groundwater:

   i) Concrete placed directly against cut-face shall be protected by a layer of plastic sheeting laid over the area to be concreted. All laps shall be at least 300 mm wide and sufficient surplus sheeting shall be left to enable a margin of at least 300 mm width to protect above the ground/concrete interface to be sealed onto the adjacent finished concrete surface with the bitumen coating. Special care shall be taken to avoid damage to the plastic sheeting during concreting.

   ii) Formed or free concrete surfaces against which backfill will subsequently be placed will be protected by the application of bitumen coating.

   iii) No protection will be applied to surfaces against which concrete will subsequently be placed, except as described in the following sub-clause.

5.26.3 Ground Floor Slabs

a) A layer of plastic sheeting will be laid over the blinding concrete and below the ground floor slab. Laps in the plastic sheeting shall not be less than 300 mm and adjacent sheets shall be securely taped down to prevent movement during

concreting operations. Care shall be taken to avoid damage to the plastic sheeting during concreting.

b) In the case of ground floor slabs no protection shall be applied to the underside of the blinding layer.

5.27 Concrete Chamfers

1. 25 mm x 25 mm chamfers shall be formed on all exposed concrete arrises unless noted otherwise on the Drawings.

5.28 Precast Concrete

5.28.1 Durability

a) Precast units required for use in exposed places, including items such as curbstones and coping liable to be affected by de-icing salts shall be made with concrete of a class not weaker than 30 Mpa and having a water/cement ratio as low as possible consistent with proper compaction.

b) The concrete shall include an air entraining admixture to provide the following air contents by volume of compacted concrete:

i) Concrete containing 40mm max. nominal size aggregate 3-5%

ii) Concrete containing 20mm max. nominal size aggregate 4-6%

iii) Concrete containing 10mm max. nominal size aggregate 6-8%

5.28.2 Dimensional Tolerances

a) Units shall be accurately formed to the dimensions shown on the Drawings and within the tolerances set out in BS 8110 unless closer tolerances are called for elsewhere in the Contract.

5.28.3 Surface Finish

a) The formed faces of precast units shall be finished to Class F3 as set out elsewhere in the Specification unless another class of finish is specified on the Drawings.

b) Free faces shall be finished to Class U2 unless another class of finish is specified elsewhere.

c) In cases where a special finish is required a trial panel shall be constructed by the Contractor which after approval by the Engineer shall be kept available for inspection at the place of casting and production units shall thereafter match the approved pattern.

d) Those parts of a unit which are to be joined to other units or to in situ concrete shall be brushed with a stiff brush before the concrete has fully hardened. Alternatively, if the concrete has been allowed to harden, the surfaces shall be roughened by sand blasting or the use of a needle gun.

5.28.4 Handling and Storage of Units

a) Precast units shall be handled in a manner which will not cause damage of any kind and shall be stored on a hard, impermeable base. Prestressed units and large precast normally reinforced units shall be handled and stored so that no stresses shall be induced in excess of those which they will incur in their final positions in the Permanent Works unless they have been designed to resist such stresses.

b) Units shall be provided with adequate lifting holes or loops, placed in the locations shown on the Drawings or agreed by the Engineer and they shall be lifted only by such holes or loops. Where it is not possible to provide holes or loops, suitable sling positions shall be indicated in paint on the units.

c) Units shall be marked indelibly with the reference number and date of casting and shall be stacked on suitable packers which will not damage the concrete or stain the surfaces. Not more than two packers shall be placed under each unit and these shall be located either at the positions of the permanent support points or in positions such that the induced stresses in the unit will be a minimum.

5.28.5 Purchased Units

a) If the Contractor proposes to purchase precast units from a supplier, he shall ensure that such units comply with the requirements of the Specification and shall carry out any tests which the Engineer may require to check compliance.

b) Units shall not be obtained from any supplier who refuses free access by the Engineer to the factory to inspect and test materials and workmanship.

5.28.6 Testing Units

a) Precast units shall be capable of safely sustaining the loads which they have been designed to carry. If instructed by the Engineer, the Contractor shall subject units

selected by the Engineer to load tests simulating the working conditions. Details of such tests shall be agreed between the Engineer and the Contractor.

b) In the case of units subject to bending loads the test piece shall be supported at full span and a loading equivalent to 1.25 times the sum of the live and dead loads which were assumed in the design shall be maintained for one hour without the appearance of any signs of distress. The recovery one hour after the removal of load shall be not less than 75 per cent of the full load deflection.

c) If the unit fails to meet the above, deflection tests shall also be carried out which, on units subject to bending, shall be as follows:

c) The unit shall be supported at full span and a load applied in increments instructed by the Engineer up to 95 per cent of the designed ultimate load. This load shall be held for fifteen minutes without failure of the unit. The deflection at the end of this period shall be not more than $1/40^{th}$ of the span. The load shall then be further increased until failure occurs.

e) If the unit fails to sustain the required load for the prescribed period or if the deflection exceeds the specified amount, the Engineer may order two further tests, and if either of these fail, the batch of units which they represent may be rejected.

5.28.7 Precast Concrete Blocks

a) Precast concrete blocks shall conform to BS 2028, 1364: 1968 Type 'A' Dense Aggregate Blocks. It shall be made in approved block making machine shall be solid or hollow, of the sizes required and shall be made in approved moulds of metal construction of sufficient strength to ensure the manufacture of blocks of even size and shape. (200 X 200 X400) mm, (150X200X400) mm, (100X200X400) mm.

b) Concrete blocks for general walling shall be of an approved size. Cutting where necessary shall be such that clean sharp arises are produced without fracture or cracking of the portion to be used. Voids in cut blocks shall be filled solid with concrete.

c) Where concrete blocks are described as 'hollow', cavities are not to exceed $^1/_3$ of the bearing surface and the material is in no case to be less than 50mm thick.

d) The face of concrete blocks to be plastered shall have a reasonably dense fair finish from molds.

e) All blocks shall be handled with care, as the use of damaged blocks will not be permitted.

5.29. Masonry Works

5.29.1. Masonry work

Masonry shall be constructed from random stones in cement mortar and shall be built to the lines and levels as shown on the drawings or as directed by the Engineer. The stone shall be sound, hard stone or rock and clean. Stone for masonry shall be taken out as nearly as possible to specified standard or directed by the Engineer. The stones shall be set in position with their natural beds as near as possible to horizontal and interstices between the stones shall be completely filled with mortar. Stones are to be selected and placed so as to keep the amount of mortar the minimum. The stone to mortar ratio shall be 60:40 with mortar mix of 1:3 or as directed by the engineer. On exposed face stones shall be a fair face showing an ever distribution of stone size. Bond stones shall be laid in staggered position. Shifting or tapping masonry after mortar has been its initial set will not be tolerated. Where adjustment must be made, the mortar shall first remove and replace with fresh mortar. All joints are to be properly filled with mortar and vertical joints shall not be continued. All stones, including exposed faces of individual stones and bond stones, shall be laid with their longest axis normal to the face of the wall in which the stones are set. Bond stones shall be provided at the rate of not less than one to every square meter of exposed face. Bond stones shall measure not less than 150mm by 150mm on the exposed face and not less than 450mm in length or the full thickness of the wall if the latter is less than 450mm. The stones shall be so handled as not to jar or displace the stones already set Plastering of masonry faces shall be made with cement mortar of appropriate mix often 1:3 and thickness as approved by the engineer. Retaining walls made of masonry have to be provided with proper drainage provisions as indicated on the drawing or otherwise specified by the engineer. The tendered rate shall include full compensation for furnishing all materials, removal of deleterious materials; ensuring a clean surface; mixing and placing the plaster; and all other work necessary for completing the work.

Masonry works measurement: Measurement will be made for the quantified volume of masonry work acceptable placed to the line, Level, grades and cross section shown on the drawing or established by the engineer. Payment made for the quantified volume of measured as provided above at the contract unit price for the masonry work shall constitute full compensation for quarrying transporting material to the site, mixing mortar and all other work related to item.

5.29.2. Hard core:

Hard core shall be of sound, hard stone or rock or hand, broken concrete, cruci form and not less than 100mm in size with the exception that sufficient binding material of smaller sizes will be permitted. Hard core for masonry bed shall not be permitted.

SECTION 6

CONSTRUCTION OF PIPELINES AND ANCILLARY WORKS

6.1 Pipeline Generally

1. The Contractor shall be responsible for setting out from information provided by the Engineer and shall include for such work in his excavation rate.
2. The Contractor shall place temporary chain age markers beside the pipe route at intervals of 100 metres and at all changes of direction. The Contractor shall maintain all the markers until the end of the Defects Liability Period and shall replace any which become displaced or are destroyed.
3. Prior to laying a section of pipeline sight rails shall be erected at each end and at each change in grade and direction with a maximum distance apart of 100 metres. Sight rails and boning rods shall be of substantial construction and shall be painted black and white in such a manner as to indicate clearly the lines and levels to be worked to. The Contractor shall include the cost of this work in his excavation rates.

6.2 Pipe Bedding and Surround

1. Pipes are to be laid, where directed, on a bed formed with approved selected material carefully and thoroughly compacted over the trench formation. The Compaction Fraction valve shall be determined in accordance with Test C9 of this Specification of this Specification.
2. The trench bottom shall be backfilled to the levels indicated on the Drawings with approved selected bedding material thoroughly compacted in 150 mm layers. As a result the trench shall be smooth and free from stones, large dirt, and any solid material. Should suitable material not be available from the particular excavation material, the Contractor will utilise material from other sections of trench or works, or find a source of suitable material.
3. Compaction shall be by hand using hand rammers of at least 7 kg weight or with approved mechanical equipment.
4. Approved selected bedding material shall be well graded granular material free from organic matter and with 100% passing through a 16 mm sieve and 90% passing through a 8 mm sieve.

6.3 Pipeline Setting Out and Alignment

1. All pipeline alignments given on the Drawings are indicative only and shall be finalized on site to the approval of the Engineer.
2. Wherever possible pipelines shall be laid along the edges of existing or proposed roads and tracks and interference with existing services shall be minimized.
3. Where pipelines are to be laid along the routes of future roads as indicated on the town master plan, the Contractor shall request the Engineer to confirm the route prior to the commencement of detailed setting out.
4. Setting out of transmission mains is indicated on the Drawings in terms of the angle of rotation at each survey station.
5. The locations of pipe bends are indicated on the Drawings. Where a pipeline changes direction but no bend is shown, the pipeline shall be laid to a curve by deflecting the pipe at each joint. The maximum deflection shall not exceed three quarters of that permitted by the manufacturer.
6. The pipes shall be placed in position true to profile and direction of slope be placed on longitudinal sections on ascending grades from washouts to air valves. Such grades shall not be less than 1 in 500 and sight rails shall be set up at all changes of grades where the gradient is less than 1 in 200.
7. No pipe shall be laid in outlet trench conditions that preclude proper bedding or when, in the opinion of the Engineer, the trench conditions or the weather are unsuitable for proper installation.
8. Where a change of pipe direction cannot be made by deflection, the curve shall be made by appropriate bend fittings.
9. No extra payment will be made to the contractor on account of changes in angular deflection or of bends in addition to those shown on the drawings, if ordered by the Engineer, save for the cost of additional bends and thrust necessitated thereby.

6.4 Concrete Protection

1. Where required by the Drawings or instructed by the Engineer or where the required minimum cover to the pipeline cannot be achieved, the Contractor shall provide a concrete surround in accordance with the details shown on the drawings. The bottom of the trench shall be free of

any loose material or debris and graded so that the minimum dimension stated on the Drawings is maintained between the trench bottom and the barrel of the pipe.

6.5 Pipe Jointing Generally

1. after the excavations of a section of pipe trench has been completed by the Contractor, it shall be inspected and approved by the Engineer. The Contractor shall then place and thoroughly compact an approved bedding material over the trench formation, after which it shall be inspected and approved by the Engineer. Just before pipe laying, the trench shall be cleaned of all stone, soil and other debris that might have fallen therein. The pipes shall then be laid upon the bed with the bed being shaped to ensure uniform bearing of the whole length of the pipe which shall include a depression being made in the bed to accommodate each pipe joint. In laying a non-pressure pipe, the work shall commence at the lower end and proceed uphill.
2. All pipes and fittings shall be examined for flaws, cracks, or any other damage immediately prior to laying, and any defective pipe or fitting shall be rejected and marked with a yellow cross in gloss paint to avoid, by accident, its incorporation into the Works at a later date.
3. If the Engineer deems the defective pipe as being suitable for use, the defective pipe shall be cut back at least 150mm beyond any visible flaw and prepared for jointing. In the event of the Contractor opting to salvage pipes in this manner, he shall do so at his own expense and carry out individual testing of the pipes so salvaged outside the trench prior to laying. The foregoing shall all be in accordance with the Manufacturer's instructions and subject to the written approval of the Engineer.
4. All pipe laying and jointing shall be carried out by experienced pipe layers, well skilled in their work, to the grades, levels and lines shown on the Drawings.
5. For potable water gravity mains, pumping mains and distribution mains no pipe shall deviate from line by more than ±200mm, nor by more than ±5mm from level.
6. For gravity sewer pipelines, no invert level shall deviate by more than ±5mm between manholes, and no horizontal alignment shall deviate by more than ±10mm between manholes.
7. Immediately before being laid, each pipe and fitting shall be carefully examined, and all dust, dirt and foreign matter must be removed from the inside. Care shall be taken to ensure that each pipe and fitting remains clean during the laying. The use of a badger will be ordered by the Engineer, if, in his opinion, dirt is not being satisfactorily excluded. The

badger, on a sound rope, is to remain within the bore of the pipe previously laid and jointed and it is to be drawn forward as the work proceeds throughout the whole length of the pipelines all at the Contractor's expense The badger used is to be soft material which will not damage the internal surface of the pipes.

8. Pipes shall mate concentrically with the next to preserve a true and uniform invert. Pipes shall be uniformly bedded and shall not be allowed to rest on the joints or on hard objects in the bottom of the trench.
9. After bedding to the correct line and level, pipes shall be jointed. The joints shall be those recommended and supplied by the various manufacturers for each class and type of pipe and the method of jointing including expansion gaps between pipes shall be strictly in accordance with the manufacturer's instructions.
10. Jointing rings and the ends of pipes must be completely free of dirt and grit when the joints are being assembled.
11. Where recommended by the manufacturer, approved non-toxic lubricant shall be applied evenly over the entire surface of the pipe end and for a distance of 75 mm back to a thickness similar to a brush coat of enamel. The lubricant supplied shall be used directly from the container and shall not be thinned.
12. Due regard must be given to the thermal expansion of pipelines and where recommended by the manufacturer, or directed by the Engineer, a gap shall be left between adjacent pipe ends when each joint is made. The method of obtaining the required gap shall be determined according to the type of proprietary joint supplied, as indicated by the manufacturer.
13. If any solvent is spilt onto any pipes or fittings these may be rejected by the Engineer. If any solvent is spilt into the trench, it should be flushed away to avoid damage to the pipes.
14. For the insertion of valves and other fittings and where required, pipes shall be cut and prepared for use as necessary using approved tools and machines suitable for this purpose. Such tools and machines shall be provided by the Contractor and kept available at all times during pipe laying.
15. Particular attention shall be paid by the Contractor to the avoidance of causing damage to any protective coatings during laying and jointing operations. Any damage thereto shall be rectified immediately in accordance with the manufacturer's recommendations and to the Engineer's entire satisfaction.
16. Screwed joints on galvanized steel pipes and fittings shall be properly cut and fully screwed home, using approved jointing compound.

