Table of Contents

SECTION 1 – WATER WELL WORKS

Drilling and construction of water production wells
SPECIFICATIONS

A: GENERAL SPECIFICATION

1. INSTALLATION CONDITIONS

The equipment, subject of the enclosed particular technical specification, is to be installed in the Gaza Strip.

• Place of installation……	GAZA STRIP
• Country …….	PALESTINE
• Altitude …….	Seal Level
• Outside temperature ranging between……...……	5 and 30 C
• Temperature inside the buildings ranging between……..…….	10 and 40 C
• Relative humidity ranging between…..…….	60 and 100%
• Climatic conditions……..…….	Mediterranean dry summer subtropical climate with mild winter
• Soil ……...	Generally sand, clay
*Power supply:	
• Three-phase power ……...	400 V between phases
• Plus neutral	
• Single-phase voltage …….	220 V
• Voltage variation……...	+/- 10 %
• Frequency ……	50 Hz
• Frequency variation ……...	+/- 5%
• Plant operating time ……..	24/24 hr

1 .METHODS OF MEASUREMENT AND PAYMENT

1.1 Description

This section covers methods of measurement and payment for items of work under this contract.

This total tender price shall cover all work required by the contract documents. All costs in connection with the proper and successful completion of the work, including furnishing all materials, equipment, supplies an appurtenances- providing all construction plant, equipment, tools, testing and performing all necessary labour and supervision to fully complete the Work, shall be included in the unit and lump sum price bid. All work not specifically set forth, as a pay item in the bill of Quantities shall be considered as subsidiary obligation of Contractor and all costs in connection therewith shall be included in the prices bid.

1.2 Quantities

All estimated quantities stipulated in the tender form or other contract documents are approximate and are to be used only.

a) As a basis for estimating the probable cost of the work.
b) And for the purpose of comparing the bids submitted for the work.

The actual amounts of work done under unit price items may differ from the estimated quantities. The basis of payment for work will be actual work done. Contractor agrees that he will make no claim for damages, anticipated profits or otherwise on account of any differences between the amounts of work actually performed and the estimated amounts, up to the extent mentioned in the contract.

B: WATER PRODUCTION DEEP WELL BOREHOLES DRILLING WORKS

Drilling of the Well

1. General

Drilling shall be performed by the percussion method, during which water and rock samples shall be taken according to the Engineers instructions. In addition, the Contractor shall be required to stop work for certain periods of time for the purpose of conducting interim tests, as defined in the section above.

The Contractor has to complete all works included in this Contract and render the completed job not later than the date specified in the Contract Data.

The Contractor shall execute the work in accordance with the drawings and relevant British standards and code of practices.

2. Structure of Borehole and Work Proceedings:

(a) The drilling shall be executed in such away as to permit the installation of a final permanent pipe .not less than 14" in diameter. The Contractor is pern1itted to use 28", 26", 24" 22" and 20" auxiliary pipes. .

(b) Each and every flight of auxiliary pipes shall be lowered only with the Engineer's approval and subject to any hydro geological alterations that may be encountered in the course of the Works.

(c) After reaching required depth, soil stratification shall be analysed and water-bearing Strata identified. Perforated pipe sections (screen pipe) shall be specified accordingly. Ordinary perforation shall be 0.5 - 2.0 mm wide (according to soil type) and 100 and. long. Vertical and longitudinal space between perforations shall be 50 mm.

(d) After installing the final permanent column of pipes a quartz gravel pack filter shall be placed in the space between auxiliary pipe and final permanent pipe. The gravel to be used is of the size 1.5-2.5 mm.

(e) The auxiliary casing pipes shall be extracted while placing the gravel pack filter. The Gravel shall be slowly placed and carefully controlled and packed. Every precautionary measure must be taken during these operations to avoid any hazard of capitation.

In case of sandy water bearing formation special perforation shall be installed to which gravel filter screens shall be fixed.

(g) Required size casing shall be retained permanently in the borehole and serve as protective casing against the upper sandy soil strata. This shall also enable the Contractor to place additional gravel to the gravel pack during test and well development pumping in case any settling of primary placed gravel is observed. .

(H) Concreting of upper end of casing pipe shall be performed along with the extraction of the auxiliary pipes

(I) Insertion of all pipes shall include cutting to the required size threading, connecting to one another by welding, and all work necessary.

The Contractor shall transpose. And install seals and insert them between two columns of pipes having different diameters the required depths and as requested by the Engineer.

(k) The Contractor shall provide a 4 mm steel plate and weld it to the bottom of the Permanent pipe

(1) If soil characteristics prove that safe yield could be obtained from well without any gravel pack filter, respective changes in the detailed design for the completion of well shall be introduced by the Engineer and the Contractor shall duly abide new instructions.

(m) Centralisers shall be installed in each column of pipes inserted in order to allow them to be lowered in the centre of the will, at the same time allowing effective concreting, where necessary.

(n) The Contractor shall make a sanitary plug by insertion of cement in the annular space, from adepth of 15m to 1 m. Other cementation works may be required at various depths in the annular space, and shall be perfumed at the request of the Owner, and according to his instructions.

3. Measurements and Payment for Drilling

Drilling work shall be measured in meters, according to the length of the drilled sections, and According to the various drilling diameters as required and executed. The sections shall not be classified according to their depth or types of penetrated rock. The first section shall be measured from the natural ground level at the location of the well.

The unit prices shall include operation *of* the drilling equipment, its maintenance; work performed by the personnel, management *of* the personnel, supply of auxiliary materials, and the drilling operation. In addition, the unit prices shall include all arrangements for water supply, where necessary, performance *of* routine tests as mentioned above, and collection of samples from the various layers.

The contractor shall keep a detailed record of drilling progress according to depth per hour, including a description of the layers and other phenomena encountered during drilling.

4. Verticality and Alignment Tests

The Engineer shall check the accuracy of the Contractors work execution from the point of well location, the diameters of the various sections, well verticality and alignment. For the purposes of the verticality and alignment tests, a gauge shall be used, composed of a steel pipe section with an external diameter I" smaller than the internal diameter of the tested section, and 12m length. The test shall be performed by lowering the gauge into the well by means of a cable. The extent of deviation from the centre shall be measured by a 6m long gauge. The deviation from the vertical up to a depth of 100 m shall not be greater than 0.3% in one direction.

In the event that the Engineer has determined that the deviation exceeds the permissible value, he shall instruct the Contractor to cease work and Correct the well, or abandon the well and drill a new

well at a site nearby, at the Contractor's expense. In the event that the work is rejected as above, the Contractor must, within a period determined by the Engineer, carry out the corrections regulated in order to suit the well to the requirement of the specification and the required professional level, or *drill* a new well.

The Contractor, on his part, must conduct tests during the course of the work in order to ensure accuracy of drilling. Failure on the part of the Owner to conduct tests during the course of the work shall not detract from his right to demand corrections or reject the work up to completion of the well if it becomes clear to him that the work has not been properly carried out.

The tests described in this section, with the exception of the final measurement, should be regarded as standard and routine, and all expenses for their performance should be included by the Contractor in the *unit* prices quoted in the Bill of Quantities.

5. Rocks and Water Sampling

The Contractor shall supply boxes with rock samples taken from the various layers penetrated by the well. The Contractor shall have to supply at least two samples from each layer, one from the top and the other from the bottom of the layer, in addition to a sample at every two-meter depth of the well. The sampling, including the costs involved, shall be included by the Contractor in the *unit* prices for drilling quoted in the Bill of Quantities.

In the event that the Contractor fails to supply samples from the top or bottom of a particular layer, or fails to supply the number of samples required by the depth, and in the event that this causes damage or losses in any way to the Owner, the Contractor shall have to pay the Employer compensati9n, which shall be deducted from the amounts due to the Contractor according to the Contract the Owner alone shall determine if any damage has been caused and the extent of the Damage.

The contactor shall supply the employer with two complete sets of such sample, remuneration for which shall be included by the contractor in the prices of various works quoted in the Bill of Quantities

Water samples shall be taken every meter below water level. Full analysis of water shall be performed to determine the different characteristics of water. The results shall be filled in the form attached hereto and should be approved by the Engineer.

6. Measurements of Water Levels

Full analysis of water results shall be filled:

During the period of drilling, the Contractor shall perform measurements to the depth of water level (hereinafter "the level") from the head of the pipe or from any other reference point in the well that shall be determined by the Engineer.

The measurements shall be performed in the event of any interruption in drilling, just before its resumption, or at any other frequency determined by the Engineer. The results of the measurements shall be entered in the work log.

The contractor shall supply to the drilling site an electric water level measuring instrument with electrodes and weights, or any other instrument suitable for this purpose.

The contractor shall be responsible for the proper working condition of the instrument, including supply of batteries, calibrated measuring cable and electrodes. The instrument shall remain at all times in the work area and shall be in working condition.

The type of instrument and its adaptation to performance of accurate water level measurements are subject to the approval of the Engineer. Supply of the instrument and auxiliary equipment, its maintenance, and performance of the measurements are considered to be routine activities and constitute an integral part of the drilling work. The costs" of the Contractor in this regard shall be included in the prices of drilling.

7. Additional Tests

In addition to the above, the Engineer shall be entitled to give instructions for performance of various tests and to take samples of water from various depths and in various ways. Payment for the above shall be included in the price per meter.

Interruptions in drilling work caused as a result of the above tests, with the exception of the activities and tests defined and detailed above shall be considered as work stoppages.

8. Pumping Test

The contractor shall perform development and test pumping in the well. The work includes installation of pumping equipment, and other works, in accordance with the requirements detailed below.

Performance /Test Pumping

1. General

Pumping shall be carried out with a vertical pump having a gear head and diesel motor suited to the requirements of the specification. The Contractor shall be requested to stop work for certain periods of time for performance of various tests or for technical consultations.

2. Description of Work

The contractor shall supply a source of power (diesel- motor) in proper working conditions, suited to the requirements as stated in this specification, with arrangements for obtaining different discharges. In addition, the Contractor shall supply all tools, accessories and materials necessary for performance of the work, transport, install and assemble them, and perform the pumping, in accordance with requirements and the Engineers instructions.

The Contractor shall supply and install

Pump outlet arrangements, included an inverted V-pipe, a calibrated water meter (with an official certificate of approval), a valve and an orifice for discharge measurements.

Appropriate pipes, attached to the pump columns, for allowing water level measurements using an electric cable.
The meter reading at the commencement of pumping, on each change in discharge and at the end of each working day should be recorded in the pumping logbook.

For continuous pumping (day and night), the meter reading every 12 hours should be recorded in addition to the above.

3. Instructions for Performance of Test Pumping

Maximum discharge required: 200 cu .m/hr.

Depth of pump installation: 100 m

Pumped water shall be removed to a distance of about conditions in the area and Engineer's instructions.

4. Pumping

00 m to the west, in accordance with

Pumping shall be perfumed by means of a pump as described in clause 8 (2) and shall commence with a low discharge, about 0.2 times the maximum discharge required according to the specification. Pumping shall continue at this rate, until clear, clean water and a stabilised dynamic water level are obtained, according to the Engineer's instructions in the field.

In this condition, the discharge may be increased to 0.4 times the maximum discharge required, with pumping continued until the conditions described above are obtained.

Pumping shall continue in stages, raising the discharge in each stage by about 0.2 of the maximum required value, until it reaches the required level. In the event that during the course of pumping, the water is still not sufficiently clean even though me water level has stabilised, pumping should be continued with interruptions according to the Engineer's instructions. Any modifications in the pumping program shall be made only after receiving instructions from me Engineer.

Pumping should only be commenced with a work docket, which shall include:

Technical specification for performance of pumping.

Technical cross-section of the well.

Pumping logs.

Reliable instruments in proper working condition for measurement of water level discharge and pressures.

5. Tests and measurements

The Contractor shall keep a detailed logbook in which the following details shall be entered

- Name of well, details of pumping equipment, drive mechanism, and date.
- Discharge- every hour and on change in discharge
- Water level-before commencement of pumping, during the course of pumping every hour and on change in discharge.
- Number of revolutions per minute of the pump-for continuous pumping and on change in discharge.

Water samples shall be taken at the Engineer's request. The Contractor shall record in the work log every detail and course of pumping.

The Contractor, on his part, shall conduct tests during performance of the work in order to ensure accuracy of pumping.

6. **Pumping Regime**

The Engineer shall determine, according to need, the pumping regime and whether pumping should be in the day and/or night. The price per pumping hour shall be uniform.

In the event that there is only day pumping, the Contractor shall be required to follow a pumping regime of 10 hours minimum pumping in winter and 12 hours in summer.

Additional Tests

The Engineer shall be entitled to give instructions for performance of various works. Payment for the above shall be on the basis of personnel hours. Interruptions caused as a result of the above additional works, with the exception of the activities and tests defined and detailed above, shall be considered work stoppages.

8. Measurements and Payment for Pumping

Pumping shall be measured according to actual pumping hours. The unit price shall include operation of the pumping equipment, its installation and maintenance, work perfumed by the personnel and supply of auxiliary materials for pumping.

In addition, the prices shall include the necessary arrangements for removal of water, requiring performance of routine tests as mentioned in clause 8-(5), and all the works related to proper performance of pumping.

C: MECHANICAL SPECIFICATIONS

PIPEWORK INSTALLATIONS

GENERAL

Pipes and fittings for general purposes (water, sludge, air) shall be made of steel, galvanized steel, ductile iron or grey iron. In some special cases, other materials (stainless steel, polyethylene, PVC) will be used, e.g. for chemical pipe-work.

Pipes passing through walls of structures retaining water or solution shall have puddle flanges or flanged anchoring sleeves. They shall be connected to the adjoining pipe-work by flanged joints or dismantling joints.

The term "pipe-work" means pipe of any description and includes associated flanges, adapters, couplings, jointing material, fittings, fixings, supports, valves, traps and the like which are necessary to complete station pipe-work systems associated with the Equipment.

Pipe-work shall conform in every respect to the requirements of the relevant I.S./BS/Din/iso All recommended tests shall be carried out and certified in writing.

Adequate provision shall be made to anchor, support, drain, vent, pressure test, dismantle and clean all pipe-work. Valves, meters, strainers and the like shall be supported independently of the pipes to which they are connected.

Pipe-work systems shall be designed to withstand the maximum internal and external forces which could occur in service and under hydraulic test pressures. The configuration and method of support shall be such as to minimize bending stresses.

Systems shall be sized so that the maximum design flow of fluid through the pipe-work will not produce cavitations, erosion or an excessive level of noise and vibration. Systems shall also be sized where practicable so that the minimum operating flow of fluid will prevent deposition of suspended solids. No forces developed within the pipe-work system shall be transferred to the civil structure without the approval of the Engineer.

Plastic pipes, flexible pipes and hoses of less than 50 mm nominal bore shall be supported throughout their length by a separate structure.

All pipe-work shall be free draining to convenient drain points where the piped fluid may be collected or discharged safely.

The Contractor shall make provision to accommodate within pipe-work systems expansion, contraction, differential movement and all other factors necessitating built-in flexibility. Flexible joints to the approval of the Engineer shall be installed where pipe-work spans construction and expansion joints in the civil structure or at points where differential movement of supports may occur.

The configuration and flexibility of the pipe-work shall be capable of accommodating the civil construction and pipe-work erection tolerances. Where practicable, flexible devices shall be of the type which transmits axial loads so that longitudinal thrusts are transferred throughout the pipe-work, thus keeping external anchorage to a minimum.

Flexibility shall be included in the pipe-work to facilitate erection and future dismantling.

Particular care shall be taken to ensure those pipe-work thrusts and stresses transmitted to associated machinery and equipment are minimized and are of a magnitude acceptable to the machinery or equipment manufacturer.

Pressure gauges shall be of the circular dial type having a 270 degree scale of not less than 100 mm diameter. The gauge parts shall be of corrosion resistant materials and no aluminum parts shall be used. The faces shall be protected with toughened glass or acrylic plastic. They shall be calibrated in Mpa (1 MPa = 98 m) and meters water column.

Pressure gauges shall be adequately supported. Fixed connection piping below 25 mm nominal bore shall be compression jointed heavy gauge copper unless otherwise approved by the Engineer.

Where the gauge is mounted on a panel or otherwise located remote from the main system, an isolating valve shall be fitted on the connection pipe near the tapping.

Where the fluid in the main system contains solids in suspension, a diaphragm or other barrier shall be provided at the point of connection to the main system and the connection therefrom to the gauge shall contain a suitable clean fluid.

STEEL PIPES AND FITTINGS

- Steel pipes of nominal size not exceeding 50 mm shall comply with I.S./BS/Din/iso and shall be hot rolled seamless pipes with steel of grade TU 34.1.
- Steel pipes of nominal diameter exceeding 50 mm shall comply with I.S./BS/Din/iso and shall be hot rolled seamless pipes with steel of grade TU 37.
  The corresponding fittings shall comply with I.S./BS/Din/iso.
- Steel pipes of nominal diameter exceeding 250 mm shall be manufactured with steel sheets grade E 24.1. Formed and electrically welded in accordance with I.S./BS/Din/iso.

  Wall thickness of pipes shall correspond to the minimum thickness in API 5L.

- Steel pipes having nominal size above 1,000 mm shall be manufactured with steel sheets, grade E 24.2, complying with I.S./BS/Din/iso. formed and electrically welded according to NF, I.S./BS/Din/iso.

DUCTILE IRON AND GREY IRON PIPES AND FITTINGS

- Ductile iron pipes shall comply with ISO 2531 standard.
- Unless otherwise specified, their thickness in millimeters shall be at least:

$$C = 9\ (0.5 + 0.001\ ND)$$

- Grey iron pipes shall be horizontally cast with FT 20 grey iron.
- Flanged fittings generally made of grey iron (FT 20) shall comply with I.S./BS/Din/iso.

OTHER MATERIALS FOR PIPES AND FITTING

The following materials shall comply with the ISO standards or equivalent approved by the Engineer:
- PVC pipes and fittings
- Polyethylene pipes and fittings shall comply with:
- Copper pipes shall comply with:

- Stainless steel pipes shall comply with:
- Galvanized steel pipes shall comply with:
- Flanges shall comply with iso 2531 for PN 10.

LADDERS, HANDRAILING AND ACCESS PLATFORMS

Ladders and hand railing shall be made of aluminum alloy 5052-0 tested to ASTM No. B210, Light Duty Aluminum, 5 KN/m^2.

Access platforms shall be not less than 750 mm wide, and shall sustain a uniform loading of not less than 5 KN/m^2 , the deflection at this loading not exceeding 0.005 of the span or 10 mm, whichever is the lesser. Higher loading shall be used as appropriate where heavy loads will be supported during installation, operation and maintenance of items of Equipment.

Flooring shall be metal of a non-slip self-draining pattern securely fixed to the supporting structure. Sections of flooring shall be arranged so that the pattern is continuous from one section to another. The sections shall fit without gaps and shall sit square on the supporting structure.

The weight of the removable sections shall not exceed 25 kg per piece.

Pipe Ends

Ends of pipes to be jointed shall generally be as follows:-

-(a) Spigots and sockets for jointing in trench or above ground.
-(b) Plain ends for use for with welded collars, mechanical couplings or flange adapters.

The spigot and socket joints for the spherical type shall be designed to take angular deflections of up to 5 degrees from the axial to accommodate changes of pipe gradient and/or direction at individual joints. For hemispherical type, the angular defalcations shall be up to 2 degrees.

Spigot and socket joints shall be of the spherical or hemispherical sleeve type with a minimum penetration of the formed ends. The joint design shall provide for the contact surface of the spigot end and the sleeve end to be formed to the same spherical radius which shall be more than 50% of the outside diameter of the barrel of the pipe for the spherical type and shall not be less than 50% of the outside of the barrel of the pipe for the hemispherical type. The minimum penetration of the spigot into the socket shall not be less than four times the pipe thickness and this overlap shall be obtained at the maximum deflection of 5 or 2 degrees. At zero deflection the minimum overlap shall be the minimum penetration as above increased by such allowance as is necessary to ensure contact between the spigot and socket over the specified maximum amount of joint movement. The joint engagement tolerance in any position shall not exceed an average of 1.60 mm with maximum isolated gaps of 2.00 mm adjacent to the weld seams.

Pipe ends of the spherical or hemispherical type shall be formed by hydraulic pressing using a full circle die or expending former capable of forming ends consistently to a constant spherical contact surface throughout the pipe production run.

The internal surface of the socket and the external surface of the spigot shall be ground smooth along the shop fusion welds for a distance of 150 mm from pipe ends measured along the pipe axis.
The external surface of the plain-ended pipes shall be similarly prepared.

All sockets shall have two tapped holes spaced at 90 degrees apart on the circumference. They shall be of not less than 6 mm diameter and shall be provided with matching plugs to facilitate the air pressure testing of field welds. These tapped holes shall be located within the end 30 mm of the sockets and shall be cleared of welding runs.

Ends prepared for butt welding shall be subject to manufacturing tolerances in accordance with Table 6.3 of Std 5L or Table 6.2 of Std 5L/S.

Plain ends for use with mechanical joints or flange adopter joints shall be truly circular with a diameter tolerance of = 1 mm over a distance of 225 mm from the pipe ends.

Bends, Tees, Tapers, etc.

Special items such as bends, tapers, tees, etc, shall be formed from completely lined pipes as specified by suitable insertion of rubber spacers during lining operation. The coating and lining on the straight pipes shall be cut back from the ends to be welded or cut for a sufficient distance to ensure that no material which is intended to remain part of the coating/lining is damaged or affected by the welding or cutting process.

Pipe specials shall be designed to withstand the full-specified factory test pressures. Compensation plates and gusset plates shall be in accordance with BS 5500.

Welding shall be of a standard equal to that of straight pipes and each butt weld shall be subjected to a 100% radiograph test. Fillet welds shall be subjected to air tests where appropriate and/or magnetic crack detection tests.