17. Flanged joints in cast iron or steel pipes and fittings shall have a rubber insertion ring, fitted without twist or distortion. The flanges shall be drawn uniformly together with the bolts fully tightened. No bolts shall be omitted. After jointing, the assembly shall be protected against corrosion with "Denso" paste, "Denso"-tape and polythene sheeting, or similar approved wrapping, which shall be installed in accordance with the manufacturer's written instructions and to the approval of the Engineer.
18. HDPE Pipes shall be butt-weld jointing for OD >75mm. other lesser diameter pipe jointing shall be as per the engineer decisions. Additional care should be taken to ensure that there is no ingress of soil, sand, stones, water, concrete, cement nor other extraneous material during the laying of pipes and suitable caps or plugs should be used, to cover open ends in the event of a prolonged interruption and on completion of each day's laying. The plugs shall be of the screw-up expanding type or of close fitting tapered wood.
19. Pipes having integral sockets shall be laid with the sockets facing up-stream unless otherwise agreed or instructed by the Engineer.
20. No more than 2 km of untested pipe shall be laid at any one time.
21. Before pipes are jointed they shall be thoroughly cleaned of all earth lumps, stones or any other objects that may have entered the interior of the pipe.

6.5.1 Limitation in Lengthen of Open Trench

The following limitations for lengths of open trenched shall rule for a pipeline hard in one continuous reach unless otherwise directed by the Engineer, and subject to any more stringent requirements imposed by the competent authorities.

a) Not more than 100 m of trench in built-up areas and/or 300 m elsewhere, shall be opened in advance of pipe laying
b) Not more than 300 m of pipe line shall be left un covered after pipe laying in a built-up areas and not more than 600 m elsewhere.

If these lengths of open trench are exceeded or if, in the opinion of the Engineer, there is un due delay in:

a) Testing the pipe line
b) Removing surplus material
c) General tidying-up off areas where pipes have been laid
d) Partial restoration or maintenance of surface.

The engineer may order that no further trenches shall be opened until the outstanding work has been carried out to his satisfaction and the contractor shall have no grounding for claims against the employer on this account

6.6 Supply, Transportation and Handling of Pipes

1. On delivery to the Site, pipes shall be carefully inspected for damaged ends, defects and any found to be faulty shall be marked and set aside for a decision from the Engineer as to their acceptability. Any pipes delivered with cracks or other equivalent defects will be rejected and the Contractor shall remove from the Site.
2. Pipes with damaged ends shall be either completely replaced or have the ends cut off and trimmed at the discretion of the Engineer. They shall be cut to approve standard lengths.
3. The Contractor shall ensure that all pipes are properly handled both by his staff and by any cartage contractor employed by him. During transport, pipes shall not be allowed to rest on narrow cross-members on vehicles or anything else that might give concentrated loads due to the weight of the pipe or bumping of the vehicle, but shall be properly supported on soft material. Sufficient labour and equipment shall be on hand before loading and unloading is commenced and under no circumstances shall any material be dropped from a vehicle. Any materials which have been dropped from a vehicle shall immediately be rejected for use on the Works. The same shall apply for any pipes found defective prior to laying.
4. The handling of any pipes exceeding 200 kg weight other than by means of a crane is specifically forbidden. The Contractor shall maintain a suitable mobile crane on the Site and shall use it for all loading, unloading, transferring between vehicles and lowering into the trench of such pipes. The crane shall be fitted with a sling of ample width. Wire rope slings or hooks in the ends of pipes shall not be used for pipes or fittings of any diameter or weight.
5. All fiber cement pipes will be tested by the manufacturer to the test pressure required by the class of pipe. Mishandling can cause latent defects which may result in fracture or blowout during site-testing or when in service. The Contractor shall be fully responsible for replacing immediately at his own expense any pipes failing from this cause.
6. The Engineer shall have the right to reject consignments or stocks of piping from which failed pipes have been drawn, or order them to be pressure-tested outside the pipelines, even though no defects are apparent, if there is reason to believe that mishandling has taken place.

7. The Contractor shall be wholly responsible for the acceptance from the supplier of all pipes and fittings ordered by the Employer, or Contractor.
8. After acceptance, full responsibility for the storage, handling, transporting, etc of the pipes and fittings shall rest with the Contractor, and any pipes and fittings subsequently found to be defective in any way shall be replaced by the Contractor at his own expense.
9. All materials ordered by the Employer shall remain the property of the Employer at all times, and whilst these materials are in the possession of the Contractor the Contractor shall insure the materials as though they were of his own supply.
10. The cutting of whole pipe lengths for use in closing sections of pipework will not be permitted except with the express approval of the Engineer. Previously cut lengths, which shall be stored separately shall be used, whenever possible, for closing sections. All cuts and the preparation of the ends shall be made strictly in a accordance with the Manufacturer's recommendations.
11. All materials ordered by the Employer shall be used under the direction of the Engineer.
12. Any surplus materials ordered by the Employer shall be transported to the Employer's store at the end of the Contract, or when directed by the Engineer.

6.7 Deviations at Joints

1. Where a pipeline is laid to a curve by changing direction at joints the maximum deflection at each joint shall not exceed the following:
   a) for any type of flexible joint, three quarters of the maximum permissible deflection stated by the manufacturer;
   b) for run lead joints in spigot and socket pipes, a deviation which will reduce the clearance between the barrel and the socket to 6mm or the permissible deflection stated by the manufacturer whichever is the less;
   c) for welded joints in steel pipelines, the deflection shown on the Drawings. The ends of the pipes shall be cut to suit.
2. No deviations shall be made at flanged or solvent welded joints.

6.8 Painting of Pipe Work in Chambers

1. All metal surfaces within chambers shall be mechanically wire brushed to remove all loose scale, grease etc. Within two hours of cleaning a primer shall be applied, followed after two

hours by a first coat of heavy consistency bitumen paint all to the approval of the Engineer. A second coat of the heavy consistency paint shall be applied after 24 hours. The final coating thickness shall not be less than 250 microns.

2. Preparation and application of the coating system shall be strictly in accordance with the Manufacturer's instructions.
3. This clause shall not be applied to chemically or thermally bonded coatings on steel pipes.

6.9 Storage of Pipes

1. Prior to undertaking any work, the Contractor shall submit to the Engineer, for his written approval, his proposals for the storage of pipes and all fittings thereto.
2. Such proposals shall ensure that all pipes are properly stored on Site in accordance with the manufacturer's recommendations. During storage, pipes shall not be allowed to rest on narrow cross-members or uneven ground or anything else that might give concentrated loads due to the weight of the stacked pipes, but shall be properly supported on soft material.
3. All uPVC pipes and fittings shall be continuously protected during storage by covering them at all times with light gauge pale blue polythene sheeting or similar approved material to prevent UV degradation. The height and method of pipe stacking shall be in accordance with the Manufacturer's recommendations and such that excessive deformation of the lower pipes is avoided.
4. All couplings rings shall be stored lying flat and particular care shall be taken to prevent damage to the internal face of the ring or the spigot ends of the pipes which may affect the sealing of the coupling.
5. All rubber jointing rings and gaskets shall be stored in a cool dry place away from grease, oil and direct sunlight until required.
6. All pipework shall be kept well away from possible contamination sources e.g. on site diesel storage.

6.10 Pipe Anchor and Thrust Blocks

1. Pipe anchor and thrust blocks, as shown on the Drawings or directed by the Engineer, shall be constructed on pipelines at all valves and fittings (crosses, tees, bends cups, plugs reducers and slopes greater than 1 in 4.

2. The Contractor shall ensure that each one is built firmly into the undisturbed bottom and sides of the trench and that the ground is solid and has not been weakened by blasting or softened by water from leakage or other causes. The blocks shall be of concrete Class B15 and shall have been completed and hardened and cured for at least seven days before testing of the pipelines.
3. Anchor blocks will be measured per cubic metre of concrete required in accordance with the Drawings and the rate shall include for all excavation, rough shuttering and screeding of surfaces.
4. Care shall be to ensure that concrete for thrust blocking does not interfere with the operation of flange bolts and nuts or prevent proper operation of valves.

6.11 Connections to Existing Pipelines

1. The Contractor shall give the Engineer at least ten days' notice of the date after which he will be ready to make a connection to an existing pipeline. The Engineer shall notify the Contractor, in writing of the date that the connection shall be made. The date notified shall normally be within seven days of the date which the Contractor will be ready to make the connection. All branches, valves, connectors, materials and tools for cutting and preparing the pipe and making the connections shall be ready before any work is done on the pipe. The nearest sectional valves shall then be shut off, the pipe drained and the connections made, all as expeditiously as possible to minimise disruption of use of the pipeline. The pipeline shall then be refilled slowly while the connections are checked carefully for satisfactory operation and any remedial works shall be undertaken immediately.

6.12 Fixing of Valves

1. Valves shall be securely fixed with a spindle in a vertical position, unless otherwise stated. They shall be checked for ease of operation and water-tightness. Spindles shall be supported at intervals recommended by the valve manufacturers, but in any case at not less than 1,500 mm intervals.
2. Before each valve is put into service, all gears, bearings and spindles shall be oiled with an approved oil, as recommended by the manufacturer. No deleterious matter shall be allowed to come into contact with the working faces, and oil sumps shall be maintained clean.

3. Every stuffing box shall be examined when the main is charged with water, and leaking boxes shall be adjusted or repacked with square plaited lubricated hemp packing of approved manufacture. The stuffing box shall not be packed so tightly as to materially affect the friction of the packing on the spindle.
4. No air valve shall be stored in the sunlight, or upside down to expose the balls and air cavities. Air valves shall be checked before the main is charged to ensure that the balls and faces are not scored or split, and that there is no dirt or deleterious material in the cavities of the body. All air nozzles should be checked to see they are clear.
5. All valves shall be installed with a suitable dismantling joint to enable the valve to be removed from the pipeline. The clear gap provided by the joint shall be not less than 15 mm.

6.13 Valve Chambers

1. Chambers and/or surface boxes for gate valves, air valves, hydrants and washouts shall be constructed to the details shown on the Drawings and in the positions shown on the Drawings or as directed by the Engineer.
2. Step irons conforming to BS 1247 shall be built into the walls of chambers to which permanent access is provided, as the work proceeds.
3. Ladders may be used in place of step irons if agreed with the Engineer.
4. Covers and frames shall be provided as shown on the Drawings. The tops of the covers shall be flush at all points with the surrounding surface of paved areas or as directed in unpaved areas. Any slight adjustment of the slab level which may be necessary to accomplish this shall be effected by topping the side walls with concrete.
5. Where any pipes are built into concrete or blockwork the pipe shall be surrounded in two layers of polythene sheeting unless a puddle flange has been shown on the Drawings.

6.14 Manhole Covers, Step Irons and Ladders

1. Manhole covers and valve surface boxes shall comply with BS 497, or BS 1426 and be to the approval of the Engineer. Manhole covers shall be of medium duty, double seal type equipment or as shown on the Drawings, and shall be lockable and be supplied with padlocks of a type approved by the Engineer, all operable with a master key.

2. Manhole covers and frames, valve surface boxes and fire hydrant covers shall be painted after installation with bitumen paint in accordance with Clause 6.8 of this section of the Specification.
3. Step rails shall be constructed of 16 mm diameter bars as indicated on the Drawings. Step rails shall be spaced at 300 mm centres.
4. Permanent ladders shall be of galvanised mild steel and shall be in accordance with BS 4211. Rungs shall be 20mm diameter solid round bar and shall be at 300mm centres. Stringers shall be 65mm x 10mm strip set 300mm aprt, shall extend 1.0m above the top rung and shall be turned out at the bottom and drilled for 12mm stainless steel holding down bolts. Intermediate and top support stays shall be 100mm x 10mm strip, bolted to the stringers with 12mm galvanised bolts and shall be of a length that will give a minimum clearance of 200mm behind the rungs. Support stays shall have a maximum spacing of 2.5m.
5. Ladders exceeding 4.0m height shall be equipped with a safety cage consisting of hoops of 50 mm x 8 mm strip bent to a diameter of 0.76m, fixed to the stringers at 0.55m centres and joined by one additional stringer of 50mm x 8mm strip at the maximum distance from the rungs.

6.14.1 Valve Boxes

Each valve shall be provide with a valve box which shall be installed plumb and centered over the key nut of the valve. The valve shall be set such that traffic loads are not transmitted to the valve. Valve box covers shall be set flush with the existing road surface or as instructed by the Engineer. Valve boxes shall provide for adjustment of the cover to a level 200 mm higher or 200 mm lower than the installed level for future adjustment of the road or ground surface. The surface box shall be supported in place by a precast concrete block to prevent displacement on settlement of backfill as shown on the construction standard drawing. The backfill around the box shall be compacted to prevent the settlement and displacement by traffic. In un travelled surfaces, stone masonry shall be constructed around the surface box to prevent its removal.

6.14.2 Hydrants

Hydrants shall be installed as shown on the drawing and shall be located as directed by the Engineer. The hydrant shall not be less than 500 mm from the gutter surface of the curb or the edge of the road.

Hydrants shall be set plumb. Hydrants shall be s et with the connector 100 mm below finished ground or side walk surface unless otherwise directed by the Engineer. The cover box shall be installed flush with the surrounding ground or directed by the Engineer. Care shall be in installing the connection pipe from the main to the hydrant to ensure that the hydrant is set at the specified level.

6.14.3 Air Valve and Chambers

Air valves shall be installed on the high points of water supply and transmission pipelines as shown on the drawings and where ordered by the Engineer. Connections shall be made to the top of the pipe line as shown on the construction standards. Complete with isolating valve, blow-off piping and fittings.

6.14.4 Public fountain

Additional public fountains shall be constructed as shown in the drawings at the locations directed by the Engineer.

6.15 Manholes

6.15.1 General Requirements

a) Manholes shall be constructed to the sizes and levels and of the materials indicated on the Drawings, taking into account also the requirements of this Clause. Ladders, step irons and other fixtures shall be in accordance with Clause 6.15 or as detailed on the Drawings.

b) Unless otherwise agreed by the Engineer, manholes shall be constructed after pipes have been laid, except that bases may be constructed earlier to avoid deterioration of the formation.

c) Backfilling around completed manholes shall be with suitable material deposited equally all round and compacted in layers not exceeding 300mm.

6.15.2 Manhole Bases

a) Precast bases shall be carefully set and levelled on a sub-base of 150mm of compacted granular bedding.

b) In situ concrete bases shall be cast on a firm formation from which soft areas have been removed. If the base includes reinforcement, a preliminary blinding layer of concrete 50mm thick shall be placed.