The outside diameter of specials conforms to the outside diameters of the standard straight pipes. The ends of plain ended specials shall be truly circular and shall conform to the tolerances required for the fitting of mechanical couplings and flange adapters.

Flanged Joints

All flanges shall be of steel welded to the pipe by the electric are process or other approved method. They shall conform in all respects with the requirements of BS 4504 unless otherwise specified. Their mating dimensions shall generally be in accordance with the Standard for PN 10, (in which case they will also be in accordance with ISO 2531 and NF E 29-201 for the same value of PN). They shall be of the raised face type and shall be truly faced over their whole width. Bolt holes shall be drilled off center lines, truly in line end to end with the longitudinal axis. All flanges shall be rated as 10 bar. All flanges shall be adequate to withstand test pressures for the specials to which they are attached.

All materials required for use in the making of flanged joints including nuts, bolts washers and joint gaskets shall be supplied by the works contractor. Joint gaskets shall be contained within the bolt pitch circle and shall be made from 4.5 mm thick rubber to BS 1154 Class Y3 reinforced with two layers of fabric in accordance with BS 5292. Each bolt shall be supplied and installed with a nut and two washers and each bolt shall be of sufficient length to show two threads past the nut when so installed.

Test certificates for the flange material shall be supplied. The finish on flange joint surfaces shall be in accordance with Clause 4.4 of BS 4504.

Blank flanges shall be designed and supplied by the Works Contractor for an end loading equivalent to the rating pressure of the flange. Lifting eyes or handles and air release cocks shall be provided as necessary.

Thrust flanges shall be designed to withstand a longitudinal force equal to the loading applied to a blank flange of equivalent diameter.

Mechanical Couplings, Flange Adaptors and Expansion Joints

Mechanical couplings for jointing plain ended pipes shall be of an approved make capable of maintaining a watertight joint over a range of axial movement between the pipe ends of at least 80 mm and with up to 3 degrees angular deflection between the longitudinal axes of the pipes.

Flange adapters for jointing plain-ended pipes to specials shall be of an approved make capable of maintaining a watertight joint over a range of axial movement of at least 25 mm and an angular deflection of not less than one and a half degrees.

Expansion joints shall be provided to conform with details as shown on the drawing. They shall be supplied complete with all accessories.

All necessary couplers, joint rings, nuts, bolts and washers, etc. required for completing joints shall be supplied by the Works Contractor.

Couplings shall be supplied with or without a central register or locating plugs as required. The central collar shall be at least 1.5 mm thicker than the equivalent standard pipe thickness.

Every coupling, flange adapter and expansion joint shall be capable of withstanding without leakage the pressure required for the works hydraulic test of the section of pipeline in which it will be incorporated. The pressure rating shall be clearly stamped on all couplings and adapters. The rubber joint rings shall be Type 1 to BS 2494 having a hardness range of 45-65 degrees measured in accordance with BS 903 and tensile stress-strain properties corresponding to the relevant hardness.

All metallic parts are to be descaled to second quality standard in BS 4232 and protected in accordance to the specification.

All welding protrusion shall be machined finished Mechanical couplings and flange adaptors shall be hydraulic tested at the place of manufacture one in every five for each size of coupling and adaptor.

Every expansion joint shall be hydraulic tested at the place of manufacture prior to delivery.

Pipes for Closing Lengths

Pipes to be used for closing lengths shall be correctly sized over their full length so that accurate alignment for split collar joints can be obtained. All such pipes shall be clearly marked.

Collars

Collars shall be provided for jointing cut pipes or closure pieces by means of internal and external fillet welding. Minimum lengths of collars shall be 250 mm. Collars may be provided as single split collars with temporary bolts and lugs. Collars shall have two tapped and plugged holes of not less than 6 mm diameter to permit air pressure testing of the joints after field welding, one each side of the collar clear of the welding runs and approximately 25 mm form the edge of the collar. The collar shall be 1.5 mm thicker than the equivalent standard straight pipe thickness. Collars shall make close contact around the circumferences of both pipes connected and the gap between the ends of a split collar after tightening shall not exceed 3 mm. Split collar ends shall be prepared for butt welding in the same manner as plain ends of pipes prepared for butt welding in accordance with Std 5L/S. The tolerances of the collar shall be such than nowhere shall the gap between the inside surface of the collar and the outside surface of the pipe at fillet weld locations exceed the tolerances permitted for spigot and socket joints.

The overlap on each pipe shall not be less than 75 mm. Collar joints shall not be required to take any deflection.

Physical Testing

Unless otherwise specified physical testing of the pipes shall also be in accordance with Section 4 of Std 5L/S.

Works Hydraulic Testing

All pipes shall be hydraulically tested at the place of manufacture in accordance with Section 5 of Std 5L/S. Full test pressures shall be maintained for at least 3 minutes during testing at the factory and automatic pressure recorders must be installed on hydraulic testing machines.

Any pipe, which fails to withstand the hydraulic test pressure, or which exhibits signs of porosity shall be deemed not to comply with this Specification and shall be rejected unless otherwise decided.

Protection

All pipes shall be protected both internally and externally against corrosion. The pipes shall be protected externally with a double reinforced bitumen enamel wrapping followed by internal protection with spun concrete lining. Both types of protection shall be applied under factory conditions but not necessarily at the place of manufacture of the pipes.

Internal and external protection at joints shall be completed on Site after acceptance of joint weld test.

External Coating

The pipes shall be coated with bitumen generally in accordance with Clauses 29 of BS 534 except that the protection shall have a minimum thickness of 6 mm for pipes over 324mm od. The bitumen shall be Type 2 of BS 4147 and there shall be not less than 2 mm of bitumen between the inner and outer wraps, and between the pipe and the inner wrap.

The coating shall be stopped short as shown on the Drawing for ends of all spigot and socket pipes, and 250 mm from the ends of all plain ended pipes for use with mechanical couplings or flange adapters. The edge of the wrapping shall be chamfered at 25 degrees.

Wrapping

The wrapping materials shall be spirally wound onto the pipes and specials simultaneously with the bitumen coating. Each wrap shall be from 150-225 mm wide and the edges shall overlap by 12-25 mm. Care shall be taken to ensure that the inner wrap does not come in to contact with the pipe metal or with the outer wrap.

The inner wrap shall be a glass fiber resin-bonded tissue reinforced in the longitudinal direction with parallel glass threads spaced 10 mm apart. The nominal thickness shall be 0.5 mm and the minimum weight shall be 0.046 kg/m2.

The outer wrap shall be of glass fiber resin-bonded tissue reinforced in the longitudinal direction with parallel glass threads spaced to 10 – 25 mm apart. It shall be impregnated with a material fully compatible with the bitumen coating to give a finished thickness of 0.75 mm.

Inspection of External Pipe Coating

All coated pipes and specials shall be rigidly inspected for defects. Thickness shall be determined by a pit gauge, continuity with a holiday detector and coating quality by cutting out 75 mm square samples at the rate of one sample per 5 lengths of pipe manufactured.

The whole coated surface area of all pipes and specials shall be tested for pinholes or other invisible defects in the coating using an approved holiday detector at a potential of 14,000 volts.

Any lengths on which the coating is in the opinion of the Engineer poorly applied shall be cleaned to bare metal and re-coated. Minor defects may be repaired by touching up. All repairs shall be checked for thickness and continuity.

Painting Coated Pipes and Specials

All coated pipes and specials shall be given two coats of undiluted commercial "Matex" or similar approved vinyl acetate paint to reduce the risk of the coating becoming tacky.

Internal Protection at Pipe Ends

Concrete shall be omitted at the following locations:

Spigot & Socket Ends	The lining shall terminate as shown on the Drawing. The edge of the lining shall be angled back at 3mm to the pipe axis in order to provide a positive key for in-situ joint protection.
Plain Ends	For butt straps or collar joints, the lining shall terminate 90mm back from the pipe end. The edge of the lining shall be angled back at 30^{O}. For mechanical coupling and flange adaptor joints, the lining shall be brought right against the retaining rings.

Pipe-work for Laying above Ground

Uncoated steel pipes and specials required for installation above ground shall be protected with three coats of approved zinc chromate primer after cleaning down to a bright metallic finish as to BS 4232 first quality standard.

End Protection

The concrete lining and the external coating of pipes and specials to be jointed by welding shall be omitted for a sufficient distance from the ends to prevent damage to the protection during site welding.

The unlined surfaces shall be protected with a suitably approved ensis oil or similar material during manufacture so that extensive cleaning of the surface is not required before and after jointing on site.

Low Friction Coating

Where necessary, the external surfaces of the pipe ends for use with mechanical couplings and flange adaptors shall be given, after blast cleaning to BS 4232 first quality, an approved system of low friction viny1-based protective coating. The coating shall be applied in accordance with the manufacturer's instructions. Where zinc or bituminous coatings adjoin the low friction coating, they shall over lap the low friction coating by 25 mm. The length of pipe barrel to be so protected by the low friction coating shall be 300 mm unless directed otherwise.

After curing but before removal from the factory the coating shall be wrapped with tape suitable for protecting the coating from damage in transit to and on the site. The tape shall be removed immediately prior to installation of the pipe or special so coated.

A coating which conforms to the above requirements is "Amercoat 23" system manufactured by Ameron, Protective Coatings Division. Brea. California 92621.

Handling

Coated pipes shall be lifted and moved only by wide non-abrasive slings or by other means acceptable to the Engineer. Wire ropes, chains and hooks shall not be permitted to come in contact with the coatings. No pipe shall be moved by rolling.

Coated pipes shall be stacked in one layer only and in such a manner that the coating is not damaged. Adequate packing between pipes for this purpose must be supplied by the woks contractor. Coated pipes must be kept clear of the ground and rested on padded sleepers or supports.

The pipes shall be so handled. Stored and transported as to prevent undue distortion and shall not be moved in any manner involving rotation of the pipe about the longitudinal pipe axis.

The pipes shall be lifted by means of tow reinforced canvas slings at least 300 mm wide suspended from a lifting beam so that the slings are positioned at a distance of one-fifth of the pipe length from each end of the pipe.

The works contractor shall provide suitable timber end struts and sufficient intermediate struts to strengthen the pipes to the engineer's approval to prevent distortion during handling and delivery. Such struts shall be left in position when thin wall pipes of 1400 mm and above are delivered to the storage areas.

Protection in Transit

All pipes and specials shall be protected prior to dispatch from the manufacturer's works. All flanges shall have wooden discs bolted on. All other ends of pipes and specials shall be protected against impact damage and entry of foreign matter. The protection shall take into account the end use intended for the pipes and whether or not the final protection has been completed.

Pipes and specials shall be wrapped or cushioned so that no load is taken directly on the external coating.

Notice of Deliveries

The Works Contractor shall send to the Engineer advance notices of all consignments. Every consignment shall be accompanied by a detailed delivery note with the item number of each pipe or special.

Inspection

The Engineer shall inspect all pipes and specials to be supplied under the Contract or an Inspector appointed by the Company at the Works Contractor's premises or at the places of manufacture if manufactured at other premises.

The Works Contractor shall provide such office facilities, assistance, labor, materials, electricity supply, fuel, stores, apparatus and instruments including X-ray or gamma ray equipment, ultrasonic thickness indicators and high voltage holiday detectors as may be necessary to allow a thorough and extensive inspection to be carried out.
The Engineer or the Inspector shall be entitled at all times during manufacture to inspect, examine and test on the Works Contractor's premises or at the places of manufacture if manufactured at other premises, the materials and workmanship of the pipes and specials. Such inspection, examination or testing including the inspection by the Engineer or Inspector shall not relieve the Works Contractor from any of his obligations under the Works Contract.

Measurement of Steel pipes and Specials

The quantities set out in the Bill of Quantities are provisional only and they are not to be taken as the actual, limiting and correct quantities of the pipes and specials to be supplied by the works Contractor in fulfillment of his obligations under the Contract. For the purpose of this clause, spigot and socket ended pipes shall be measured and paid in effective length. The effective length shall mean the net length of the pipe as laid, i.e. after deduction of the length of overlap at any spigot and socket joint to be made with the pipe.
The cost of all works testing and all other requirements of the Specification including lining, coating, wrapping, etc, involved in the manufacture and delivery of the steel pipes shall be deemed to be included in the Contract Rates.

CAST IRON PIPES

Cast Iron Pipes and Specials

Cast iron pipes shall be spun iron pipes complying with BS 4622 and BS 4772 for grey iron spun pipe and ductile iron spun pipe respectively. They shall be centrifugal cast pipes made by pouring molten cast iron into a horizontal water-cooled metal mould which is rotating at high speed.

Joint for Cast iron Pipes

Types of joint to be used shall be as specified unless otherwise stated to meet the approved Manufacturer's instructions.

Making Flanged Joints

Flanged joints shall comply with BS 4504 (metric) and shall be very carefully aligned before the bolts are inserted and the flanges pulled together. The rubber ring inserted between the flanges shall be of such diameter that it lies inside the bolt circle but shall not intrude into the pipe bore.

Flanged joints underground shall be protected by two layers of an approved bitumen-impregnated tape.

Making Joints with Mechanical Couplings and Adapters

Joints made with mechanical couplings and shall be made in strict accordance with the instructions given by the manufacturer.

Cast Iron Specials

Special pipes and castings, including bends tees and branches shall comply with BS 78: Part 2. Joints shall be approved flexible joints unless otherwise specified.

T-pieces for air valves shall be spigot and socket with a flanged branch drilled to suit the air valve, unless otherwise specified. T-Pieces for washouts shall be double sockets with a flanged branch unless otherwise specified, level with the invert and drill for a sluice valve.

Protective Coatings on Iron Pipes

Spun iron pipes shall be coated inside and out with a coal tar pitch giving a smooth surface. For extra exterior protection, pipes may be sheathed with a 6.6 mm sheathing of filled bitumen, sometimes reinforced with glass fiber wrapping as and when specified.

Alternatively, the pipes and specials shall be sheathed in sleeves of 0.25. mm (1000 gauge) polyphone sleeving which shall be sealed together with tape. Self-adhesive PVC tapes, having a thick layer of a mastic compound on one side or fibrous tapes impregnated and coated both sides with a similar compound shall be wound spirally lapping, over the joints externally to complete exterior protection before polyphone sleeving.

Testing of Cast Iron Pipelines

Recommended test and working pressures shall be as set out in BS 4622, BS 4772 and CP 2010 Part 3.

When applying field test pressures, which are higher than the working pressure, care shall be taken to ascertain that thrust blocks at bends, etc. have been designed for the test pressure and not for some lower working pressure.

Valves Specification.

Unless otherwise specified all valves and penstocks shall be anti-clockwise opening and the maximum effort required, applied at the circumference of the hand wheel to operate the valves against the maximum unbalanced head shall not exceed 220 N.

All hand wheels shall have the words " to open " and " to close" in Arabic and English with arrows indicating the direction of rotation cast on and shall be coated in plastic, nylon or other approved materials in order to withstand the ambient conditions.

Unless otherwise specified or agreed the screwed portion of spindles and extension and extension spindles shall be of stainless steel.

Rising spindles to be installed in open air shall be protected with suitable metal or plastic cover

Extension spindles, where required, shall be connected to the screwed spindle with a suitable muff-coupling. Universal joints shall be provided at cranks.

The nuts shall be of gunmetal or synthetic material and mating surfaces of gates and bodies shall be of gunmetal, copper alloy or synthetic material. Nylon or other thermoplastic materials liable to attack shall not be used where hydrogen sulphide is likely to be present.

Where " operation by tee key" in specified the valve or pen-stock shall be supplied with a suitable yoke with a squared cap of standard size to receive the tee key.

The keys shall be supplied at the rate of one key per two valves or two pen-stocks unless the valve or pen-stock is to be installed in an isolated location in which case one key shall be supplied for each fitting location.

All valve waterways are to be coated internally with a solvent free epoxy or polyester lining of 100 solid content to be applied at the place of manufacture.

Valves and penstocks shall be capable of withstanding corrosion in the ambient conditions and any parts manufactured from a material, which is not it self resistant must be protected.

All valves and penstocks will normally be witness tested at works.

Before delivery to site all working surfaces shall be thoroughly cleaned, and, if metal, protected by grease.

Packing must be sufficient to ensure complete protection of the fitting during transit and storage.

Valves under 300 mm diameter together with all hand wheels an other easily detachable items on both valves and pen-stocks are to be packed in timber packing cases and properly bound with steel packing bands.

All valves of 300 mm and over are to be protected with wood or plywood discs or flanges together with straw rope and hessian wrapping.

Gate Valves for Water Supply

Unless higher pressure rating are required for the pipeline, gate valves shall have a nominal pressure designation of 10 bars which shall be marked on the valve body. Unless detailed to the contrary to suit existing pipe work, flanges shall have a pressure designation of 10 bars and shall be drilled accordingly. The face to face lengths of the valves shall be in accordance with ISO 5752 Series 2. Valves with lengths to Series 14 may be used with suitable make up pieces to achieve the Series 3 lengths.

Valves stem seals shall be of the stuffing box and gland form. Valves shall not be fitted with resilient seals.

Indicators, hand wheels, caps for key operation, extension spindles, capstan head stocks and locking devices shall be provided as specified as or shown on the drawings.

Valves shall be " open end " tested.

Valves for which witnessed tests at works are required are so specified.

Air Valves

Air valves for pumped pressure pipelines will be the special high pressure " Dual" large orifice type with a maximum working pressure of 100 meters head and a body test pressure of 200 meters head, for other duties, such as distribution mains single, small orifice type valves may be used.

Pressure Reducing Valves

Pressure reducing valves shall be flanged with cast iron bodies and shall be supplied complete with inlet and outlet pressure gauges and adjustable regulating weights. The maximum sustained inlet pressure shall be determined from the closed valve pressure of the installed pumps.

Inlet Float Valves

Inlet float valves shall be of the streamlined needle type complete with stilling and control basins and 38 mm dia. syphon. The sizes of the valves for each installation are shown on the drawings.

Metal Flap Valves

Flaps and frames shall be of close grained cast iron. Mating surfaces of flaps and frames shall be of non-ferrous metal (excluding aluminum) machined to ensure a watertight fit in the closed position.

Hinge pins shall be of phosphor bronze, all flaps shall be double hung.

All cast iron surfaces shall be cleaned by grit or shot blasting to be free from grease, then coated as specified for the environment. Hinge pins and mating surfaces shall be smeared with grease.

Plastic Faced Flap Valves

Flap valves shall be faced in an approved synthetic material so as to be corrosion-free in the ambient conditions. The flap shall be weighted to assist closing and shall be suitably braced and reinforced.

Hinge pins shall be of stainless steel and all flaps shall be double hung and seated off the vertical.

Mating surfaces shall be accurately molded or machined to ensure a watertight fit in the closed position.

Non-Return Valves

Unless higher-pressure ratings are required for the pipelines non-return valves shall have a pressure designation of 10 bars. Unless detailed to the contrary to suit existing pipe work, flanged valves shall have there flanges to a pressure of 10 bars and be drilled accordingly.
The face to face lengths of the valves shall be either 2 x ND + 100 mm or ISO 5752 Series10, the longer length to be allowed for in all cases using make up pieces where necessary to achieve the required lengths.

Valves shall be of the single door swing check type and shall have a cast iron body, copper alloy seating and resilient faced disk.

All valves shall be clear way, and lugs provided on screwed seats etc., for assembly purposes shall be removed.
Valves shall, unless impracticable through size, or otherwise specified as capable of passing solids not exceeding 90 mm dia.

Valves shall be provided with a removable cover on top of the body casting, to enable the hinge and door to be inspected or removed.

The door opening shall be restricted to a maximum, of 70^0 at the hinge, measured from a plane passing through the hinge at right angles to the axis of flow. Valves shall be provided with extended spindles to the doors fitted with level arms suitable for balance weights.

The valve should be provided with limit switch , operated by external cams rigidly attached to the door spindles. The limit switch shall operate when the valve door has moved through approximately 10^0 . The switch shall provide one normally open and one normally closed electrically separated contacts of the make before break type.

Pressure and Compound Gauges

Pressure gauges for use with water shall be Borden gauges. The pressure transmission system shall be of the air-filled or oil-filled sealed type incorporating reinforced plastic or stainless steel capillary tubing and diaphragm transmitter.

For the air-filled system, the diaphragm shall be mounted in a clean-out housing. The transmitter housing shall be mounted directly onto a 25 mm or greater bore straight through isolating cock. The cock shall be mounted directly onto the pressure tapping.
Where the gauge is mounted directly on the pressure tapping a schaffer diaphragm gauge may be used. Schaffer diaphragm gauges shall be fitted with 20 mm or greater born straight through isolating cocks.

Gauges shall be graduated in meters of water and bars gauge, together with vacuum where appropriate. The accuracy of the system shall be = 1.50 of range or = 2.50 m bar. Gauges shall have 100-150-mm diameter circular fac

Air Release Valve/ Parts Specification

Part	Material
Screw	Polypropylene
Protective Cover	Polypropylene
Bolt and Nut (X6)	Galvanized Steel, Chromate Plated
Cover and Nozzle	Brass ASTM – B – 124
O-Ring	Buna-N
Float	Polypropylene Natural Rubber Coated
Screen-Basket	Polypropylene
Body	Cast Iron ASTM – A-48
Male Adaptor	Brass ASTM – B – 124 ¾" x 1"
Filter	Nylon
Seal	Fiber
Cover	Cast Iron ASTM-A-48
Nozzle	Natural Rubber on Bronze Seat
O-Ring	Buna – N
Basket 2"	Polypropylene
3" , 4"	Cast Iron
Float	Polypropylene
Body	Cast Iron ASTM-A-48

Gate Valve/ Parts Specification

DENOMINATION	DESIGN A – FOR LIQUID AND GASES UP TO 70ºC
Protecting Ring	Perbunan Extra
O – Ring	Perbunan Extra
Locking Nut	Brass MS 58
O – Ring	Perbunan Extra
Slide Ring	Nylon 6
Cover	Nodular C.I. GGG 50
Stem	Stainless Steel Cr. > 13%
Stem Nut	Bronze Cu Al 10 Ni
Bolt	Stainless Steel
O – Ring	Perbunan Extra
Body	Nodular C.I. GGG 50
Resilient Wedge	Nodular C.I. Perbunan Coated.
PIN	Brass
Handweel	Cast Iron GG 20

BUTTERFLY VALVE

The butterfly valve is bi-directional, leak tight and appropriate for on-off regulating service due to its resilient seat. The parts are:

1. **Body** – Double flanged solid one piece construction made out of cast iron as standard,
2. **Bushing** – self lubricating to minimize shaft friction under maximum torque.
3. **Seals** – Complete sealing is made as vulcanized seat against disk and vulcanized sleeve along shaft and " O " rings on stem.
4. **Stem** – Stub shafts made of polished stainless steel. Motion is transferred to disc with fitted square end.
5. **Disc** – The disc is especially shaped with a smooth contoured edge to minimize friction losses and provide a drop tight seal.
6. **Liner** – vulcanized to body in an extramurally accurate manner to form a drop tight resilient seal with low friction and long life.