6.15.3 Brick Manholes

a) Bricks for manholes shall be either an engineering class brick or a sound hard low permeability brick complying with BS 3921 and approved by the Engineer.

b) Bricks shall be laid on a full bed of 1:3 cement/sand mortar and all cross joints shall be filled. Bricks shall be laid with frogs up. Joints on the inside faces shall be flush pointed as the work proceeds unless the faces are to be rendered in which case the joints shall be raked out to a depth of five millimetres. Rendering shall consist of 1:2 cement/sand mortar applied to the thickness shown on the Drawings.

6.15.4 In Situ Concrete Manholes

a) Formwork for interior faces shall Class F2. Exterior faces may be cast against formwork or against natural ground. In-situ concrete manholes shall be constructed generally in accordance with Section 5 of this Specification.

6.15.5 Manhole Covers and Frames

a) Covers and frames shall be the type, size and weight shown on the Drawings. Frames shall be set in 1:3 cement/sand mortar to the levels indicated on the Drawings. Level differences shall be made up by not more than three courses of brickwork between the frame and the roof of the manhole or shaft.

b) Care shall be taken to see that frames do not suffer any distortion and that the cover will seat without any rocking.

6.15.6 Testing Manholes

a) All pipes leading into a manhole shall be effectively plugged and the manhole shall then be filled with water to the top or to 1.5m above the highest pipe soft whichever is the less.

b) If the water level drops by more than 25mm in thirty minutes, the Contractor shall search for, repair the leak and then repeat the test.

6.16 Sealing of Cable Ducts

1. As shown on the Drawings or directed by the Engineer, cable ducts and similar openings into buildings or structures are to be sealed with a combination of expandable foam and outer sealant to prevent the ingress of water or vermin into such buildings and structures.
2. Surfaces for treatment shall be clean and grease free and porous surfaces shall be sprayed with water to ensure full curing of the expandable foam.
3. Expandable foam shall be applied and allowed to be cured in accordance with the manufacturer's recommendations.

4. Any accidental spraying of existing or new Plant with expandable foam shall be cleaned using Acetone or Tangit Cleaner, in accordance with the manufacturer's recommendations and all at the Contractor's expense.
5. Health precautions shall be taken during the application of the expandable foam in accordance with the manufacturer's recommendations.
6. After the expandable foam has cured, an outer sealant is to be applied to the exposed surfaces of the plug formed by such foam. The sealant shall be a silicone based building sealant.

Section 7

Technical Specification for Pipes, Fittings and Accessories Supply

7.1. GENERAL

7.1.1. SCOPE

This specification refers to pipes and appurtenant fittings for water supply and distribution pipelines. Unless noted otherwise, these materials will be supplied under Contract: Goods - Supply of Pipes and Fittings. The contract comprises the design, manufacture, inspection and works testing, supply and delivery to site of pipes, fittings, specials valves and water meters and installation of them.

A general description of the Works is given in Section 3.

7.1.2. STANDARDS

All material shall comply with the appropriate ISO or British Standard. Where an alternative specification to those from such standards and recommendations are to be use, these will be specifically referred to hereinafter. The materials shall be compatible and interchangeable with each other without the use of special adapters.

All work carried out under this Contract shall comply with the latest requirements of any duly constituted authorities having jurisdiction over the work.

All references to such standards shall be to the latest edition or revision thereof unless otherwise stated. Where a specific British or other Standard is referred to in this Specification, another Standard will be acceptable provided that it ensures an equal or higher quality of material and workmanship than the standard referred to at no extra cost to the Employer. If the Contractor intends to use such alternative Standard, he shall notify the Engineer thereof, submitting with his notice two copies (in English), of the proposed Standard and shall not order any material or perform any work unless and until he had obtained the Engineer's approval of such Standard.

All materials and equipment shall be to the approval of the Engineer.

The names of the manufacturers of materials and equipment, together with certified test reports and other significant information pertaining to the same, shall be furnished when requested for consideration by the Engineer, who shall have power to reject any parts that in his opinion are unsatisfactory or not in compliance with the Specification. Such parts shall be replaced by the Contractor at no extra cost the Employer.

All materials and equipment shall be the most suitable for the purpose specified and shall be new and of first class quality, free from imperfections and selected for long life and minimum maintenance.

No secondhand materials whatsoever will be acceptable. The Contract may be required to produce certified invoices.

All articles and materials specified to conform to British or other standards shall be clearly and indelibly marked with the appropriate standard number specified, except where marking is impractical when the relevant advice/delivery notes shall include the British or other standard number with which they are to comply.

7.1.3. Design, Standardization and Submittals

The Contractor shall be responsible for the design and submission of calculations for all Plant in respect of strength and for the selection of appropriate lengths of flanged pipes to form vertical stacks.

The Contractor's design shall be subject to the approval of the Engineer, which approval shall not in any way affect the Contractor's responsibilities.

The Plant shall be designed on the basis that all welds are made at the manufacturers' works.

Manufacturer's data shall be submitted for all materials specified in this section. The submittal shall be in accordance with the specifications in this document.

7.1.4. Ambient Conditions

All materials shall be suitable for the climatic conditions prevailing at the Site. These conditions are indicated in this Specification.

7.1.5. Data Schedules of Technical Information

The Contractor shall complete all the Data Schedules of technical information contained in the Tender Document particularly any departure or deviation from the Specification and names of manufacturers of the Plant. Should he fail to do so, then the Tender may be liable to rejection.

7.1.6. Copies of Orders

Copies of all orders for all Plant items, materials and sub-contract works placed with suppliers and sub-contractors shall be provided in triplicate to the Engineer. The orders shall give or shall be accompanied by full details of the material, plant or work ordered.

Copies of all orders shall be provided in the English language or with an English translation where the actual order is placed in any other language.

7.1.7. MATERIALS TESTING

Testing services by independent testing laboratories for manufactured goods shall be appointed by the Owner and test specimens may be selected by the Engineer either at the place of manufacture or at the job site and shall be delivered to the testing laboratory by the Contractor. The number of pipes and fittings specimens to be tested shall not normally exceed 0.5% of the number of pieces to be supplied to the site. However, where initial testing indicates inadequacies in the materials additional testing may be required. The expenditure for testing is covered by the supplier. As and when any Plant shall have passed the tests referred to in this clause, the Engineer shall issue to the Contractor a notification to that effect. On delivery to Installation Site, the Plant will be visually inspected, and any Plant with obvious defects will be rejected.

7.1.8. Packing, Transport and Storage of Materials and Plants

Before dispatch from the manufacturer's works the Plant and equipment shall be thoroughly cleaned, protected against damage, deterioration, corrosion and ingress of dirt. The packing shall be suitable for transport by sea, prolonged exposure to a hot atmosphere and storage on Site.

All packages shall be clearly and conspicuously marked with the Contractor's identification mark and the Employer's reference mark.

All separate component parts of the Plant shall be identified by metal tags tied by wire and referenced to drawings, installation instructions, packing lists, etc. Details of the referencing system shall be submitted to the Engineer for approval.

All items shall be adequately protected from damage and deterioration at all times, including the period of storage at the Site.

All wooden cases and support timbers within cases shall be proofed with suitable anti-termite solution. Straw or similar organic materials shall not be used for packing.

7.1.9. Reference Documents

The following documents are referred to in this Specification shall apply.

ISO 2531		Ductile iron pipes, fittings and accessories for pressure pipeli
ISO 4179		Centrifugal applied cement mortar lining.
ISO 4633		Joint gaskets; material specifications
ISO 8179		External zinc coating
BS 21		Specification for pipe threads for tubes and fittings wher pressure-tight joints are made on threads (metric dimensions)
BS 143/1256		Specification for malleable cast iron and cast copper alloy threaded pipe fittings
BS 1387	1985(1990)	Specification for screw and socketed steel tubes and tabular a for plain end steel suitable for welding or for screwing to BS pipe threads.
BS 1452	1990	Specification for flake graphite cast iron
BS 2494	1990	Specification for elastomeric seals for joints in pipe work and pipelines.
BS 2789	1985	Specification for spheroidal graphite or nodular graphite cast iron
BS 3505	1986	Specification for unplasticised polyvinyl chloride (u-PVC)pressure pipes for cold potable water
BS 4190	1967	Specification for ISO metric black hexagon bolts, screws and nuts.
BS 4346		Joints and fittings for use with unplasticised PVC pressure pi
Part 2	1970	Mechanical joints and fittings, principally of unplasticised PV
BS 4504		Circular flanges for pipes, valves and fittings (PN designated)
Part 3		Steel, cast iron, and copper alloy flanges
Sec 3.2	1989	Specification for cast iron flanges
BS 4772	1988	Specification for ductile iron pipe and fittings
BS 4865		Dimensions of gaskets for pipe flanges to BS 4504
Part 1	1989	Specification for non metallic flat gaskets (including gaskets flanges to BS4772)
BS 5153	1974(1991)	Specification for cast iron check valves
BS 5155	1984(1991)	Specification for butterfly valves

BS 5156	1985(1991)	Specification for diaphragm valves
BS 5163	1986(1991)	Specification for predominantly key operated cast iron gate valves for waterworks purposes
BS 5728		Measurement of flow of cold potable water in closed conduit
Part 1	1979(1987)	Specification for single meters
Part 2	1980(1988)	Specification for installation requirements for single meters

7.1.10. Manufacturer's Manuals and Catalogues

The Contractor shall deliver 5 copies of all relevant manufacturers manuals and catalogues to the Engineer within 14 days of the Commencement Date.

7.2. Ductile Iron Pipe Work

Ductile iron or equivalent ferrous pipes and fittings shall be in accordance with the following:-

ISO 2531:1998 "Ductile iron pipes, fittings and accessories for pressure main Lines".

Material: - All pipes and fittings should manufacture from Spheroidal Graphite (S.G) Irons complying ISO 2531.The dimensions portions and numbers of bolt holes should be in International Standards, to allow interconnection of all types of fittings, pumps, valves or other accessories. Bolts hole, pitch circles, flange dimensions should comply ISO 2531 Nuts and bolts to ISO 4014 & ISO 4032. For pipes and fittings of 600mm diameter and less, flexible joints shall be of the "Tyton" spigot and socket type unless otherwise indicated. For pipes and fittings of 700mm diameter and above, the type of spigot and socket flexible joint shall be subject to the approval of the Engineer. All spun ductile iron pipes shall be Class K9. All standard branched fittings shall be Class K14. All other standard fittings shall be Class K12.All puddle flanges shall be of the thrust resisting type. All ductile iron pipes and fittings shall receive a centrifugal cement mortar lining in accordance with ISO 4179, and an external surface finish in accordance with ISO 8179 comprising a sprayed Zinc coating to give a coverage of 130 g/m^2, followed by a bituminous varnish of 70 micron minimum dry film thickness.

All ductile iron pipes, fittings and specials with flexible joints or self-anchored flexible joints shall be supplied with all necessary jointing materials, including lubricating paste, for use with pipes conveying potable water. Material specification for joint gasket should comply with ISO 4633. Self-anchored flexible joints shall be of the spigot and socket type, but the joint shall be tied together to prevent longitudinal movement. The joint shall permit as per the following table.

Angular deflection

DN	Permissible laid deflection Degrees	Pipe end displacement cm	Length of pipe m
50 to 150	5°	52	6

7.3. HDPE PIPE AND FITTINGS

7.3.2. General

All pipe and fittings shall be designed and manufactured for working pressure of greater than 10.0 kg/cm^2 unless otherwise specified.

HDPE pipes and fittings of specified PN shall comply with Ethiopian Standard ES ISO 4427:2005 (identical with ISO 4427:1996).

Moreover, The HDPE Pipes should comply with the following standards or equivalent:

The pipes are manufactured from polyethylene containing only those anti-oxidants, UV stabilizers and pigments necessary for the manufacturing of pipes conforming to the required specification. The pipes manufactured for drinking water are black color. For these pipes the carbon black content in the compound is prepared in accordance with ISO 6964 or equivalent which meets 2.25 or 0.25% by mass.

Applicable up to 16 bars

- Suitable for cold water supplies & and manufactured as per ISO **4427** or equivalent.
- The dimensions and tolerance of the pipes are in accordance with **ISO 3126** or equivalent, ISO **161-1** or equivalent and **ISO 11922-1** or equivalent.
- Made from first quality virgin material Containing antioxidants, UV stabilizers, and pigments & very suitable for cold water Supplies.
- Non- toxic, non-contaminating & completely resistant to Corrosive & aggressive soils & water.
- Black in color. The Carbon Black content in the compound is 2.25 or 0.25 % by mass in accordance to **ISO 6964** or equivalent.

The Outside diameters, Nominal pressures & Wall thicknesses

- Dimensions of pipes are measured in accordance with ISO 3126 or equivalent.
- Nominal outside diameters conform to ISO 161-1 or equivalent. The selected nominal outside diameters & the wall thickness is in accordance with the selected nominal pressures.
- The tolerances on the outside diameters are manufactured in accordance with ISO 11922-1 or equivalent.
- The nominal wall thicknesses is in accordance with ISO 4065 or equivalent (however, for reason of jointing techniques the smallest wall thickness is limited to 2.3 mm) corresponding to the selected nominal pressures given in tables above.
- The tolerance on the minimum wall thickness permitted at any point i.e. min. corresponding to the nominal wall thickness is conforming to ISO 11922-1 or equivalent.

7.3.2. Length of pipes

The length of a pipe shall be limited:

- For diameters 20mm - 63mm coil length -100m
- For diameters greater than 63mm up to 90mm coil length can be provided with 50m, 65m, and 75m depending on nominal pressure.
- For diameters greater than 90mm up to 300mm it is provided with pipe section of 6m & 9m length.

7.3.2. Measurement of dimensions

All measurements of outside diameter and wall thickness are made in accordance with the method specified in the applicable pipe standard, or in accordance with ISO 3126.2 or equivalent

7.3.3. Ovality

The ovality of pipes at the manufacturer after extrusion but prior to coiling is all conformed to ISO 11922-1 or equivalent.

The minimum diameter of a dram for coiled pipe is 18 x d_n and in any case such that kinking of the pipe is prevented.

7.3.4. FITTINGS

All fittings shall be designed and manufactured to with stand the required operating conditions to connect any diameters of HDPE with galvanized or HDPE with HDPE pipes supplied by the company are standard qualified fittings.

7.3.5. JOINTS

Unless otherwise specified, pipes and fittings will be jointed by compression, Electro fusion and screw joint and fitting shall be threaded end/s. Screw joints shall conform to ISO 7/1. Joint types and materials for all pipes and fittings shall conform to the following requirements and unless otherwise specified, shall include 5% allowance.

7.3.6. PIPE SADDLES FOR WATER SERVICE CONNECTIONS

Pipe saddles for use on HDPE pipe shall be similar to the pipe material, or as approved.

Saddles shall be sized properly for the type and outside diameter of the pipe on which they are installed. Makes and models must be submitted for the prior approval of the Engineer.

7.4.1. WORKMANSHIP

7.4.1.1. HANDLING

The Contractor shall use every precaution to prevent damages to the pipe. Any damage to the pipe from any cause during transport and before final acceptance by the Owner shall be repaired as directed by the Engineer, by and at the expense of the Contractor. Material that can not be repaired shall be removed and replaced at the Contractor's expense.

Pipe shall be loaded and unloaded without dropping, by hand or by using side boom tractors or other equipment approved by the Engineer. The Contractor shall not roll or drop the pipe from any conveyance used for hauling.

Pipe and specials shall be handled using only wide canvas, leather, or rubber padded slings. Use of bare cables, chains, hooks, pipe clamps, or other similar equipment will not be allowed. The width of belt slings shall be not less than one-half (1/2) the diameter of the pipe being handled.

Extreme care shall be exercised to prevent damage to pipe ends. Cement-mortar ends which have been chipped shall be repaired with mortar and allowed to set for 48 hours prior to welding.

7.4.1.2. PAYMENT

Payment for the supply and handling of materials referred to in this section to the point of delivery, will be made as shown in the Contract: Goods - Supply of Pipes and Fittings.

7.6. Galvanized Steel Pipe Work

7.6.1. MATERIAL AND MANUFACTURING STANDARD

The material of general-purpose steel pipework with screwed fittings shall be of in accordance with 1387. In addition the manufacturing kind of the steel pipes and fittings to be supplied shall comply with BS 1387 medium grade and with BS 143 and 1256.

Pipe shall be fabricated in accordance with BS 534 with welding in accordance with BS 2633 or BS 2971 & BS 4515.

7.6.2. COATINGS

Steel pipes and fittings shall be galvanized inside & outside by the hot deep process according to BS 1387 & BS 729. The galvanizing shall be done before screwing of pipes and fittings.

Steel pipes and fittings over 80mm diameter, shall be carbon steel in accordance with BS 3601 with pipe sizes to BS 3600.Where specified all pipes and specials shall then be degreased and gift blasted prior to coating with an approved fusion bonded epoxy coating. The coating shall be tested to ensure the correct thickness and the absence of pores using spark testing equipment.

7.6.3. JOINTS

Pipes shall be supplied with taper threads and fitted with one screwed socket. All threads on pipes & fittings shall comply with BS 21. Couplings for use with steel pipes shall comply with BS 534 except where other types of coupling are known on the contract drawings or specified in other sections of this Specification. Components of flexible joints from different manufacturers shall not be used together.

Flanges on steel pipes shall be welded in accordance with BS 2633 or BS 2971 and shall have raised or flat faces. Gaskets for use in flanged joints shall consist or rubber complying with BS 2494 for type 1 rings or rubber reinforced with cotton and complying with BS 5292 or as instructed by the Engineer. On flat face flanges the gaskets shall extend over the full flange area and on raised face flanges they shall cover the raised face only.

No asbestos shall be used on any flange of pipework or fitting carrying potable water.

Steel pipes, which are to be welded, shall have the ends prepared by the manufacturer to suit the type of welded joint stated. The pipes shall be free of external and internal coating for a distance of 75mm from each weld line. After fabrication all welding scale and beads as well as hardened fluxes shall be removed and joints shall be free of pores and as smooth as possible.

7.6.4. LENGTH

Unless other length is specified in the schedule of price the pipe shall be supplied in 6 meters. The lengths of the pipe do not include the depth of any socket.

OUTSIDE DIAMETER WALL THICKNESS & PIPE WEIGHT

Unless it is specified in the schedule price the dimension, outside diameter, wall thickness & weight of medium grade shall be applicable.

Medium grade						
Nominal size (DN)	Designation of thread	Outside diameter		Thickness (mm)	Mass of black tube	
		Max. (mm)	Min. (mm)		Plain end (Kg)	Screwed and Socket (Kg)
15	½	21.7	21.1	2.6	1.21	1.22
20	¾	27.2	26.6	2.6	1.56	1.57
25	1	34.2	33.4	3.2	2.41	2.43
32	1¼	42.9	42.1	3.2	3.10	3.13
40	1½	48.8	48.0	3.2	3.57	3.61
50	2	60.8	59.8	3.6	5.03	5.10
65	2½	76.6	75.4	3.6	6.43	6.55
80	3	89.5	88.1	4.0	8.37	8.54
100	4	114.9	113.3	4.5	12.2	12.5
125	5	140.6	138.7	5.0	16.6	17.1
150	6	166.1	164.1	5.0	19.7	20.3
Note. Maximum and minimum outside diameters meet the requirement of ISO 65						

Heavy grade						
Nominal size (DN)	Designation of thread	Outside diameter		Thickness (mm)	Mass of black tube	
		Max. (mm)	Min. (mm)		Plain end (Kg)	Screwed and socket (Kg)
15	½	21.7	21.1	3.2	1.44	1.45
20	¾	27.2	26.6	3.2	1.87	1.88
25	1	34.2	33.4	4.0	2.94	2.96
32	1¼	42.9	42.1	4.0	3.80	3.83
40	1½	48.8	48.0	4.0	4.38	4.42
50	2	60.8	59.8	4.5	6.19	6.26
65	2½	76.6	75.4	4.5	7.93	8.05
80	3	89.5	88.1	5.0	10.3	10.5

100	4	114.9	113.3	5.4	14.5	148
125	5	140.6	138.7	5.4	17.9	18.4
150	6	166.1	164.1	5.4	21.3	21.9
Note. Maximum and minimum outside diameters meet the requirement of ISO 65						

7.6.6. TOLERANCE

The tolerance on the outside diameter thickness, mass & length shall comply with BS 1387.

7.6.7. TEST

7.6.7.1. Leak Tightness Test

Steel pipes shall be tested for leak tightness at the manufacture's work. The test shall be a hydraulic test at a pressure of 50 bars. The pressure should be maintained sufficiently long for proof and inspection. The proof test shall comply with BS 1387. The proof test shall be applied after galvanizing of pipe.

Fittings shall be tested for leak tightness at the manufacturer's work the test shall be hydraulic test at a pressure of 20 bars. The proof test shall comply with BS 143 & 1256.

7.6.7.2. OTHER TESTS

The steel pipes should be subjected to tensile test; the test shall be in accordance with BS 18 part 4 and as requirement of BS 1387 section three. Bend test should be applied to pipes up to and including DN 50 in accordance with BS 1387 and the finished pipes shall with stand the test without showing any signs of fracture or failure. Flattening test should be applied to steel pipe greater than DN 50 in accordance with the requirements of BS 1387.Each pipe and fittings shall be subjected to hydrostatic pressure test complying with BS 1387. Other mechanical tests like hardness and elongation tests shall be performed at random pipes in each batch of manufactured pipes. Any pipe that does not withstand the above test shall be rejected. The result of all required tests on the steel pipes and fittings shall be submitted to the Client.

Each pipe and fitting should be inspected to ensure compliance with BS 1387, section 2.3. All pipes and fittings should be free from surface imperfections; the ends shall be cut cleanly and nominally square with the axis of the tube and be free from excessive burrs. The pipes should be straight and shall not include welds used for joining length of strip. Bends, branches and other fittings for use with steel pipe shall comply with the British standard or other approved standard. Calculations for the design of all special fittings shall be submitted to the Engineer before manufacture commences.

7.7. Puddle Flanges

The thrust to be resisted by puddle flanges shall be calculated as: -

$$T = 3.75 \times 10^{-4} \times P \times D^2$$

Where: -

T is the thrust to be resisted in kN

P is the flange pressure rating in bar

D is the pipe outside diameter in millimeters

Puddle flanges may be integrally cast or welded on, but shall be proportioned to resist the above thrust.

7.8. Valves

7.8.1. GATE VALVES

All wedge gate valves for working pressures up to and including PN16 shall comply with ISO 5752. Wedge gate valves for higher working pressures and resilient seal valves shall also be of a water works pattern and flanged valves shall have face-to-face dimensions in accordance with the above standard.

Valve bodies and wedges shall be of cast iron, with facing rings, seating rings, wedge nuts and other trim of corrosion resistant bronze. The valve stem, thrust washers, screws, nuts and other components exposed to the water shall be of a corrosion resistant grade of bronze or stainless steel.

All gate valves shall close in a clockwise direction and the direction of opening and closing shall be cast on the hand wheels or valve casing with the words 'OPEN' and 'CLOSE' respectively. All gate valves shall be capable of being operated manually with a maximum applied torque of 150 Nm for valves with a nominal diameter more than 450mm and of 100 Nm for valves with a nominal diameter less than 450mm. The Contractor shall ensure that the gate valves supplied are fitted with appropriate thrust bearing guides and gearing to fulfill these requirements, ensuring that when reduction gearing is employed, the gear ratio shall not exceed 4:1.

Bypasses shall be fitted to gate valves where pipeline pressures deem it necessary and universally to valves of 500 mm diameter and larger. Each valve shall be tested in accordance with the requirements of ISO 5208 open-ended in each direction.

Where specified, resilient seat type valves shall be provided. The wedge shall have a resilient Nitrile Rubber covering bonded to the cast iron wedge. The gates of all resilient seal valves of the same size and class shall be completely interchangeable, and be shaped so that the shoulders of the gate seal against the valve bonnet when the gate is fully open. Stem sealing shall be by O rings, which shall be replaceable under pressure with the gate fully raised.

Flanged drilling should comply with ISO 2531:1998. Butterfly valves for use in flanged pipe system face to face and center to face dimensions should comply to ISO 5752.

7.8.2. BUTTERFLY VALVES

Butterfly valves shall be suitable for the stated application/pressures and for mounting in any position and shall comply with ISO 5208, for double flanged valves, except where otherwise specified. All bolts, nuts and other fixings, which will be in contact with the contents of the pipelines or, in the case of buried valves within the ground, shall be stainless steel.

Butterfly valves shall be suitable for frequent operation as well as for operation after long periods of idleness in either the open or closed position. The valves shall be hand operated with hand wheels driving through 90^{o} gearboxes. The valve body shall be cast gray iron, the flanges and hubs for the shaft bearing housing being integrally cast with the valve body.

The disc shall be ductile iron having edges machined with rounded corners and polished to a smooth finish. The valve disc shall rotate through an angle of 90 degrees from the valve opened to the fully closed position where the seating shall be at an angle normal to the axis of the pipe. Adjustable mechanical stops shall be provided to prevent over-travel of the valve disc in both the open and closed positions.

The shaft shall be fabricated of stainless steel. The shaft, disc and mechanical stops shall be capable of absorbing the full operating torque with a minimum design safety factor of five. Shaft seals, when used, shall be rubber 0-ring type. Packing shall be either rubber 0-ring or self-adjusting chevron type.

The valve seat shall be replaceable and formed of nitrile rubber 70/75 IRHD securely clamped into a machined groove in the valve body or to the edge of the disc by seat retention members, or equivalent so as to prevent leakage and to hold the seat securely during operation. The seat retention members shall be of stainless steel and securely clamped with stainless steel fasteners. All fastenings shall be set flush so as to offer the least resistance possible to the flow through the valve.

Valve seats which extend over the face of the flanges to secure the seat in place, or which require surface grinding and/or hand fitting of the disc, or designs which require the adjoining pipe flange to retain the seat in place and resist line pressure, are not acceptable.

Each valve shall be tested in accordance with the requirements of ISO 5208 for body, seat and disc strength tests. Seat and disc strength tests shall be carried out in each direction and the valve shall be drop tight.

The flange drilling should comply with ISO 2531.

Metal faced butterfly valves shall generally be as above except:

The valves shall have metal-to-metal seating

The valves shall be designed for operation in the partly closed, throttled position for long periods.

7.8.3. NON-RETURN VALVES (CHECK VALVES)

Check valves should comply BS-5153: 1991

If not specified differently for particular purposes, the valve should generally be manufactured from the materials as listed below (or equivalent or better).

Name of Part	**Materials**
Valve Body	Meehanite Cast Iron or Ductile Cast Iron
Valve Wedge	Meehanite Cast Iron, Cast Steel or Ductile Cast Iron
Wedge Seal	Synthetic Rubber
Valve Shaft	Stainless Steel
Water Temperature	40^0 Celsius
Internal and External Coating	Plastic enamel

The valves shall also have the following features:-

a) Detachable cover-plate of ample dimensions to facilitate inspection and withdrawal of the flap.

b) An ample pocket below the flap into which may fall any solid matter which might otherwise prevent the flap from closing.

c) Suitable stops or other means to prevent the flaps from opening to an angle of less than 30^0 with the axis of the pipe.

d) Hinged pin of gunmetal of stainless steel and extended on one side of the valve casing through a gunmetal bushed gland, and fitted with mild steel external lever.

e) Drain plug fitted at the bottom of the body.

The valves shall be tested at a pressure of 15 kg/cm^2 with the flap open. They shall grant a fully open flow section at a pressure of 1 kg/cm^2 and close perfectly at a pressure of 1m-water column.

Valves greater than 500mm diameter shall be provided with lifting eyes, feet and jacking screws.

Flaps shall be fitted with renewable bronze or gun metal sealing faces, which shall mate accurately with renewable bronze on gun-metal seating rings in the valve body. all seating/seals shall be positively located.

Covers shall be provided to allow ample access for inspection, cleaning and servicing and shall be supplied complete with tapped boss fitted with an air release cock.

Hinge pins/shafts and internal fixing devices shall be stainless steel. Hinge pins/shaft shall preferably be square in section to ensure positive location of flaps and provide for secure fixings.

For valves with external levers and adjustable balance weight the hinge pins/shafts shall extend through a renewable sealing gland on the side of the body.

Valve body design shall be such that there is adequate clearance around and at the back of the flap to minimize jamming by rags, solid matter, etc.

Each valve shall be tested in accordance with BS 5153 or if outside the size of this standard to the form as set out in BS 5153 and to the nominal pressure designation/test pressure relationship set out therein or 700 kPa for 30 minutes whichever is the greater.

7.8.4. AIR VALVES

Air valves shall be equipped to operate automatically as follows: -

- Air release during filling of the pipe network
- Air entrance during flushing
- Air removal when air pockets occur

In no case must the operation of these valves result in the creation of pressure surges in the pipes and the valves must therefore be equipped with the appropriate safety mechanism and isolation valves. The valve should generally be manufactured from the material as listed below (or equivalent or better).

Name of Part	**Materials**
Valve Body	Meehanite Cast Iron or Ductile Cast Iron
Stem	Stainless Steel
Floats	Synthetic Rubber
Water Temperature	40^0 C
Internal and External Coating	Plastic enamel

The valve closure device will consist of a rubber coated, spherical, perfectly calibrated float, either left to float freely or guided in the body.

Each air relief valve must be tested separately with the float and without the float. In the latter case, the valve is tested after closure of the air outlet orifice. In both cases, the sealing of the body, cover, packing, valve piece and stop valve must be perfect. Single air valves shall be of the small orifice type and shall have bodies of cast iron. The inlet shall be 25mm diameter fitted with an isolating plug clock and shall be screwed into an 80mm diameter blank flange drilled and tapped to BS21. Single air valves shall be of a pattern and manufacture approved by the Engineer. For the conditions under which they will operate and be fitted with a pressure gauge tapping and plug. Floats are to be manufactured from stainless steel.