7. **Base** – Stub shaft is sealed by bushing and plug.

LEVEL REGULATOR

The level regulator is consists of a float linked to a cable and equipped with switches.

The maximum depth immersion is 20 m (65 ft).

The casing of the regulator will be-made of polypropylene and the cable sheathed with a special PVC compound.

The level regulator contains a micro switch with two positions common with on/off. The liquid density is for wastewater and storm-water.

Other specifications:

- Standard ISO 9001 / 9002 or BS equivalent.
- Cable 20 m length.
- Electrical waterproofs IP58.

DISMANTLING JOINT

The dismantling joint is installed close to a valve (or check valve) to enable easy dismantling.

It is available in the range of the valves and must be installed above-ground or in a chamber.

This joint consists essentially of two flanged spigot pieces, one of which slides in the other, and a loose gasket which has a trapezoidal cross-section. This joint is clamped by means of studs.

The three components constituting the joint are in welded steel and the bolts and nuts are cadmium plated.

It complies with the standards ISO 2084 or BS 4504 for flanged pipes and fittings.

Dimensions and weight:

DN	**mm**	**100**	**150**	**200**	**250**	**300**
Length Maxi	mm	225	225	245	245	245
Maximal service pressure	bar	10	10	10	10	10
Weight (+ 20%)	Kg	20	35	50	65	75

PIPE COUPLING

For pipe couplings there are brass compression fittings a full range of fittings suiting PE pipes from ¼" to 2" O. D. also for couplings, elbows, tees, etc. there is a long pipe piece inside the fitting, thick and wide gasket, three tooth gripping ring ensuring full installation safety and tightness at 10 bar.

Deep-Set, Water lubricated

A. Scope

This specification covers a line shaft turbine pump with above ground discharge, the line shaft bearings lubricated by the water being pumped and furnished with suitable driver and accessories as specified herein. The pumping unit shall be designed and furnished in accordance with the latest Hydraulic Institute and AWWA Standards for line shaft turbine pump.

B. Service Conditions

The pump shall be designed and constructed to operate satisfactorily with a reasonable service life, when installed in a dependable and adequate water resource location. The pump shall be the product of, and manufactured by Goulds,Paterson ,Vertlin ,Hamechadash or equivalent approved type. Other manufacturers will be considered providing the unit offered is an approved equal in all
respects to the brand and model preferred by the customer. Factory pump performance curves for alternate pumps shall be submitted with the bid.

C. Operating Conditions

The following sizes and figures shall be applied unless other figures specified as per bill of quantities which will has the priority and the lead.

Design flow conditions: ____60 m^3/hour
Design head: _____100_____ Meter total dynamic head (TDH)
Minimum pump efficiency: ___80___Percent
Maximum allowable speed: __1450_____ RPM
Pump bowl diameter : ____8____ Inches
Well diameter I.D.: _____12_____Inches

D. Pump Construction

1-Bowl assembly:

The bowls shall be flanged type constructed of close grained cast iron conform to ASTM A48,class 30. They shall be free from sand holes, blowholes, or other faults and must be accurately machined and fitted to close tolerances. They shall be capable of withstanding a hydrostatic pressure equal to twice the pressure at rated flow or 1.5 times shut-off head, which ever is greater. The intermediate bowls shall have enamel or epoxy
lined waterways for maximum efficiency and wear protection. All intermediate bowls shall be of identical design for interchangeability. A discharge bowl shall be used to connect bowl assembly to the discharge column. All the bowls (include the discharge bowl) shall be fitted with sleeve type bearings of bronze alloy C89835.

2. **Impellers**:

The impellers shall be constructed from ASTM B584 Silicon Bronze and shall be the enclosed (or semi open) type. They shall be free from defects and must be accurately cast, machined and filed for optimum performance and minimum vibration. Impellers shall be balanced to grade G6.3 of ISO 1940 as minimum. They shall be securely fastened to the bowl shaft with taper locks of C1018 steel.

3. **Suction**:

The suction bowl shall be provided with non-soluble grease packed bronze bearing. A bronze sand collar shall be provided to protect this bearing from abrasives in the pumping fluids. The bearing housing shall have sufficient opening at the bottom for easy removal of the bearing.

4. **Shaft**:

The bowl shaft shall be constructed from ASTM 582 type 416 stainless steel. It shall be precision ground and polished with surface finish better than 40 RMS.

E. Column Assembly-Water Lubricated

1. **Column pipe**:

The column pipe shall be furnished in sections not exceeding a nominal length of 10 ft and shall be connected by threaded-sleeve couplings. Pump speeds between 2200 RPM and 3600 RPM shall have intermediate column length and bearing spacing no greater than 5 feet. The length of the top and bottom sections shall not be more than 5 ft. The pipes shall be of ASTM A53 grade B steel pipe and the weight shall be not less than schedule 30. The end of the pipe shall be with 8 threads per inch with 3/16" taper per foot thread and faced parallel to butt against the centering spiders of ASTM B584 Silicon Bronze to form accurate alignment. The inside diameter of the pipe shall be such that the head losses shall not be more than 5 feet per 100 feet of pipe based on rated flow of the pump.

2. **Line shaft:**

The line shaft shall be of ASTM 582 type 416 stainless steel, ground and polished with surface finish not to exceed 40 RMS. They shall be furnished in interchangeable section not over ten feet in length, and shall be coupled with threaded steel couplings machined from solid steel bar. It shall have left-hand thread to tighten during pump operation. The diameter of the shaft and coupling shall be designed in according with AWWA E101 Standard.

3. **Bearing:** Bearing shall be fluted rubber retained in the centering spider by a shoulder on each end of the bearing

F. Discharge Head Assembly-Water Lubricated

1. **Discharge Head**:

It shall be of the high profile type to allow shaft coupled above stuffing box and provided for mounting the driver and support the column and bowl assemblies. It shall be of high-grade cast iron, ASTM A48 Class 30, or fabricated steel. The above ground outlet shall be flanged to match __4_ inch ANSI class 125 (for cast iron) or class 150 (for steel). It shall have a 1/2" NPT connection for a pressure gauge.

2. **Stuffing Box**:

The stuffing box shall be cast iron and shall contain a minimum of five rings of packing. It shall have a pressure relief connection. The packing gland shall be a 316 SS split type secured in place with non-corrosive studs and nuts. The bearing shall be C89835 bronze. A rubber slinger shall be secured to the shaft above the packing gland.

3. **Head shaft:** The head shaft goes through the stuffing box shall be of ASTM 582 type 416 stainless steel. It shall be precision ground and polished with surface finish better than 40 RMS.

G. Suction Pipe and Strainer

The suction pipe shall be ___ feet in length and shall have a minimum inside diameter and weight equal to or larger than that of the discharge column pipe. A suitable cone strainer of galvanized steel shall be provided having a free area of at least four times the flow area of the suction pipe.

H. Electric Motor

The motor shall be a heavy duty squirrel cage induction type, NEMA Class B or Class F insulation with WP-1 enclosure, __1450__ RPM vertical hollow (or solid) shaft motor, with a non-reverse ratchet (or self-release coupling) to prevent reverse rotation of the rotating elements. A thrust bearing of ample capacity to carry the weight of all rotating parts plus the maximum hydraulic thrust load under all conditions of operation calculated L10 life shall be no less than 8800 hours. The motor shall be standard (or premium) efficiency, 1.15 service factor, and suitable for use on _400__ volt, three phase, 50 Hz electric service. An adjusting nut shall be provided at the top of the motor for setting the impeller to bowl running clearance.

Submersible Turbine Pumps

A. Scope

This specification covers a deep well submersible turbine pump with above ground discharge and furnished with suitable driver and accessories as specified herein. The pumping unit shall be designed and furnished in accordance with the latest Hydraulic Institute and AWWA Standard for submersible turbine pumps.

B. Service Conditions

The pump shall be designed and constructed to operate satisfactorily with a reasonable service life, when installed in a dependable and adequate water resource location. The pump shall be the product of, and manufactured by Goulds,Rovatti,Lowara or equivalent approved type. Other manufacturers will be considered providing the unit offered is an approved equal in all respects to the brand and model preferred by the customer. Factory pump performance curves for alternate pumps shall be submitted with the bid.

C. Operating Conditions

The following sizes and figures shall be applied unless other figures specified as per bill of quantities which will has the priority and the lead.

Design conditions: _____60_____m^3/Hour
Design head: _____100_____Meter total dynamic head (TDH)
Minimum pump efficiency of: ____78____ Percent
Maximum allowable speed: ___2800_____ RPM
Pump bowl diameter : ___6_____ Inches
Well diameter I.D.: ___10_____ Inches

D. Pump Construction

1. **Bowl assembly**:

The bowls shall be flanged type constructed of close grained cast iron conform to ASTM A48,
class 30. They shall be free from sand holes, blowholes, or other faults and must be accurately machined and fitted to close tolerances. They shall be capable of withstanding a hydrostatic pressure equal to twice the pressure at rated flow or 1.5 times shut-off head, which ever is greater. The intermediate bowls shall have enamel or epoxy lined waterways for maximum efficiency and wear protection. All intermediate bowls shall be of identical design for interchangeability.

All the bowls shall be fitted with sleeve type bearings of bronze alloy C89835. A discharge bowl
shall be used to connect bowl assembly to the discharge pipe. An extra long bronze bearing packed with non soluble grease shall be provided in the top bowl and extended into the discharge bowl The bearing shall have a threaded cast iron cap or plug at the top to protect the bearing from abrasives. The hub of the discharge bowl should be such that the bearing can be easily removed through the top of the hub. A thrust ring shall be above the top impeller to prevent excessive vertical up thrust.

2. Impellers:

The impellers shall be constructed from ASTM B584 Silicon Bronze and shall be the enclosed type. They shall be free from defects and must be accurately cast, machined, balanced, and filed for optimum performance and minimum vibration. Impellers shall be balanced to grade G6.3 of ISO 1940 as minimum. They shall be securely fastened to the bowl shaft with taper locks of C1018.