Double air valves shall combine small orifice air release and vacuum release valves in one cast iron body. The inlet shall be fitted with an isolating valve with vertical spindle, key operated from above. Double air valves shall be of a pattern and manufacture approved by the Engineer for the conditions under which they will operate and be fitted with a pressure gauge tapping and plug. Floats are to be manufactured from stainless steel. The valves shall be suitable for the stated maximum working pressures and tested for pressure tightness in steps of 200 kPa up to the maximum working pressures and then for mechanical strength at 1.5 times maximum working pressures.

7.8.5. FLAP VALVES

The flap valves shall have plain covers. The valve should generally be manufactured from the materials as listed below (or equivalent or better).

Name of Part	Materials
Valve Body, Flap:	Cast Iron or Ductile Cast Iron
Flap Shaft	Stainless Steel
Water Temperature	40^0 C

7.8.6. DISMANTLING PIECE

This part serves to facilitate the removal of the accessories and shall be of the rigid type if not otherwise specified. The packing has to consist of brand new material.

The movable distance shall be DN 80 to DN 500, ± 15mm. The dismantling piece should generally be manufactured from the materials listed below:-

Name of Part	**Materials**
Body	Meehanite Cast Iron or DCI
Coating	Plastic Enamel

7.8.7. FIRE HYDRANTS

7.8.7.1. Underground Fire Hydrants

The hydrants will not be attached directly on the pipeline but will be installed on the pavement.

The hydrants should generally be manufactured from the materials as listed below (or equivalent or better).

Name of Part	**Materials**
Body, outlet cover, stem support	Meehanite Cast Iron or

and operating nut	Ductile Cast Iron
Main Valve	Meehanite Cast Iron or Ductile Cast Iron
Stem	Stainless Steel
Internal and External Coating	Plastic Enamel

The hydrants must be equipped with automatic drainage. The nominal diameter has to be 80mm. The pressure class PN10. The maximum height of the hydrant shall be 530mm. The nominal flow shall be at least 100 m^3/hour. The hydrants shall be equipped with all necessary items for underground installation inclusively:

- CI Surface box;
- Hydrant;
- DN 80 flanged extension (as specified);
- Double flanged duck foot bend;
- DN 80 flanged extension (as specified);
- Tee-fitting;
- Standpipe with two instantaneous fire hose couplings type C;
- Operating tee key.

All above items are listed separately in the Bill of Quantities.

Fire hydrant cover shall be manufactured in accordance with suitable for medium to heavy duty marked with letter HYDRANT and incorporate lift and cover chained to the frame.

7.8.8 BALL FLOAT VALVES - ISO 7121:1986

Ball float valves shall be designed for installation on the inlet pipe to a storage tank and shall automatically shut off when the water reaches a predetermined level. They shall be of the single-beat type with balancing piston and direct float and lever operation. Valves shall be designed for a working pressure of 1000 kPa. Valves shall be drop-tight when they are held shut by the floating ball. Valves shall be tested for leakage at 1000 kPa when they shall be drop-tight, and shall be tested for body and valve element strength with the valve closed and a test pressure of 1500 kPa applied to the inlet end.
Valves shall be constructed of mehanite cast ion to BS 1452 Grade 220 with gun-metal trim to BS 1400 Grade LG2. The valves shall incorporate rubber faces. the ball float shall be made in tinned cooper and the float lever shall be mild steel.

7.8.9. TEE KEYS

For the operation of the underground gate valves, hydrants and manhole covers tee keys will be supplied. The keys will be galvanized steel.

a. For valves and hydrants universal key will be supplied to the quantities in the bill.

b. For the manhole covers also universal keys will be supplied, one for each manhole covers.

7.8.10. PAINTING OF VALVES - ISO 12944-4:1993

All valves shall be painted internally and externally to the approval of the Engineer. The following paint system, defined in accordance with ISO 12944-4:1993 "Code of Practice for Protective Coating of Iron and Steel Structures against Corrosion" shall be used:

PREPARATION: Abrasive blast cleans to B.S. Second Quality

PAINTING:

a) Apply single coat of two-pack epoxy zinc phosphate primer (KP 1A) to 70 micron D.F.T.

b) Apply two coats of two-pack epoxy (KF 3A) to 300 micron D.F.T. Epoxy to be approved for use with potable water.

7.8.11. Water Meters

Water meters shall consist of self-contained integrating measuring instruments continuously determining and displaying the volume of water flowing through them, employing a direct mechanical process involving the action of velocity of the water on the rotation of moving part, and conform to the recommendations of ISO 4064.

Water meters for potable water services and public fountains shall be a single rotary vane type, capable of withstanding a working pressure of 1.0 MPa (PN 10) with dry dial, completely waterproof encased gear train, flow indicator, register, magnetic coupling and conform to the following supplementary data: -

a. Nominal sizes shall be 12, 20, 25, 40 and 50mm with male threaded end connections complete with tailpiece couplings on each end to connect the meter to threaded fittings which are the same nominal size as the meter.

   Threads shall be of a uniform standard throughout, compatible with threaded pipe, valve and fittings specified in these documents.

b. Materials used in the construction of the meters shall be of the best quality, mechanically and chemically suited for the intended service conditions without any detrimental effect on the quality of the water.

c. The flow indicator shall consist of a single pointer and circular scale, which shall rotate whenever the flow through the meter is greater than the starting flow rate. One revolution of the pointer shall correspond to a fixed unit of flow.

d. The register shall consist of a row of direct reading, in-line consecutive digits visible in one or more apertures, indicating totalized volume of water in cubic meters as following: -

Characteristics	**Nominal Meter Size (mm)**				
	12	**20**	**25**	**40**	**50**
Nominal Flow Rate (m^3/h)	1.5	2.5	3.5	10	16
Minimum Capacity of Register (m^3)	104	104	104	105	106
Minimum Readable Quantity (m^3)	0.001	0.001	0.002	0.005	0.010

e. Meters shall conform to the minimum operating and performance standards as follows:-

Characteristics	Nominal Meter Size (mm)				
	12	**20**	**25**	**40**	**50**
Nominal Flow Rate (m^3/h)	1.5	2.5	3.5	10	16
Starting Flow Rate (m^3/h)	0.010	0.020	0.030	0.035	0.070
Limiting Flow Rate (m^3/h)	0.075	0.125	0.175	0.500	0.800
Maximum Flow Rate (m^3/h)	3	5	7	20	32

Maximum head loss at the maximum flow rate shall not exceed 10m water column.

f. Tamper proof devices consisting of a wire and lead seal shall be provided for the register and the plug above the adjusting screw to protect against unauthorized opening and tampering with the meter.

Meters shall be designed for a lifetime of ten (10) years under normal operating conditions. The Supply Contractor shall obtain and submit a separate written guarantee from the Manufacturer of the meters against defects due to five (5) years after the date of delivery. Meters that are found to be defective during this period shall be repaired or replaced by the Supply Contractor at no additional cost to the Owner.

g. Flanged Water Mete

Characteristic	Nominal meter size (mm)					
	80	**100**	**150**	**200**	**250**	**300**
Nominal flow rate m^3/h	40	60	150	250	400	600
Maximum flow rate m^3/h	80	120	300	500	800	1200

7.8.12. Pipe Saddles

Pipe saddles for use with ductile iron and uPVC pipes shall be of cast iron, and shall have female threaded outlets.
Pipe saddles for use on ductile iron pipe shall be similar to Rockwell 323, bronze double-strip, construction.
Pipe saddle for use in uPVC shall be sized properly to fit to the outside diameter stated in this specification to the tapping size indicated on the Bill of Quantity.

7.8.13. Pipe Wrap

Pipe wrap shall be a cold applied self adhesive pipe wrap, comprised of an extruded, heavy, highly conformable thick PVC carrier combined with a layer of rubber rich tropical grade bituminous compound.
Minimum thickness of PVC shall not be less than 0.76 mm with total thickness of wrap not less than 1.65 mm.
Minimum physical characteristics of wrap to be:

Tensile strength	13.6 MPa
Elongation	230%
Tear resistance	47 N forces
i) Impact strength	7.2 Joules
Adhesion to ASTM D1000	
(180° Peel)	3.7 N/cm
Dielectric strength	20,000 V min.
Operating temperature	20°C - 75°C
Insulation resistance	1,000,000 megohms

7.8.14. Flange Jointing Materials

Each set of flange jointing material shall comprise the gasket and all nuts, bolts and washers.

Gaskets shall be of the inside bolt circle type manufactured from 80 Shore hardness EPDM, 3 mm thick. Where required by the diameter and pressure rating, the gaskets shall have a reinforcing metal insert.

All nuts, bolts and washers shall have a 15 micron galvanized coating.

7.8.15. Ferrules

Ferrules shall be zinc free bronze, with integral key-operated plug cocks and shall be suitable for vertical under pressure tapping. The ferrules shall have female threaded outlets.

7.8.16. Underground Installation

Surface boxes shall be sectional, telescoping construction, capable of withstanding surface traffics and impact loading without transmitting such loads to the valve. A top section of surface box shall be complete with a lid, which is secured in place and detectable with metal/magnetic field locating equipment. A middle section or sleeve pipe shall be suitable for inserting a valve-operating key. Valve boxes shall be fabricated of corrosion resistant materials or have corrosion resistant coatings on surface in contact with the soil.

These valves shall be equipped with all necessary items for underground installation inclusively.

- CI Surface Box,
- Stem adaptor (universal size)
- Stem extension,
- Stem connector,
- Protection tube (PVC material).

7.8.17. Manhole Covers

Manhole cover for chambers shall be municipal casting type Class E600 heavy duty ventilated square frame diameter 850mm with a clear opening of 600mm.

7.8.18 Special Tools and Equipment

7.8.18.1. DRILLING OF HOLES IN uPVC AND DCI PIPES

Tapping devices and cutters for the proper drilling of 15 mm, 20 mm, 25 mm and 40 mm holes through the saddle clamp (under non-pressure conditions) for uPVC and DCI - pipes shall be supplied.

7.8.18.2. EQUIPMENT FOR TESTING OF PIPELINES

A special diesel motor engine-driven plunger pumps for testing of the pipelines with the following characteristics.

Maximum pressure	30 bar
Delivery	15 l/min.

In addition the necessary suction hose (5m), strainer, pressure relief valve, discharge hose, pressure gauge, stop valves, blank flanges and fittings all as specified in the Bill of Quantities.

7.8.19. Globe Valves and Fountain Taps

Globe valves for meter chambers shall be straight pattern rated to 1.4 MPa for cold water, all bronze with renewable composition disc and screwed connections.

Taps for public fountains shall be rated to 1.4 MPa for cold water, globe type, all bronze with renewable composition disc and screwed connection.

7.8.20. Pipes for Drainage

Pipes for drainage shall be of uPVC and shall be in accordance with ISO 3633

DATA SCHEDULE A

DELIVERY SCHEDULE

THE GOODS UNDER THE PROJECT ARE EXPECTED TO BE DELIVERD TO ZU-HAMUSI TOWN IN 12 WEEKS FROM THE DATE OF OPENING OF THE LETTER OF CREDIT. The suppliers are expected to confirm their compliance with this delivery schedule.

DATA SCHEDULE B

LIST OF MANUFACTURERS

List the names and addresses of the manufacturers that will supply the items under the

Tender:

ITEM	DESCRIPTION	NAME OF MANUFACTURERS
1.1	DCI Pipes	
1.2	HDPE Pipes	
1.3	GS Pipes	
1.4	Fittings	
1.5	Gate Valves	
1.6	Air release valves	
1.7	Flap valves	

DATA SCHEDULE C

SPECIFICATION DEVIATION

Bidders should list below Technical Deviations of their offered items; if any; from that of the tender's requirement.

Sr. No.	Tender's Specification	Deviation of the Technical features of the offered Goods, in cross – reference to the Tender Requirement
1		
2		
3		
etc		

SECTION 8

BUILDING AND MISCELLANEOUS WORKS

8.1 Damp Proof Course

1. The sheeting for horizontal damp proof courses shall be fibrous asphalt felt cut to cover the entire width of the foundation walls. It shall protrude beyond the outer face of the wall for a minimum of 25mm, the last 10mm of which shall be turned down on an approved profile to form an anti-ant lip, and laid on a cement screed trowelled smooth. At all angles, intersections etc. the material must be lapped not less than 75mm.
2. A damp proof membrane of 500 gauge polythene shall be laid under floor slabs where indicated on the Drawings or directed by the Engineer and shall have laps of not less than 200mm at all joints.
3. Damp proof courses shall conform with the requirements of BS 743.

8.2 Bonding to Concrete

1. All door frames shall be fixed withhold fasts screwed to the frames one end and built into block work or concrete at the other end. Alternatively hold fasts may be formed as an integral part of metal door frames. Door frames shall have three hold fasts at each side.
2. The hold fasts shall be of 6mm x 25mm galvanised wrought iron 200mm long, one end turned up, twice drilled and countersunk for screwing to frames with stout screws and the other end formed swallowtail for building into brickwork etc.
3. Bonding ties shall be of 6mm x 15mm galvanised wrought iron 150mm long with both ends formed swallowtail for building into block work, etc.

8.3 Painting

8.3.1 Delivery and Storage

a) All materials are to be delivered to the site in the manufacturers' original containers with seals unbroken and are to be clearly marked with the manufacturer's name or trade mark

and a description of the contents, colour or pattern, and, if applicable, the conditions for storage and the date by which they shall be used.

b) All materials are to be stored at Site in accordance with the manufacturer's directions and to the satisfaction of the Engineer.

8.3.2 Materials Samples and Tests

a) During the course of the work the Engineer may take samples of any of the paints, varnishes, stains or sealers, either from the sealed or open containers, before or during use.

b) When requested by the Engineer to do so, the Contractor shall submit samples for testing in accordance with the applicable standard. The costs of such test, including transport and incidental costs, shall be borne by the Contractor if the results show non-compliance with the Specification.

c) Any work executed with materials tested and found not to comply with the requirements of the Specification shall be burnt off or otherwise removed and re-executed as directed by the Engineer.

8.3.3 Workmanship

a) Before painting, varnishing, staining or sealing is commenced, every possible precaution shall be taken to keep down dust.

b) Only skilled workmen shall be employed. A properly qualified foreman shall be constantly in attendance on the work while it is proceeding.

c) All brushes, tools and containers used in carrying out the work shall be clean and free from foreign matter and shall be thoroughly cleaned before being used for a different type of material.

d) All containers shall be kept securely covered with tight fitting lids when not in use.

e) The Contractor shall arrange his work so that any treated surfaces to be subsequently covered up shall be treated before they become inaccessible.

f) The painting work shall be carried out in accordance with the applicable standards and all painting varnishing, staining or sealing shall be executed in dry conditions and when relative humidity is less than 80%. No such finishes shall be applied to surfaces structurally or superficially damp and all surfaces must be ascertained to be free from condensation, dust, oil or any other foreign matter before application of each coat.

g) Rubbing down prior to application of the final coats shall be my means of the wet process with waterproof glass paper. Preliminary coats of paint shall be lightly rubbed down with fine sandpaper before the next coat is applied.

h) Finishing coats shall be applied evenly over the whole surface to give a solid film free from brush marks, sags, runs, orange peeling or other defects.

i) The Contractor shall clean down all paintwork on completion, remove all marks due to spill and leave all painted surfaces to the complete satisfaction of the Engineer.

8.3.4 Samples of Workmanship and Colour

a) The Contractor shall prepare samples of the different finishes on the appropriate backing material, with the correct priming and undercoats where applicable, for acceptance by the Engineer, including alternatives as directed. These samples shall be prepared at least twenty-eight days before commencement of the actual work.

8.3.5 Preparation of Surfaces

a) General

i) All surfaces shall be thoroughly prepared and shall be clean, free from loose dirt or other impurity. No paint shall be applied until all surfaces are thoroughly dry.

ii) Preparation of the different materials to receive decorative and protective finishes shall be as specified below.

b) Concrete and Concrete Blockwork

i) Plaster and rendering surface to be painted shall be brushed down to remove loose materials and dust. The surface shall be washed, where directed with a minimum of worm water & detergent, and allowed to dry.

ii) All plaster & rendering surfaces to be painted shall be corrected, all minor defects, cracks and holes.

iii) All concrete and concrete block work surfaces to be painted shall be brushed down thoroughly to remove all loose material, mortar dropping and nibs.

c) Plaster and Rendering

i) All surface to receive paint shall be rubbed down smooth with fine abrasive and cleaned of all grease or any other deleterious matters.

ii) All surfaces shall be thoroughly sanded and all nail holes, cracks and any other defects shall be puttied to a smooth and flush finish.

d) Iron and Steelwork

i) All metal surface shall be oil painted unless other paints are specified. All steel components other than galvanized steel shall be prepared and primed in the shop and finish painted after erection.

ii) All metal surfaces to be painted shall, prior to application of paint be prepared in the following manner:-

- All soil or other foreign matter (other than grease & oil) shall be removed by brushing & scraping
- Oil or grease shall be removed by wiping the surface with rags or brushes wetted with an approved solvent
- Excessive rust scale shall be removed by hand clipping or or by power impact tools

iii) Rough welds and sharp edges shall be ground smooth and all weld spatter shall be removed.

iv) The whole surface shall be cleaned by means of powered steel scrapers or steel brushes.

e) Galvanised Iron and Steel

i) Galvanised iron and steel surfaces shall be thoroughly cleaned to remove all grease, dirt, dust etc.

8.3.6 Priming

a) General

i) Before priming, painting, varnishing, staining or sealing is started, all possible precautions shall be taken to keep down dust.

ii) All metal fittings and fastenings shall be removed before the preparatory processes are started. They shall be cleaned and refined in position on final completion of the work.

b) Special Priming

i) Unless the paint manufacturer recommends otherwise the following materials shall receive special priming:

ii) Cement based surfaces, such as concrete, fair face blockwork and brickwork, render and plaster, and asbestos free boards containing cement which are to receive oil based paints, shall be treated with an alkali-resistant primer.

iii) Galvanised iron and steelwork shall be treated with calcium plumbate or a two-pack etching primer.

iv) Copper shall be treated with a suitable etching primer.

v) Hardwood shall be treated with aluminum primer.

vi) The smooth face of hardboard shall be treated with specially formulated hardboard primer.

viii) All uncoated iron and steelwork cleaned of rust, millscale, etc., in preparation for painting shall be primed within twenty-four hours of preparation whether at the works or on Site.

8.3.7. Painting for Different Surfaces

8.3.7.1 Oil Paint to Steel Surfaces

i) One or two coats of anti-corrosive paint and two coats of oil paint. Sufficient time shall be allowed for drying for each new coat.

ii) Galvanized metals are to be painted, they shall be first etched with 5% acetic acid and washed clean before priming.

8.3.7.2 Oil Paint to Wooden Surfaces

i) Paints shall be applied in 3 coats including one coat of prime paint. Sufficient time shall be alluded for drying between each new coat.

8.3.7.3. Plastic Paint for Concrete Surfaces

1 coat under coat & 2 coats of approved plastic emulsion

8.4 Plumbing

8.4.1 Pipework

a) Water supply pipework shall be of galvanized steel and should comply with BSCP 310:1965

b) Internal sanitary pipework shall be of uPVC and shall comply with BSCP 304:1968. standard.

c) External sanitary pipework shall be of concrete as detailed in Section 3.14 of this Specification.

8.4.2 Galvanized Mild Steel Pipes

a) Galvanized mild steel pipes and fittings shall comply with BS1387 Class or "Medium Grade". Threading for screwed and socketed joints shall be in accordance with the requirements of BS 211. Joints shall be made with an approved pipe jointing compound in accordance with the manufacturer's instructions. Red lead compounds shall not be used. Joints in underground piping shall be coated with bitumen or other approved composition.

8.4.3 Fittings for Galvanized Pipes

a) All fittings for galvanized steel water pipework shall be galvanised heavy weight fittings in accordance with BS 1740. Fittings for waste pipework shall be galvanised malleable iron complying with the requirements of BS 143.

b) Brass or gunmetal fittings shall be subject to the approval of the Engineer.

8.4.4 Fixing of Pipework

a) Galvanized malleable iron brackets shall be used for fixing galvanized steel pipes up to 50mm diameter. Pipes larger than 50mm diameter shall be fixed with galvanized iron or brass hinged holder bats. For fixing to timber stout galvanized pipe clips screwed to the timber shall be used.

b) Beneath floor slabs drainage pipes shall be encased with 150mm surround of Class B15 concrete.

8.4.5 Sanitary Ware

a) Sanitary ware in white glazed fire clay shall be to the Engineer's approval.

b) Lavatory basins shall be 275 x 450 and shall be supplied complete with 2 No. 300mm porcelain enameled cast iron fixing brackets, 30mm chromium plated grid waste with plug and chain, 30mm chromium plated bottled trap, 38mm seal, and 12mm chromium plated pillar taps as necessary.

c) W.C. suites shall be to the Engineer's approval and shall either be supplied complete with 11 litre white fire clay low level cistern with vertical valve and chromium plated flush handles, 30mm porcelain enameled steel curved flush pipe including jointing to pan and cistern and white plastic seat or complete with 11 litre high level cast iron cistern with chrome plated chain and handle, 33mm flush pipe including jointing to pan and cistern and white plastic seat.

d) Shower units shall comprise 38mm chromium plated grid waste, 38mm copper P-trap, 12mm dia. chromium plated stop cocks and mixing valve as required and 12mm diameter chromium shower arm with 100mm dia. shower head.

e) Stainless steel sinks and drainers shall comprise 20 SWG pressed stainless steel single bowl single drainer sink overall size 1350mm x 525mm fixed in kitchen cabinet framing complete with 38mm dia. chromium plated grid waste with plug, chain and combination overflow, 38mm copper P-trap with brass cleaning eye and combined taps and mixer with swivel inlets with adjustable centres. Double units shall be provided where these are indicated on the Drawings.

f) Bathtub units shall comprise white porcelain enameled cast iron bath 1675mm or 1525mm long as required complete with 38mm chromium plated grid waste, 38mm bath trap assembly

Bathtub units shall comprise white porcelain enameled cast iron bath 1675mm or 1525mm long as required complete with 38mm chromium plated grid waste, 38mm bath trap assembly and 19mm chromium plated pillar taps or combined taps and mixers as required.

8.4.6 Taps and Stopcocks

a) Taps and stopcocks shall be to the relevant BS 1010. Stopcocks shall be fitted on the main service as it enters any building.

8.4.7 Testing and Sterilizing

a) All pipework shall be tested in accordance with Clause 8.2 of the Specification and shall be sterilized to the satisfaction of the Engineer.

8.5 Block Work Walling

1. The blocks for walling shall comply with Clause 5.27 of this Specification and shall be properly bonded together and in such manner that no vertical joint in any one course shall be within 100mm of a similar vertical joint in the courses immediately above or below.
2. Alternative courses of walling at all angles and intersections shall be carried through the full thickness of the adjoining wall. All perpends, reveals and other angles of walling shall be built strictly true and square.
3. The blocks shall be bedded and jointed in 1:3 cement/sand mortar with beds and joints not more than 20mm or less than 12mm thick, all flushed up and grouted solid as the work proceeds. All walling shall be properly protected as the mortar is setting.
4. Ends of lintels, sills, joints, roof trusses, etc. shall be built in and bedded solid in mortar. Block walls etc. shall be pinned up to the underside of concrete beams and slabs with cement.
5. Timber frames shall be built in with holdfasts and bedded solid and pointed both sides in cement mortar. Lugs of window frames shall be built in or cut and pinned to blockwork. Frames shall be bedded solid in mortar and pointed in approved mastic applied with a caulking gun externally.
6. All holes for pipes, electrical conduits, etc. mortices for bolts, dowels, etc. shall be cut or formed grouted up in cement and made good.

7. Horizontal reinforcement consisting of approved fabric shall be provided in every third course to span between the vertical block reinforcement. A proprietary wall reinforcement system may be used with the Engineer's approval.
8. At corners and junctions of walls all horizontal reinforcement shall be lapped 300mm. The cavities of the blocks shall be filled with 1:3 cement/sand mortar around a mild steel reinforcing bar.
9. External faces of block work shall be rendered with 12 mm thick 1:5 cement/sand mortar to BS 5262 with a wood float finish.
10. Internal faces of block work shall be plastered with an undercoat to suit the blockwork surface. The total thickness shall be 20 mm.
11. All block work shall not be erected more than one meter above another at a time. All blocks shall be well wetted before use and the top of unfinished walls shall be wetted before work is recommenced.

8.6 Polythene Sheeting

1. Polythene sheeting shall comply with BS 4646.

8.7 Precast Concrete Products

1. Lintels to windows, louvers and door openings where these are separate from the reinforced concrete ring beam can be of precast concrete complying in all resspects with BS 1239. They shall bear 300mm on supports and shall be cast with a recessed throating under the front edge. Design calculations for lintels shall be submitted to the Engineer for approval before casting is commenced.

8.8 Workmanship in Timber

1. All joiner's work shall be wrought and finished with a clean even and smooth surface, arises straight and cleanly cut, and all to be properly framed together, single or double morticed, and tenoned, housed, dovetailed or fitted with all proper and suitable joints whether these are shown on the Drawings or not, and all joints shall be fitted without stopping, the whole being glued, feathered, tongued and fixed with screws, nails etc. all detailed on the Drawings or as approved by the Engineer and in accordance with the best class of workmanship.
2. Adhesives used for timber work shall be synthetic resins of the phenol and amenoptastic type BR in accordance with BS 1204 Parts 1 and 2.
3. Nails for joinery shall be oval lost head nails.
4. Screws shall be countersunk wood screws. Steel screws shall be used only in concealed positions, or where the work is to be painted, elsewhere brass shall be used. Steel screws in contact with aluminum shall be dipped in zinc chromate solution before fixing. Iron mongery is to be fixed with screws of the same metal, except for aluminum which shall be fixed with chromium plated brass screws.
5. All joinery shall be properly protected from injury or from weather by casing wherever required.

8.9 Wooden Doors and Windows

8.9.1 General

a) The materials sample used in the construction of wooden doors shall in accordance with BS 459. Doors and windows shall be obtained from an approved manufacturer and the details and methods of construction shall be to the Engineer's approval.

8.9.2 Flush Doors

a) Flush doors shall be 45 mm thick overall, faced both sides with 4mm plywood and lipped on all edges with 10 mm thick hardwood. External doors shall be faced both sides with exterior quality plywood and assembled with waterproof adhesive to type MR of BS 1203. Suitable blocking pieces for door furniture shall be built in. Glazed vision panels shall be inserted as shown on the Drawings and shall be to the approval of the Engineer.

b) Cupboard doors shall be as above but 40mm thick overall.

8.10 Metal Doors and Windows

1. Metal frames shall be of Seko profile, or similar approved, be manufactured from galvanized steel and shall comply with BS 990.
2. Surface panals for doors shall be manufactured from galvanized 15 mm thick sheet steel and shall be corrugated as indicated on the Drawings.
3. Surfaces of the doors shall be seamless and surface sheets shall be continuously welded along vertical edges.
4. All welds shall be primed with zinc rich primer.
5. Doors shall be strong, rigid and neat in appearance and free from warpage or buckle. Corner bends shall be true, straight and the minimum radius for the gauge of metal used.
6. Two samples of each type of door, door frame, window frame and door and window furniture shall be submitted to the Engineer for approval at least four weeks prior to construction.
7. Shop drawings of doors, door frames and window frames shall be submitted to the Engineer for approval prior to fabrication. Shop drawings shall show size, material, thickness, mortices, reinforcement and anchor details.

8.11 Door and Window Furniture

1. Each door shall be provided complete with all hinges, handles, locks, three keys per lock, bolts, door stops etc. and all necessary screws, bolts and other fixings. Double leaf doors shall be provided with barrel bolts top and bottom of the first closing leaf, complete with flush mounted floor socket, and handle for the top bolt extended to 2.0m above floor level.
2. Door furniture shall be to the approval of the Engineer. (Generally shall be manganese brass sanded, toned bronze lacquered flush and lacquered).
3. Windows shall be provided with all necessary hinges, fasteners, locks, catches, stays, etc. Fittings generally shall be manganese brass, sanded, toned and bronze lacquered and fixed just prior to glazing and carefully protected against damage.

8.12 Glazing

1. All glass is to be of approved manufacture complying with B.S. 952 and to be of the quality specified, free from bubbles, smoke wanes, air holes and other defects. Glazing shall be clear or obscured glass, set in metallic putty and shall be subject to the approval of the Engineer.
2. Clear glass shall be used for all windows except in toilets or as otherwise directed by the Engineer.
3. Glazing shall be carried out in accordance with BSCP 152 "Glazing and fixing of glass in buildings", and the window manufacturer's instructions.
4. All cracked, broken, scratch, chipped or other with defective glass, shall be taken out and replaced all glazier's work shall be cleaned and polished inside and out and left prefect on completion.

8.13 Metal Labors

1. Metal labour shall be pressed from steel sheet of minimum thickness 1.22mm (18 gauge). They shall be rust-proofed at works by the hot dip galvanising process and supplied complete with steel frames and coupling transoms and mullions as required. All metal labour shall be supplied complete with fine copper mesh woven flyproof screening fixed to the interior face.

8.14 Roofing Works

8.14.1 Corrugated Sheet Metal Roofing

1. Galvanized corrugated sheet steel for roofing shall be Ethiopian 28 gauge with 125 mm corrugations complying with BSCP 143 Part 10 and the brand and manufacturer shall be subject to the approval of the Engineer. Aluminum roofing shall comply with BSCP 143 Part 1.
2. Sheets shall be fixed with side laps of one and a half corrugations and minimum 300mm end laps secured to purlins by galvanised iron bolts and iron and lead washers spaced not more than 300mm apart horizontally on each purlin.