3. **Motor Adapter:**

The inlet motor adapter shall be of ASTM A536 Gr. 60-40-18 ductile iron and shall contain an

extra long bronze bearing. The inlet area shall have a net open area of at least four times the eye of the impeller and shall be protected with a 304 stainless steel screen. The openings on the screen shall not be more than 75% of the minimum opening of the water passage through the bowl or the impeller.

4. **Shaft:**

The pump shaft shall be of ASTM 582 type 416 stainless steel. It shall be precision ground and polished with surface finish better than 40 RMS.

5. **Coupling:**

The shaft coupling shall be of stainless steel and be capable of transmitting the total torque and total thrust of the bowl assembly in either direction of rotation.

E. Discharge Pipe

The discharge pipe shall be ASTM A53 grade B standard weight steel pipe, in ___ feet (or random) lengths and connected by threaded sleeve type steel coupling. The ends of the pipes shall have ANSI B1.20.1 standard tapered pipe threads. Inside diameter of the pipe shall be such that the head losses shall not be over 5 feet per 100 feet of pipe.

F. Submersible Cable

Pump cable shall be sized to limit the voltage drop to no more than 5%. The cable shall have three separate conductors and a ground and shall be included in a single continuous jacketed assembly. The insulation shall be water and oil resistant, and suitable for continuous immersion. The cable should be the length of the discharge pipe plus __40_ feet to extend from the surface plate to the electrical controller. The cable should be adequately secured to the discharge pipe by plastic ties, or other non metallic means, at 10 foot intervals.

G. Surface Plate

The surface plate shall be of fabricated steel. The plate shall incorporated a long radius elbow welded securely to a ANSI Class 150 ___ " flange and shall rigidly support the total weight of the motor, bowl assembly, discharge pipe, cable, and column of water. The plate shall have a cable seal of adequate size to accommodate the cable size and well vent and water level indicator.

H. Submersible Electric Motor

The motor shall be a heavy duty canned (or wet wound) type of NEMA design __2800__ RPM, with outside diameter not to exceed ___6__ inches. The motor shall be capable of continuous operation under water at the specified conditions outlined above. A suitable thrust bearing shall be incorporated in the lower end of the motor adequate to receive the entire hydraulic thrust load of the pump unit plus the weight of the rotating parts regardless of the direction of rotation.

The motor shall have a 1.15 service factor, and suitable for use on _400___ volt, three phase, 50 Hz electric service.
The motor leads shall be of sufficient length so that they may be spliced above the bowl assembly and the leads shall be protected by a type 304 stainless steel cable guard held in place with stainless steel banding. As the motor lead exit the top of the cable guard it shall be properly protected to prevent damaging or cutting the lead by the cable guard material.

DOSING UNIT SPECIFICATION

Operating conditions:

Sodium hypochlorite solution of 12% active chlorine

Consisting of:

1solenoid type metering dosing pump
1 mixer
1 tank
-All associated electrical connections and mechanical pipe work installations including tubes ,injection nozzles ,suction foot valves

1. Tank specifications

- Volume	500 liters
- Material	Polyethylene /white

With a drain valve and loading hatch including float switch to switch off the pump at certain low level.

2. Mixer

- Rotor material	SS 316 L polyethylene coated

3. Dosing pumps

Performance:

- Flow rate	0-4 l/h
-Maximum allowed pressure	16 bars

-Accuracy of feeding to be within +/- 4% of the set rate
-Adjustable doing rate knob from 10% to 100%
-4-20mA, control input signal

Pump electrical supply:

- Power Supply	230 V,50 Hz
- Protection/Isolation class	IP 55 F

Construction:

- Type	Diaphragm
- Check valves type	balls
- Connection at suction	Flexible hose with union nut and union screw collar
- Connection at discharge	same

Material:

- Body	PVC
- Diaphragm	PTFE
- Check valves body	PVC
- Seats	PVC
- Balls	Glass
- Valve seats	Viton

Including:

- 10 m of flexible pipe for discharge
- 2 m of flexible for suction
- On/Off switch control included in the terminal box of the pump

With union nut and union screw collar for each.

Other data

The dosing pump shall be wall mounted on a corrosion rigid plastic panel

SECTION 2 – WATER WORKS

2. INSTALLING AND LAYING OF PIPES

2.1 Pipes Embedded in Concrete

The contractor shall prepare these pipe sections with their fittings where necessary, to the shape and dimension as shown in the drawings and shall fix them in their exact positions.

Puddle flanges shall be welded to the pipe section to be embedded in concrete. Prior to installation the pipe surfaces shall be thoroughly cleaned of all dirt, paint residue, loose rust and mill scale, and of any other foreign matter detrimental to a good bond between the steel and concrete; light rust adhering to the metal may remain.

The Contractor shall not commence placing of concrete around the pipes until the Engineer has inspected the installed pipes and given his consent to start concreting.

Prior to casting concrete surround, the pipe surfaces shall first be covered with a rich, semi-dry mortar which shall be made to adhere to the steel. Concrete must then be cast while the mortar is still wet.

2.2 Underground Pipes

All jointing between pipes and between pipes and fittings shall be done by welding, except that where shown on the Drawings or directed by the Engineer, flanges or mechanical couplings shall be used.

Before lowering-in, the pipe coating shall be inspected and all defects repaired. Lowering of pipes into the trench shall be done by pipe layers or other equipment acceptable to the Engineer, so that no injury or deformation is caused to the pipes or the coating and lining.

Welded pipes shall be laid on the finished trench bottom, so that each pipe is supported over its entire length. The interior of the pipes shall be kept clean and free from any dirt and foreign matter. At the end of each working day and wherever work is discontinued for a considerable time, the ends of each welded section, whether in or alongside the trench, shall be closed by a suitable cover snapping onto the pipe end.

Lowering-in of pipes shall be done carefully to prevent damage to pipe coating or lining.

2.3 THRUST BLOCKS, ANCHORS AND CONCRETE SURROUNDING

If not otherwise instructed the Contractor shall provide thrust blocks at all bends, tees, branches and tapers and at blank ends for the pressure pipeline as specified by the pipe Manufactures and the Engineer. Enlargements shall be excavated in sides and bottom of the trench to accommodate anchorage and thrust blocks. The back of supports and blocks shall abut on to undisturbed solid ground. All loose material shall be removed before concreting.

The thrust blocks shall be designed by the Contractor in accordance with the BS.8110- 54 the structural use of concrete. The Contractor shall show that soil resistance is greater than or equal to 1.2 times the force exerted by the pipe when subjected to the test pressure. The soil resistance shall be calculated as the frictional resistance of the soil against the thrust block. The passive resistance of the soil shall not be considered in thrust block calculations.

Concrete shall extend to undisturbed ground on thrust faces of thrust blocks and on both faces of anchor blocks.

Where details are not shown on the drawings, the Contractor shall prepare proposals for thrust and anchor blocks and submit them to the Engineer's Representative for approval. Such approval shall not relieve the Contractor of his responsibility for the adequacy of his proposals. Special details shall be shown on the drawings or instructed at site where environmental or ground conditions dictate.

All thrust blocks, anchors shall be constructed from concrete with minimum strength of 250 kg/cm2.

2.4 VALVES - GENERAL

2.4.1 General

Valves shall be suitable for potable water supply.
All protective coatings shall be non-toxic and shall not foster micro biological growth nor impart any odour, taste, cloudiness or discoloration to the water. All ferrous surfaces in contact with water shall be coated with epoxy paint or similar approved by the Operator.
Valve bodies shall give the following information
Year of manufacture
Manufacturer's name.
Working pressure;
Size of valve;
all to be cast in raised letters, upon an appropriate part of the body. Where appropriate the marking shall have a minimum size of 25mm (1 inch), raised 3mm (1/8 inch).
After completion of assembly, each valve shall be shop operated three times from the fully open position to the fully closed position and returned to fully open under no flow condition to demonstrate that the assembly is working.
All valves shall be hydraulically tested at the place of manufacture to the pressures specified and shall satisfactorily pass the specified tests before they are packed for delivery. The operating gear of valves shall be such that one man can open and close the valve against an unbalanced head 15% in excess of the maximum to be encountered in service. Packed glands shall be arranged for easy replacement of the packing, which shall be accessible without removal of the valve from the pipe and while the valve is still in service.
Precautions shall be taken to prevent corrosion of the valve spindles in contact with the gland packing. Flanges of valves shall be to PN10.

2.4.2 Gate Valves

Gate valves shall conform to ISO Standards.
All Gate valves shall be fabricated in ductile iron.
The minimum working pressure of all gate valves shall be PN10.
Gate valves shall be of the resilient face type .The operating stem shall have 'o' -ring seals.
The direction of opening for all gate valves shall be anti-clockwise as viewed from the top.
Valve ends shall be flanged type. All external body and flange surfaces shall be coated with epoxy paint, or similar approved by the Operator.
All interior surfaces except the finished and seating surfaces, shall be coated with, epoxy paint, or 55 similar approved by the Operator.
For resilient faced gate valves, a hydrostatic test pressure equal to twice the rated working pressure of the valve shall be applied to the body with the gate in the open position. The test shall show no leakage through the metal, flanged joint, or stem seals. Subsequently, a test shall be made from each direction at the rated working pressure to prove the sealing ability of each valve from both directions of flow. The test shall show no leakage through the metal, pressure - containing joints, or past the seat.

2.4.3 Check Valves (Non Return Valves)

Check valves shall be of the swing type with an extended hinge pin extended from both sides. Check valves shall be used to prevent automatically reversing of flow. Check valves shall comply with BS 4090 with cast iron body, door and cover, gunmetal seats and stainless steel hinge pin. All materials shall be to appropriate British Standards.

2.4.4 Butterfly Valve

Butterfly valves shall comply with B.S.5155 or B.S.3952. The valve body and disc shall be of cast iron to B.S. 1452 with stub shafts of stainless steel to B.S.970. The seal shall be of nitrile rubber sealing against phosphor bronze seats. The valve body shall be attached to the pipeline with flanges. Butterfly valves in the smaller sizes may be of the water type where the valve is bolted in between pipe flanges. The seal shall be of nitrile rubber covering and lapped over the internal surface of the valve. Valves of this type shall be only for sizes up to and including 300 mm. All valves above this size shall have integral flanges. For both wedge gate valves and butterfly valves manual mechanisms for operation shall be provided. The gearing shall be such that seven to eight complete revolutions of the hand wheel is required for complete closure. All valves shall be operated by hand wheel unless otherwise specified. No valve shall be lever operated. Tee keys and bars may be specified on washout valves.Handwheels shall be turned in a clockwise direction to close the valve and shall be clearly marked with the word "CLOSE" in English and an arrow in the appropriate direction. Hand wheels shall be
of cast iron or plastic encased steel.

2.4.5 Altitude Valve

Altitude valve shall be of the globe pattern and shall be hydraulically operated. The valve body and cover shall be manufactured of cast iron conforming to ASTM A48 and shall be suitable for a working pressure of 10 bars. Valve trim shall be type 303 stainless steel. The pilot pipe and control system shall be constructed of cast brass with type 303 stainless steel trim. Altitude valves shall be configured to close when the water level in the reservoir reaches the high water level shown on the drawings and shall open when the water level in the reservoir drops by one meter. Control pipe connecting the valve with the water reservoir shall be galvanised steel pipe. The valve shall be installed in a concrete vault as shown on the drawings.

2.4.6 Air Valves

Air valves shall be fabricated to ISO standards.
All air valves shall have flanged ends.
All air valves shall be fabricated in ductile iron and pressure rated to PN 10.
Air valves shall be of single and double orifice type.
All air valves shall have a means of isolation. Each air valve may be supplied with a horizontally positioned isolating valve of the same size, with bevel gearing arrangement for vertical operation and a set of flange jointing materials including nuts, bolts, washers and joint gaskets for insertion between the air valve and isolating valve. The bevel gear pinion shall be of corrosion proof steel.
The supplier may propose an alternative, for approval by the Operator.
All surfaces, except the finished or seating surface shall be coated with epoxy paint, or similar approved by the Operator. Double orifice air valves shall be of ‘aerokinetic’ type incorporating hydrodynamic principles suitable for air exhausting during charging or venting when emptying of the main. The ball-sealed orifice shall always remain open while air is discharged and shall be immediately closed when the water rises in the valve to lift the ball and seal the orifice. The escaping turbulent air or a mixture of air and water spray (even at the critical velocity of 300 m/sec) shall not cause the ball to be thrown into the discharging air stream and be blown shut prematurely during the filling of the water main at high rate. Under no circumstances shall the large orifice ball blow shut prematurely. The ball of the large orifice shall bear a calculated mathematical relation with the inlet diameter of the valve i.e. the average cross - sectional area of escaping air stream, so that the ball will be blown shut by a stream of water but held down by a stream of air. The weights of each ball

of the same size and type shall not differ by more than 2%.Single orifice air valves shall be relief in action and shall operate such that the ball cannot be held against the orifice by air pressure alone.The design of the valve shall be such as to allow maximum free air discharge and inflow at pressure differentials of plus 0.5 bar and minus 0.2 bar respectively. The supplier shall submit with his Tender, curves for free air discharge and inflow against various air pressures at valve inlet.
The orifice shall be either copper alloy or stainless steel, not less than 3 mm and tapering to 10 mm suitable to release accumulated air within the pipe. The profile of the orifice shall be such as to avoid damage to the ball surface. The orifice shall be protected by a suitable plug of stainless steel. All air valves shall be made insect proof by providing stainless steel screens at the vents leading into the atmosphere.
The low-pressure cover shall be designed to withstand the full operating thrust in the working condition. A neoprene seat ring shall be held securely in place under the low pressure cover by a joint support ring to prevent it from sagging when the ball is not sealing the orifice. After completion of machining but before assembly the valve body shall be hydraulically tested to twice the working pressure for a period of 5 minutes and thereafter compressed air at a slightly higher pressure shall be released through the valve inlet to check the function of the ball. Subsequently the hydraulic pressure shall be reduced to 0.5 bar and there shall be no leakage through any of the orifices.

2.5 Water Meters

The water meters shall be for cold water and shall be:

_ Fully in accordance with ISO 4064/1 with short body length on flanges,
_ The rotor shall be parallel to the direction of flow,
_ Shall have EC (or equivalent) approval of accuracy for class B as specified in ISO 4064/1,
_ The accuracy shall be guarantied if the meter is installed with any inclination,
_ Shall be of cast iron with internal and external epoxy coating,
_ The flanges shall be drilled in accordance to DIN 2532/3 or BS 4662 NP 10/16,
_ The coupling between the wet and the dry (recording mechanism) part shall be magnetic and fully tamperproof against external non-destructive action,
_ The housing of the dry mechanism shall be of copper with solid glass window which shall be fully condensation-free and waterproof under 2 m water pressure,
_ The measuring mechanism shall be equipped to enable telemetric (pulse) connection without destruction of the seal and/or requirement for the meter parts removing,
_ The complete measuring mechanism shall be removable and interchangeable with effect on the meter accuracy in the range of +- 2%
_ The meter shall provide possibility for two pulse rates: 10 litters and 1m3 with possibility to use both outputs simultaneously,
_ The meter shall be able to function in continuous and intermittent supply conditions, without exceeding the maximum permissible errors (+/- 2%).

Admissible metering errors
-Highest range of measurement: between maximum flow rate Max and transitional flow rate Qt: +/- 2%
-Lowest range of measurement: between transitional flow rate Qt and minimal flow rate Min: +/- 5%

2.6 Flow Control Valve

The valve limits the flow rate in the network to a preset, value regardless of upstream pressure variations. The valve fully opens when the flow rate drops below the set point. The valve shall be of the globe pattern and flanged connected. The valve shall be hydraulic, direct sealing diaphragm type, which allows inline maintenance. No stem, shaft or guide bearing will be located within the water passage. The valve shall be activated by the line pressure or by an external hydraulic or pneumatic pressure. The valve shall be operated by a pressure reducing differential pilot valve for controlling the flow through the main valve, regardless of pressure variations. The valve shall be suitable for a working pressure of 16 bars.

Valve Material: Body and Bonnet shall be Cast iron; Diaphragm: Nylon Reinforced Natural Rubber; Spring: SST 302; Nuts and Bolts: Stainless steel; Coating: Epoxy. The valve shall be installed as shown on the drawings.

2.7 Fire Hydrants

Fire hydrants shall be 'Street Fire Hydrant' type, for above ground operation.
Fire hydrant nominal flange size shall be 80mm diameter.
All fire hydrants shall be pressure rated to PN 10.
Hydrant thread to be 2.5 inch Round Thread Outlet.
Direction of opening to be anti-clockwise as viewed from the top.
Nozzle size to be 2.5 inch
Operating nut shall be key-bar operated
The body and cap of the hydrant shall be fabricated from, ductile iron.
The fire hose connection shall be fabricated from cast bronze having the following properties;
Chemical Composition;
Copper: 82.0-87.0%
Lead 4.0-6.0%
Tin 4.0-6.0%
Zinc 4.0-7.0%
Mechanical Properties;
Tensile Strength 210 MPa minimum
Yield Strength 95 MPa minimum Elongation 15%
'O' rings and gaskets shall be suitable for potable water supplies.
All foundry and machine work shall be in accordance with standard good practice.
When assembled hydrants shall be well fitted and smooth operating.
All joints shall be faced true and watertight under operating and test pressures.
All iron parts receiving bronze mountings shall be made true and smooth, and the bronze mounting shall be finished to fit.
All castings shall be clean and sound without defects that would impair their service. No plugging, welding, or repairing of such defects shall be permitted.
All like parts of the same model and size produced by the same manufacturer shall be Interchangeable.
Each hose connection shall have caps attached to the barrel by chains.
All internal and external surfaces, except seating surfaces shall be coated in epoxy paint.

2.8 Finishes to Valves

Internal un-machined surfaces of valves shall be coated with two coats of an approved epoxy paint, and machined surfaces liable to corrosion with an anti-corrosion composition. External surfaces for valves in chamber shall be coated with two coats of epoxy paint and valves to be in contact with the soil shall be supplied primed for wrapping.

2.9 Flanged Joints

Flanges shall comply with BS 4504 NP 12. Each flanged joint shall be supplied complete with rubber jointing rings, and steel bolts and nuts which shall include two washers per bolt.

2.10 Installation of Valves and Accessories

2.10.1 General

Before being installed, the valves and accessories, and especially valve seats, shall be cleaned of any dirt that may have entered them.

When installing the valves, their correct position shall be ensured by means of a spirit level. Fitting the valves to pipes shall be done accurately, but without using force. Fitting of valves by tightening bolts forcibly or by any other method that will cause internal stresses in the valve or flanges will not be permitted.

2.10.2 Flanges

Flanges shall be welded to the pipes in accordance with the requirements. Care shall be taken to weld the flange with the face perpendicular to the pipe axis and the bolt holes straddling the centre line. Flange faces shall be kept free from weld material, spatter, and any other foreign matter, and all defects that may prevent proper sealing of flanges shall be repaired.

2.10.3 Bolts

Only bolts of the correct diameter shall be used. All bolts used on a valve shall be of equal length, which shall be such that after the nut has been tightened not less than one thread and not more than three threads of the bolt will protrude from the nut. Bolts shall be tightened crosswise, gradually and uniformly.

2.10.4 Gaskets

Only one sealing gasket shall be used between each pair of flanges. Gaskets shall be of the ring type, i.e. their outer rim shall just touch the bolt holes and their inside diameter shall be equal to

that of the corresponding pipe. Gasket material shall be either fabric-reinforced rubber or compressed asbestos sheets known as "Klingerit".

Gaskets shall be fabricated by cutting from sheets. Cutting the gaskets by hammering on the flange will be strictly prohibited. When being installed, the gaskets shall be absolutely clean. Each gasket shall be used only once.

2.10.5 Gate Valves

Before being installed, each valve shall be fully opened and cleaned on the inside with a clean rag soaked in kerosene. Then the valve shall be completely closed and the flange faces also cleaned with kerosene. After cleaning, the flange faces shall be protected with wooden or cardboard covers, which may be removed only immediately prior to installing the valve.

2.10.6 Check Valves, Float Valves, etc.

The operation of all such valves shall be checked before and after installation and their proper functioning when put to use must be ensured.

2.10.7 Mechanical Couplings

Mechanical couplings shall be of the "Dresser" or "Victaulic" type as shown on the Drawings.

Ends of pipes to be joined by Victaulic couplings shall be fitted with accurately machined rings.

Ends of pipes to be joined by Dresser couplings shall be cleaned of paint, coating or other foreign matter and shall be sufficiently round for at least 20 cm from the pipe edge so that joint rings and couplings shall slide freely onto pipes; no forcing-on of rings by hammer blows will be permitted.

All joint components and pipe ends shall be cleaned and inspected before installation of joint. Rubber gaskets shall be kept in a clean and dry place and protected against sunshine until immediately before installation. Coupling bolts shall be tightened evenly and gradually with sufficient force to attain a tight joint, but without causing undue stresses in bolts or joint components.

2.11 CLEANING AND TESTING OF PIPELINES

2.11.1 General

The Contractor shall submit for the Engineer or his representative for approval details of his proposed methods and program for testing (including details of test equipment) and shall arrange for all tests to be witnessed by the Engineer or other persons appointed by the Engineer. Pipelines shall be properly completed and supported before being put under test. Notwithstanding the foregoing the Contractor may at any stage of construction, carry out such other tests as he considers desirable to check materials and workmanship on the pipeline but this shall not relieve the Contractor of his obligations to achieve successful tests under the Contract. All water required for testing and cleaning the pipelines shall be potable or any suitable water approved by the Engineer or his representative.

The Contractor shall provide the required number of pumps, plug ends, shop fabricated test blank flanges, pipes and connections and all approved leakage detection equipment and all other items necessary and suitable for the testing of all pipes as described herein. The Contractor shall also provide all necessary temporary Works and material required for the test and shall remove the same upon successful completion of these tests.

The Contractor shall also provide the services of specialized personnel to conduct the test operation together with all required labor.