3. Ridges, hips and valleys shall be 28 gauge galvanised sheet, minimum 450mm girth with roll tops and fixed with 90mm galvanised iron screws and iron and lead washers spaced not more than 300mm apart lapped 150mm at junction of lengths and with edges close dressed into corrugations of sheeting.
4. Valleys shall be inverted, lapped 150mm at ends of lengths close welded and securely fixed under edges of roof sheeting.

8.14.2 Proprietary Sheet Metal Roofing

1. Proprietary sheet metal roofing shall be Ethiopian 28 gauge I.B.R fluted sheeting 747 mm wide to the approval of the Engineer. Cranking of sheets shall only be carried out by the manufacturer, and all flashings etc. shall be Ethiopian 28 gauge standard units supplied by the manufacturers. The fixing of all sheeting and flashings etc. Shall be in accordance with the manufacturer's details and as shown on the Drawings.

8.14.3 Bituminous Felt Roofing

8.14.3.1 Bituminous

1. Bituminous Roofing felt shall be in accordance with BS 747 Part 2, and shaall be laid in accordance with BSCP 144 Part 3.
2. Before laying roofing felt the underlying concrete surface shall have any cracks and expansion joints sealed with a bituminous patching compound. A slip membrane comprising one layer of one ply roofing felt shall be laid and adhered to the concrete at all edges.
3. Two under layers of two ply roofing felt shall be applied with 100 mm overlaps between strips, bonded with bitumastic compound at all edges. The overlap joints between successive layers shall be staggered to half the strip width.
4. A surface layer of Grey Mineralized Surface felt of an approved colour, shall be laid with 100 mm overlaps, fully bonded with hot applied bitumen compound.

8.15 Ceiling

Ceiling shall be of 8 mm chipboard attached to a suitable grid of wooden cross runners. The surface of this ceiling shall be painted with a plastic emulsion coating after treatment with a scalar under coat.

8.16 Fencing and Gates

1. Steel barbed wire and metal or precast concrete posts used in compound boundary fences and gates shall be of galvanized steel to the details indicated on the Drawings.
2. Posts, stays and gates shall be primed with one coat of zinc chromate paint and finished with two coats of oil based aluminum paint.
3. The whole of the fencing shall be to a pattern approved by the Engineer.
4. The costs with bent tops shall be of Grade 25, precast reinforced concrete and approximately 3.2 m long over all. The posts shall be sunk into the ground and bedded in concrete so as to stand 2.4 m high and shall be spaced at 3 m intervals. Holes of 25 mm dia. shall be cast into each posts, through which the fencing wires shall pass.
5. The steel fencing wire shall be 12 S.W.G and shall be attached galvanized iron straining bolts of 13 mm securely fastened to the straining posts. Suitably strutted straining posts shall be provided at all corners and terminals points and in strength runs at intervals not exceeding 300 mm.
6. The entrance gates shall be single leaf or double leaf, to the details and dimensions shown fabricated from DN 50 standard black water pipe and black iron fittings, and covered with 50 mm welded square mesh. The gates shall be hinged to reinforced concrete gate posts and shall be complete with locks and stops. All metal parts shall be painted in accordance with the pertinent clauses of Section 7.3.7.1.

8.17 Ladders

1. Unless otherwise indicated permanent ladders shall be of mild steel and shall be in accordance with BS 4211. Rungs shall be 20mm diameter solid round bar and shall be at 300mm centres. Stringers shall be 65mm x 10mm strip set 300mm apart shall extend 1.0m above the top rung and shall be turned out at the bottom and drilled for 12mm holding down bolts. Intermediate and top support stays shall be 100mm x 10mm strip, bolted to the stringers with 12mm bolts and shall be of a length that will give a minimum clearance of 200mm behind the rungs. Support stays shall have a maximum spacing of 2.5m.

2. Ladders exceeding 4.0m height shall be equipped with a safety cage consisting of hoops of 50mm x 8mm strip bent to a diameter of 0.76m, fixed to the stringers at 0.55m centres and joined by one additional stringer of 50mm x 8mm strip at the maximum distance from the rungs.

3. All components of ladders shall be galvanised after cutting, drilling and welding and all fixing bolts, nuts washers, etc, necessary to complete the installation shall be provided.
4. Ladders to insides of water retaining structures shall be galvanised mild steel.

8.18 Open Mesh Steel Flooring

1. Open mesh flooring shall be to BS 4592 and shall be painted black in accordance with the Specification.
2. Kicker plates 100mm high shall be provided round all openings.

8.19 Chequer Plate Flooring

1. Chequer plate flooring shall be of mild steel and manufactured with diamond chequering or other non-slip pattern. The plates shall be of sufficient thickness not to bend or spring in ordinary usage and shall be fitted evenly and truly into steel angle frames or curbing with suitable attachments for building into concrete flooring.
2. The plates and frames shall be painted an approved colour in accordance with the Specification.

8.20 Hand railing

1. Hand railing shall be designed and manufactured in accordance with Handbook No. 7 (revised 1973) published by the Engineering Equipment Users Associations. It shall consist of 38 mm diameter galvanized steel sections of tubing BS 1387. Screwed at each end. The sections shall be jointed by 38 mm diameter galvanized steel equal crosses, equal tees or short radius 90^{o} bends where appropriate, such that the top rail shall be 1 meter and the lower rail 0.5 meter above the concrete slab, and the spacing between standards shall be 2 meters maximum. A 38 mm diameter galvanized steel flange shall be screwed to the base of each standard and drilled for four 20 mm diameter, 100 mm long steel lag doors which shall be cast into the R.C. slab.
2. All hand railing components shall be galvanized after cutting, screwing and drilling and shall be supplied complete with all bolts, nuts, washers and other fixings necessary to complete the installation.

8.21 Rainwater Goods

1. These shall be of galvanised steel 28 gauge.
2. Gutters shall be of the box type, 150 mm square in cross section or as shown on the Drawings.
3. Down pipes shall be 100 mm square or as shown on the Drawings.
4. Gutters shall be laid to falls as directed.
5. The general arrangement of the drainage system shall be to the Engineer's approval.

8.22 Weep Holes

Weep holes shall be in masonry above all masonry flashings and at the bottom block in exposed masonry at 600 mm or horizontally.

8.23 Pointing

Brick or hollow block walls to be pointed shall have the joints raked out to depths of 25 mm and pointed in cement mortar composed of 1 part of cement and 1/2 part of lime and 3 parts of sand by volume. Mortar is to be properly ironed to level

8.24 Terrazzo Tile

Terrazzo tiles for flooring and base shall be 200 mm x 200 mm x 20 mm units complying with the latest Ethiopian Standard. Colour and pattern shall be selected by the Engineer.

8.25 Ceramic Tile

Ceramic tile for walls shall be 150 mm x 150 mm x 5 mm units complying with BS 1281. Colour and pattern shall be selected by the Engineer.

8.26 Plastic Floor Tiles

Plastic tiles shall be installed in accordance with the manufacturer's recommendations and the engineer's instructions.

The under laying concreted surface shall be finish with a 30 mm thick 1:3 cement/sand mortar screed shall be finished level & smooth.

8.27 Cleaning up and Protection of Floors

All floor finishes are to be left in a clean and perfect condition, and all dirt, grease, extrusions of bedding and other adhesive material are to be carefully removed without damaging the floor finish. The contractor must protect all floors & skirting from damage. Any faulty sections, cracked, broken or chipped tiles etc. must be replaced and made good as must any other damage resulting from the floor not being properly protected.

SECTION 9

ELECTRICAL INSTALLATION ON CIVIL STRUCTURES

9.1 General

9.2 Scope of Work

This work includes the supply, erection, installation, testing, commissioning and putting to work complete L.V. supply network, all electrical installation, services and street lights as shown generally in the drawings and described in this specification.

9.3 Testing of Completed Installation

Site testing of the general electrical installation shall be carried out on completion of sections of the works, or at any time as requested by the Engineer. These test shall be witnessed and three copies of Test Certificates giving the results of the tests shall be submitted.

The following tests shall be carried out in accordance with the requirements of EELPA.

- Insulation resistance tests between phases and each phase to earth.
- Earth continuity tests on all circuits
- Line and neutral earth loop impedances from selected positions on site

9.4 "As Built" Record Drawings

A complete and detailed lay-out drawing together with the specification of materials used for the works shall be submitted at the completion of works.

9.5 Material & Execution

9.5.1 General

Materials used in the works shall be new, the best of their respective kinds, and obtained from manufactures approved by the Engineer.

1. Materials shall be fully in accordance with qualities, tolerances, tests, recommendations, methods of workmanship and requirements as described or named in the relevant British Standard Specification, the International Electro-technical Commission (IEC) Publications, or in conformity with the latest edition of EELPA specifications.
2. The Contractor, when and if required, shall supply samples where or prototypes of all materials or workmanship before work is put in hand. The samples shall be retained until the main bulk of materials is delivered to site.

9.5.2 Mounting Heights

Except where otherwise detailed in the drawings or stated in the Bill of Quantities all accessories and fittings shall be fixed at the following heights above finished floor level:-

- Distribution boards 1700 mm to centre line of board
- Lighting switches and push buttons 1400 mm
- Lighting switches and push buttons above beds 1000 mm
- Sockets (general 300 mm)
- Sockets on or above benches 1500 mm above bench top
- Sockets in workshops 1100 mm
- Telephone outlets 300 mm
- Bells 2100 mm

9.6 Underground Cable Ducts

9.6.1 General

Underground cable ducts for incoming power supply cables and telephone service cables to the buildings, shall be supplied and installed by the Contractor. It shall be the responsibility of the Contractor to ensure that the underground duct is installed correctly according to each party's requirements, and to the purpose. The Contractor shall liaise closely with EELPA and ETA to ensure that their requirements are fully satisfied. It shall be the Contractor's responsibility to ensure that adequate information concerning easy bends, directions of runs, etc. is given before work commences.

9.6.2 Precast Concrete Pipes

Precast concrete pipes for cable drawing shall comply with the requirements of ES C D3.326. The pipes shall be jointed in cement sand mortar mix 1:3.

Precast cement pipes shall be measured in length and shall be understood as including fitting and related earth and concrete work.

9.6.3 Galvanized Steel Pipes

Galvanized steel pipes for cable drawing shall generally comply with the requirement of BS 1387, light gauge having threaded ends to BS 21.

Galvanized steel pipe laid for cable drawing shall be measured in length and understood as including all earth, masonry and concrete work.

9.6.4 PVC Pipes

PVC drain pipes for cable drawing shall generally comply with the requirement of BSS 5481.

PVC pipe laid for cable drawing shall be measured in length and understood as including all earth, masonry and concrete work.

9.6.5 Manholes

Manholes shall be in precast concrete C-20 quality, brick or Class A hollow block work as indicated and detailed in the drawings. The manholes shall be laid on a minimum concrete bed of 150 mm, C-20 concrete.

Manholes other than precast concrete shall be rendered internally and externally with two coats of cement mortar. Joints of precast concrete manholes shall be flush pointed.

Manholes covers shall be in cast iron cover and frames or C-25 precast reinforced concrete.

Manholes shall be enumerated stating size and shall be deemed to include related earth and other works for the completion of the work.

9.6.6 HDPE Pipes

Procured and Supplied HDPE pipes shall be of required PN as per the design and satisfying Ethiopian standard ES ISO 4427:2005 (POLYETHYLENE(PE)PIPES FOR WATER SUPPLY –SPECIFICATIONS;IDENTICAL WITH ISO 4427:1996)

9.7 Conduits for Internal Wire Drawing

All metal conduits shall be heavy duty galvanized and shall be laid in straight and symmetrical lines. The ends of all conduits shall be carefully trimmed to remove all burrs and sharp edges after the screw threads have been cut. The ends of the conduits shall be but welded solidly in all couplings, and where conduits terminate in switch fuses, fuse boards, adaptable boxes etc., they shall be connected there to by means of smooth bore male brass brushes, compression washers

and sockets. All bends shall be made on site to suit site conditions and not more than two right angle bends shall be permitted without the interposition of a draw box. No tees, elbows or bends either solid or inspection will be permitted, unless specifically mentioned in the specification or in the drawings.

All PVCC conduits shall be of high impact PVC type. Ends shall be carefully trimmed of all burrs. Joints shall be made using adhesive supplied by the conduit manufacturer.

9.8 Cubicle Panel Boards

The Contractor shall supply and install medium voltage main distribution panels as indicated in the drawing. The main distribution panel shall be of the cubicle panel type. The Contractor shall submit detailed drawings of the proposed panel lay-out for approval of the Engineer.

The design and arrangement of the panel shall be such as to permit the ready addition or replacement of incoming and outgoing cables. There shall also be ready access to any component requiring maintenance including all bolted or clamped connections.

9.9 Main and Sub Distribution Boards

The Contractor shall supply and install distribution boards in the positions indicated on the drawings. All sub-main distribution boards shall be complete with isolator of fused switch as applicable.

The distribution boards shall be complete with all necessary earth bonding gland-plates, cable entries, fixing brackets and supports for the cables specified and the locations indicated.

Sub-distribution boards shall be surface-flush mounted as specified in the Bill.

Distribution boards shall be of the type fully enclosed sheet steel cabinets and hinged cover. Each shall be a one standard panel section having the number of pitch units as detailed in the drawings. Boards shall consist of approved single and triple pole miniature circuit breakers. The current rating and type of each panel are indicated on the appropriate distribution boards diagram.

Unused reserve pitch units shall be fitted with molded plastic cover strips. Full facilities shall be provided within the panel for the fitting of future additional circuit breakers. The current rating and type of each panel are indicated on the appropriate distribution boards diagram.

Distribution and sub-distribution boards, bus bar rating, type of mounting (surface, flush) etc., shall be indicated in the drawing. The reference number of the Board shall be used in the Bill.

Distribution boards shall be enumerated and understood as including all related works.

Terminal covers shall be of molded plastic, surfaces mounted with bare plate, 35 mm wider rail and wire entry knock outs. Terminal covers shall include all related work.

9.10 PVC Cables

Underground cables shall be PVC bedded, steel wire unarmored-armored and PVC served overall. Unless, specifically indicated otherwise, all cables shall have copper conductors.

PVC sheathed and insulated power cables shall generally be of the type Siemens NYY 0.6-KV or equivalent.

PVC cable shall be measured in length and understood as including all related work.

9.11 Light, Power and Socket Outlets

9.11.1 General

Unless indicated on drawings or schedules the following shall be the minimum standard of light, power switch and other outlets fittings.

Outlets shall be enumerated and understood as including all related work.

9.11.2 Light Points

Light points fed through specified size PVC insulated conductors of type Siemens NYM or equivalent, in thermoplastic conduits of 13.5 mm diameter for recessed installation, including junction boxed with cover insulating caps, as well as flush mounted switches.

9.11.3 Light Switch

Light switches shall be of commercial grade quality, shall have a rating to suit the circuit load. Those subjected to water spray or splash and to dust and those located out-off-doors shall be weather proof. Those located in chemical feed building and the chlorination rooms shall be corrosion resistant to the effects of chlorine contamination.

9.12 Socket Outlets

9.12.1 General

All socket outlets shall generally be "Siemens SCHUKO" type or similar approved by the Engineer

9.12.2 Socket Points

Socket points shall be of specified rating fed through PVC insulated conductors inside thermoplastic conduits of diameter as shown in the drawings for recessed installation including junction boxes with covers and insulting caps.

9.12.3 Power Outlets

Power outlets shall be of specified rating PVC sheathed cable in specified size of thermoplastic conduit for recessed installation, including junction boxes with covers and insulating caps.

9.12.4 Telephone Outlets

Conduits for telephone system shall be installed complete as indicated in drawings. The wiring for each telephone outlet shall be carried out by the Ethiopian Telecommunication Authority. The Contractor shall liaise with ETA to verify that adequate concealed conduits have been included.

Telephone conduits shall be thermoplastic conduit for recessed installation.

9.12.5 Bell System

Bell system with buzzer and call indicator panel of specified number for flush installation, including bell transformer 220/8V.

9.12.6 Light Fixtures

Light fittings and fixtures shall be approved type and be installed as indicated on the drawings and the Bill.

Tungsten filament lamps shall be of the general service type and coiled coil pattern in applicable size where lamps are visible under normal viewing conditions, they shall be of the Argenta K (Pear) lamp types.

All fluorescent lamps shall be of the bright white colour, temperature around 4000 K (Philips TL-33) or equal which combines well with daylight.

The reference number for light fittings as indicated on the drawings and schedules shall be strictly adhered to.

9.13 Sundry Items

9.13.1 Poles

Galvanized or mild circular steel pipes painted with aluminum paint shall be constructed and erected in accordance with the detail drawings for street lighting. C-25 concrete shall be used for anchoring the poles.

9.13.2 Earthling

The installation of the earthing system shall be in accordance with Section D of EELPA regulations. The sub-contractor shall supply, install and connect all necessary conductors, clamps, connectors, terminals etc., for an efficient earthing system.

The entire electrical installation together with the armouing or metallic sheathing of all cables shall be electrically continuous throughout forming a completely bonded earth system.

The Contractor shall ensure that every complete earth loop circuit comprising conduits, cable sheaths, core conductors etc. shall have an impedance value not exceeding that laid down in the latest edition of EELPA Regulations.

SECTION 10:

TESTING AND STERILISATION

10.1 Cleansing of Pipelines

1. All of the pipelines shall be cleaned by pigging and the cost of this shall be included in the rate for pipe laying, unless otherwise allowed for in the Bill of Quantities.
2. The Contractor shall put forward his proposals for the method of programming of the pigging and sterilizing to the Engineer and obtain his written approval at least 28 days prior to commencement.
3. After testing, but prior to sterilization, the length of pipeline of differing diameters shall be separately swabbed by passing a foam pig throughout each length or sections of each length as may be convenient at the discretion of the Engineer. The pig shall be inserted at one end of the length to be cleaned and its movement caused and controlled by feeding water into the pipeline from a convenient connection behind the pig and allowing the water to discharge to waste at the other end through a washout or other temporary valued arrangement.
4. Perforated discs shall be provided by the Contractor and temporarily inserted between conveniently situated flanged items in the pipeline to retain the pig where the configuration of the pipework and location of washout do not in themselves permit proper retention of the pig.
5. The time for any pigging operations to commence shall be decided by the Engineer and the operation of the Employer's existing apparatus to provide a supply of water and the rate of supply shall be strictly under the control of the Engineer.
6. Pigging shall be repeated as many times as necessary to ensure the complete removal of all extraneous material from the pipelines to the complete satisfaction of the Engineer.
7. The Contractor shall allow in his rates for all labor, plant, materials, the supply of water and compliance with all other obligations specified herein.
8. Before handing over any pipeline to the Employer, the Contractor shall pass through it a rubber disc plunger or swab and in the case of jointed pipelines shall simultaneously flush the line with clean water. Both ends shall then be closed by temporary plugs or bulkheads to prevent entry of dirt or foreign matter.

10.2 Testing of Pressure Pipelines

10.2.1 General

a) The Contractor shall provide all water, fittings, blank flanges, test pumps, pressure gauges and all necessary labor, tools and materials for the testing of pipelines and pipework and shall include for this in his rates. Flange adaptors suitable for each pipe diameter and material will be supplied with the pipe.

b) The Contractor shall put forward his proposals and programming for testing to the Engineer and obtain his written approval prior to commencement.

c) No section of pipe work will be accepted by the Engineer or paid for until all requirements regarding tests have been fulfilled.

d) Any section of pipe work which fails to pass the tests applied shall have the defects made good by the Contractor and a further test carried out. The cost of all remedial work and re-testing shall be borne by the Contractor.

e) The Contractor shall inform the Engineer at least 24 hours before a length is ready for an inspection or test.

10.2.2 Water Tests on Pressure Pipelines

a) Pipelines in trenches shall be satisfactorily tested before backfilling over joints and fittings, but after all concrete anchor blocks and surrounds have set. Trenches shall be kept dry until the pipes have been satisfactorily tested.

b) The length of the section of pipelines to be tested may be determined by the Contractor but shall not exceed 600 metres and shall be approved by the Engineer. Levels of the length of pipe section under test shall be such that the maximum test pressure, of 1.5 times the maximum allowable working pressure, is achieved at the lowest point whilst the minimum test pressure, of 1.3 times the maximum allowable working pressure, is achieved at all other points.

c) The ends of the section to be tested shall be blanked off by means of the end pieces, blank flanges or discs provided by the Contractor, together with any temporary anchorages that may be required to prevent any movement of the pipes during the test. Valves shall not be used to isolate test sections of the pipeline.

d) No filling of pipes with water for testing purposes shall be undertaken without the prior agreement of the Engineer. The pipeline or pipework shall be filled with water in such a

manner as to prevent shock and the accumulation of air, and kept under observation for leakage at static head for twenty four hours or until the lining is saturated. The water for this purpose shall be reasonably clear and free of solids and suspended matter. If the Engineer is satisfied that the water content of the pipeline has been maintained a pressure test shall commence in the presence of the Engineer.

e) The pressure shall be raised slowly to 1.5 times the maximum working head specified for the class of pipe and maintained at that pressure for a period long enough for the Engineer to examine the whole section under test or as per the manufacturers instructions whichever is longer period.

f) Thereafter, for a period of not less than 4 hours, the leakage of water as measured by the amount drawn into the pumps to maintain the pressure, shall not exceed 0.10 liter per 24 hours for each 1,000 meters of pipeline for every millimeter of internal diameter of pipe for each 30 m head of pressure applied at the lowest point.

g) All pipes or joints which are proved to be in any way defective shall be replaced or remade and retested as often as may be necessary until a satisfactory test shall have been obtained and any work which fails or is proved by test to be unsatisfactory in any way shall be redone by the Contractor at his own expense.

h) On completion of a satisfactory test any temporary anchor blocks shall be broken out and stop ends removed, and backfilling of the pipeline shall be completed.

i) No section of pipework shall be accepted by the Employer until all requirements of the test have been obtained.

j) On completion of successful tests on all sections, an overall test over the entire length of main shall also be carried out.

10.3 Sterilization of Water Mains

1. Potable water mains shall be sterilised after pigging and final pressure testing operations have been completed by filling them with chlorinated water containing at least 20 mg per litre of free chlorine.
2. Filling of the mains shall be effected through a metered connection from an approved source and chlorination shall be carried out at this filling point. The Contractor shall allow in his rates for a metered connection from the existing supply, should this be utilized, to the new

main and also for the temporary provision of suitable chlorinating apparatus and its installation and such a chlorinator shall be capable of accurate dosage.

3. Before commencing chlorination, the Contractor shall submit for the Engineer's approval the chlorine sterilizing agent he proposes to use. The Contractor may submit for the Engineer's approval an alternative method for sterilizing the mains and should this be given, it shall in no way limit the Contractor's obligations in complying with the requirements below.
4. The chlorinated water shall remain in the main for 24 hours after which period samples shall be drawn off as directed by the Engineer to determine the chlorine residual of the water. The mains shall then be flushed out with water from the approved source and further tests of chlorine residual taken to ensure that the heavily chlorinated water has been completely evacuated from the main. Samples shall then be taken from a suitable connection and sent for bacteriological examination by the Contractor to an approved laboratory.
5. The samples shall be taken by the Contractor in the presence of the Engineer. If the results of the test on the samples show that the water contains any presumptive or typical coliform organisms in 100 ml of water the mains shall be either reflushed or the whole sterilization process repeated as the Engineer may direct.
6. All operations affecting the Employer's existing supply mains shall be carried out only after the Engineer's approval has been given and then under the direct control of the Engineer and all arrangements for sterilization shall be as directed by the Engineer who may require lengths of mains to be sterilized in separate sections.
7. The Contractor shall allow in his rates for all labor, plant, materials, the supply of water and compliance with all other obligations specified herein. Any repetition of sterilization which may be required shall be at the Contractor's own expense and to the satisfaction of the Engineer.

10.4 Testing of Concrete Structures Designed to Retain an Aqueous Liquid

1. All concrete structures designed to retain water or other liquids shall be tested by the Contractor after completion for water-tightness. Such testing will not be allowed to begin until the structure has been fully completed and all concrete has reached its specified strength. The Contractor shall make preparations to begin testing as soon as possible after each main structure has been completed.
2. The tests shall be carried out by filling the structure with clean potable water obtained from an approved source. The Contractor shall be responsible for organising the supply of water and all costs involved including for water and transport if necessary.
3. After cleaning to the satisfaction of the Engineer, the structure shall be filled at an approximately uniform rate of increase of water level of not more than 2m in 24 hours to the intended top water level.
4. The water shall be left to stand for seven days, during which period visual examination and readings of water levels shall be taken. To allow for absorption where the structure is constructed of concrete, the level shall be maintained by topping up as necessary for four days. To allow for evaporation, an approved "evaporation tank" of minimum depth 1m shall be provided by the Contractor and supported inside the structure with its open top above top water level.
5. The evaporation tank shall be partially filled with water, to approximately the same level as the structure, and the levels monitored during the test period.
6. After the four days absorption period, no topping up of the structure or the evaporation tank shall be carried out. For the following three days, the water levels in the structure and in the evaporation tank should be noted at intervals of twenty four hours. During this period, the outer faces of the structure shall be carefully examined for signs of damp patches. If, after allowance for evaporation, the level in the structure is found to have dropped by more than 3mm in any twenty four hour period, or by more than 9mm overall, or there is excessive evidence of damp, i.e. "wet to the touch", during any time over a continuous 24 hour period on the outside faces, then the structure shall be deemed to have failed the test. If, after allowance for evaporation, the level in the structure has not dropped by more than 3mm in

any twenty four hour period, nor by more than 9mm overall, and no signs of excessive damp are visible on the outside faces, then the structure shall be deemed to have passed the test.

7. If the structure does not satisfy the conditions of the test, and the daily drop in water level is decreasing, the period of test may be extended for a further three days and if the specified limit is then not exceeded the structure may be considered as satisfactory.
8. Should the structure be deemed by the Engineer to have failed the test, the Contractor shall be responsible for, and bear the expense of, locating the source of leakage and carrying out all necessary remedial work as required by the Engineer to make the structure water-tight. A further test shall then be carried out as before and the procedure shall be repeated until the structure is deemed by the Engineer to have passed the water tightness test.
9. In reservoirs consisting of more than one compartment, each compartment should be separately tested to the level of the top of the division wall or walls before conducting the test to overflow level.
10. Roofs to potable water retaining structures shall be tested by the Contractor for water-tightness on completion. The Contractor shall flood the roof to a minimum depth of 25 mm of water for a period of 24 hours. The roof shall be considered satisfactory if no leaks or damp patches show on the soffit.
11. The structures will not be accepted by the Employer until they have been ascertained to be in a perfectly useable and watertight condition to the complete satisfaction of the Engineer.
12. No claim for extra payment to the Contractor shall be allowed if for any reason the Engineer is unable to allow filling or emptying to be carried out at the time requested by the Contractor.
13. The costs of all testing including the provision of water for water-retaining structures shall be deemed to be included in the Contractor's rates for concrete.

10.5 Sterilization of Structures for Potable Water

1. On completion of the test for water-tightness, to the satisfaction of the Engineer, the Contractor shall thoroughly clean the interior of the structure by hosing down the roof, walls, columns, baffle walls and floor with clean, potable water, from an approved source, and removing all debris, soil, silt or other material.

2. After the structure has been cleaned as described, to the satisfaction of the Engineer, the Contractor shall, when instructed by the Engineer and under the direction of the Engineer, sterilize the structure by chlorination as described below.
3. The Contractor shall provide a suitable chlorinator (including the provision of the chlorine), which shall be capable of injecting the required concentration of chlorine solution at a steady rate into the structure.
4. The Contractor shall introduce at least 30 milligrammes per litre of free chlorine whilst filling the structure to a minimum depth of 100mm.
5. The Contractor shall then spray all surface areas to the underside of the roof, walls, columns and pipework with the heavily chlorinated water by means of a stirrup pump or similar appliance. A pump which requires petrol or fuel oil for its prime mover shall not be used inside the structure, but at the Engineer's discretion, an electrically driven pump may be used.
6. On completion of the spraying to the Engineer's satisfaction, the heavily chlorinated water shall be drained out of the structure and each compartment shall be filled with potable water from an approved source, to a minimum depth of 200mm. This water shall then be drained out and the structure filled with potable water to overflow level.
7. Samples shall be taken as directed by the Engineer after the structure has been full for a period of at least two hours and shall be sent to an approved laboratory for analysis. If the results of the tests show that the water contains any presumptive or typical coliform organisms in a 100 ml water sample then sterilisation shall be repeated until the tests show that all pollution has been eliminated.
8. On completion of sterilization, the Contractor shall close off access to the structure to all personnel, and no further work shall be permitted in areas allowing direct access to the interior of the structure. Should any unauthorized access occur, and if the Engineer rules that contamination may have resulted, the Contractor shall carry out at his own expense, such tests as the Engineer may require, to determine the extent of the contamination, and shall also carry out and bear the cost of any additional sterilization measures required by the Engineer.

10.6 Alignment Test on Non-Pressure Pipeline

1. The alignment of all pipelines having a nominal diameter of less than 300mm shall be tested by drawing through each completed length a mandrel 750mm long and having a diameter 10mm less than the nominal pipe diameter.

2. Pipelines having a nominal diameter of 300mm and over shall be visually inspected in the following manner:
   At one end of a run a mirror large enough to cover the pipe area shall be set at 45^{o} so as to reflect the sky into the pipe. Alternatively a floodlight having a white reflector may be used. The pipe run shall be inspected from the other end for straightness and obstructions. If no light can be seen through the pipe, the Contractor shall seek out the cause and correct it.
3. Large diameter pipelines shall be inspected by personnel entering them and the Contractor shall provide any equipment necessary for doing so.