All tests shall be done in the presence of the Engineer or his representative, and the results of such tests shall be signed by the Contractor and handed over to the Engineer or his representative on demand. The results of all tests specifying the section of pipe tested, and all relevant date of the testing shall be produced in the form of a report by the Contractor and submitted to the Engineer or his representative for approval. This report shall be signed by both the Contractor and the Engineer or his representative.

The Contractor shall bear all costs in providing all labor, water, end caps, blank flanges, test pumps, gauges, piping and other necessary apparatus required to carry out the tests,

The whole -cost for testing shall "be on the Contractor's account, including any repairs, re-testing, re-excavation, replacement or any other costs as may arise.

2.11.2 Cleaning and Inspection of Pipelines

During and until commissioning, the Contractor shall provide and maintain wooden plugs in all open ends of pipes, to prevent the ingress of silt and deleterious matter into the pipelines.

After backfilling pipe trenches and completing chambers, hatch boxes etc. and before the trench surfaces are reinstated, the interior of pipelines shall be cleaned of silt and debris by approved methods for inspection by the Engineer's Representative as follows:

All newly constructed pipelines of 500mm (nom.) internal diameter and smaller shall have a loose plug passed through them to show that they are clear of obstruction and free from deflection. The loose plug shall be dimensioned to suit the permissible minimum deflected diameter of the pipe.

2.12 Hydrostatic Pressure Testing of Pressure Pipeline

2.12.1 General

After pipe laying, casting of concrete structures on the pressure pipeline and partial backfill have been completed, the lines shall be tested over their entire length or, in the case of long lines, in sections. The pressure test shall only be performed in the presence of the Engineer's Representative.

The test pressure shall be determined by the Engineer in each case. The required pressure shall be obtained by means of a special pressure pump or by connecting the line to a suitable source of pressure.

2.12.2 Preparation for Pressure Test

The Contractor shall provide written notice to the Engineer of any test two days before the test is to be carried out. The Contractor shall maintain written records of the tests and provide copies of the records to the Engineer prior to the completion of the project.

Filling of the pipelines with water shall not begin until 7 days after the last concrete structures have been cast. Prior to filling the lines, all joints and structures shall be inspected and be in good condition and proper functioning of all valves shall be ascertained. When testing a section not ending in a valve, the open end shall be a bulkhead and securely anchored. The testing installation and the working of the pump shall also be examined.

Prior to hydraulically testing the pipelines the Contractor shall provide adequate temporary thrust blocks at the ends of uncompleted sections, pipes shall be partially backfilled to about 500 mm above the crown of the pipe, in order to anchor the pipes during testing. Joints and fittings, however, shall remain uncovered until the pipeline has been tested satisfactorily.

The length of the section of pipeline to be tested may be determined by the contractor but shall not exceed 500 meters. Levels of the length of pipe under test shall be such that the minimum test pressure specified is achieved at all points whilst the maximum test pressure specified is nowhere exceeded.

2.12.3 Filling the pipeline with Water

The lines shall not be filled until the Engineer's written approval has been given. The lines shall be filled gradually and slowly in order to prevent water hammer or chattering in the pipes and to permit the escape of all air from the pipelines. The rate at which the lines are to be filled shall be determined by the availability of water. Consideration shall be given to filling mains at night, but always with the approval of the Municipality Engineer.

Before testing the line should be filled slowly and evenly with water through any convenient top or valve from the lowest end point. At every high point an automatic air release valve must be installed. After expelling all the entrapped air out of the test portion, all air release valves should be closed. If it is not possible to fill the line from the lowest point, an additional outlet should be added at the inlet point to release air at that point and this

line/section should be kept filled for 24 hours before the pressure test.
At the commencement of filling, all blows out valves shall be open and each valve shall be closed after the water has flushed all dirt that may have accumulated in the pipes.
After the filling has been completed, but before the pressure is raised, all valves shall be inspected for water-tightness and all leaks in gaskets and stuffing boxes shall be stopped. Should this inspection show any leaks at the joints or defects in the valves that cannot be repaired while the lines are full of water, the lines shall be drained and the necessary repairs done. This inspection shall be repeated until all leaks are stopped.
Valves shall not be used to isolate sections forming the pipeline during testing operations.

2.12.4 Pressure Test

The pressure test shall be 1.5 times the maximum working pressure. The pressure shall be raised slowly to the specified test pressure and maintained at that pressure for a period long enough for the Engineer to examine the whole section under test. The pipeline shall be maintained under this pressure for a period of 24 hours, during which the pressure shall not be allowed to fall below 100% of the test pressure but shall be restored to the full test pressure by such pumping as may be necessary.
Should any inspection be unsatisfactory or any test fail, the Contractor shall replace defective pipes, leaking joints or otherwise re-execute defective work as instructed following which cleaning and testing will be repeated until the Engineer's Representative certifies the pipeline to be satisfactory.
The pressure test shall also serve as a strength test for the concrete anchor and thrust blocks, thus these structures shall be designed by the Contractor accordingly. Any structures failing the test shall be replaced by the Contractor at his own expense.

SECTION 3 – SEWAGE WORKS

3.1 Handling and Transporting of Pipes

3.1.1 General

A. The Contractor's arrangements for handling, lifting, transporting and stacking pipes, valves and specials, shall ensure that these articles are brought to their final place in the works undamaged and in good order.

B. All damage to the pipes or their coating while in the Contractor's charge shall be repaired as required and directed by the Engineer, and all expenses in connection with such repairs shall be borne by the Contractor. In the event of any pipe being damaged to such an extent as to make the repair thereof, in the Engineer's opinion, impossible or uneconomical the Owner will provide a new pipe in place of the damaged one, and the Contractor shall pay the cost thereof to the Owner.

C. When loading and unloading, handling, transporting, and moving and placing the pipes alongside and in the trench, care shall be taken to preserve the undamaged condition and roundness of the pipes, particularly at the ends. Special care shall be taken to keep the pipe coating intact.

D. Pipes shall not be stacked on the vehicles to such a height as may cause flattening of the lowermost pipes or damage to the coating. The height of the load for the various pipe diameters shall be as recommended by the Manufacturer and approved by the Engineer. Pipe specials shall be supported by sandbags or other padding and lashed down as described above so that they are not damaged during transport.

E. The trucks and cars used for the transporting of the pipes shall be adequately equipped to prevent displacement of pipes and/or damage to pipes or coating. Pipes shall be well secured to the vehicles to ensure stability of the load, and all parts of trucks and cars as well as cables coming into contact with coated pipes shall be well padded.

F. Unloading of pipes from trucks or cars shall be done by means of cranes or other suitable equipment ensuring slow and careful lowering of each pipe length. Pipes shall not be gripped by hooks or other equipment liable to injure or distort pipe ends.

G. The Contractor shall provide cranes for lifting and lowering pipes at the site of work and at the storage area and wherever pipes are being handled.

H. Pipes must not be dropped on the ground or on other pipes. When lifting or lowering pipes by means of a crane, each pipe shall be kept under full control when suspended to prevent its colliding with equipment, rocks, trees or any other objects that may injure the pipe or its coating.

I. Pipes shall not be moved by dragging them on the ground, but shall be lifted by crane or other means and placed carefully at their new locations. In rocky country, pipes shall be deposited with their bare ends on wooden skids at least 100 mm wide.

J. Each pipe placed on the ground shall be prevented from rolling. Walking on coated pipes in the field shall not be permitted. Pipes shall also be protected from contact with metal tools or heavy objects that may injure the coating.

K. No steel cables or ropes likely to injure the coating shall be used for handling the pipes, but only belts at least 250 mm wide or such special tackle as will not damage the coating.

3.1.2 Ductile Iron Pipes

A. Considering all above mentioned general instructions, for ductile iron pipes, slings of canvas, rubber belting or other non-abrasive material, or special fittings shaped to fit the pipe ends and approved by the Engineer shall be used for lifting and lowering pipes and specials. Pipes shall not be lifted by hooks nor shall they be dropped or dragged.

B. Ductile iron pipes being transported shall be supported on timbers, sand bags or padding arranged so the pipes do not rest on their sockets and adjacent pipes do not touch.

3.1.3 Concrete Pipes

A. Considering all above mentioned general instructions, concrete pipes and fittings shall not be dispatched from the factory before 28 days have elapsed after manufacturing.

B. All pipes and fittings shall be Sulphide resistant, and be carefully inspected and examined for cracks and other defects while suspended above the trench immediately before installation in final position.

C. Material found to be defective or damaged shall be rejected and removed from the Work. Spigot ends shall be examined with particular care as this part is the most vulnerable to damage from handling. Any damage to exterior protective coatings shall be repaired before the pipe is laid in the trench. In case of damage to the interior protective coating or lining, the said pipe or fitting shall be laid aside for inspection by the Engineer, who will prescribe corrective repairs or rejection. Where a portion of a length of pipe is damaged, the damaged part shall be cut off in an approved manner and discarded and the remaining sound portion may be used. Any materials which fail or become damaged will be deemed to have been caused by the Contractor's negligence in handling and must be replaced with new or repaired as the Engineer decides without cost to the Owner.

3.1.4 Polyvinyl Chlorine (PVC) and Polyethylene (PE) Pipes

A. Considering all above mentioned general instructions, PVC and PE items deteriorate in sunlight and are slightly brittle, especially at lower temperatures, so care shall be taken in loading, transporting and unloading items to prevent injury to the items. All items shall be examined before installation and no piece shall be installed which is found to be defective. Handling and installation of pipe and fittings shall be in accordance with the manufacturer's instructions, referenced standards and as specified herein.

B. Any pipe or fitting showing a crack or which has received a blow that may have caused an incident fracture, even though no such fracture can be seen, shall be marked as rejected and removed at once from the work.

C. In handling the items, use special devices and methods as required to achieve the results specified herein. No unquestioned devices shall be used in handling the item.

1. **PVC gravity sanitary sewer pipe** and related fittings shall be manufactured in accordance with all the requirements of ASTM C3034, SDR 35, Type PSM polyvinyl chloride sewer pipe and fittings. All fittings shall use rubber gaskets which conform to the requirements of ASTM F477.

2. **General**: This section covers material requirements, inspection and testing, marking and delivery, installation, and field performance and acceptance tests of Polyvinyl Chloride (PVC) Sewer Pipe and Fittings for use in gravity, non-pressure, storm or sanitary sewer installations.

3. **Referenced Standards**: This section references American Society for Testing and Materials (ASTM), American
4. **National Standards Institute** (ANSI), and American Water Works Association (AWWA),
5. **UNI-Bell PVC Pipe Association** (UNI), which are made part hereof by such references, and shall be the latest edition and revision thereof. All material, manufacturing, operations, testing, inspection and production of Poly (Vinyl Chloride) (PVC) sewer pipe shall conform to the following referenced standards:
   - ASTM F477 Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
   - ASTM F679 Standard Specification for Poly (Vinyl Chloride) (PVC) Large-Diameter Plastic Gravity Sewer Pipe and Fittings.
   - ASTM F789 Standard Specification for Type PS-46 and Type PS-115 Poly (Vinyl Chloride) (PVC) Plastic Gravity Flow Sewer Pipe and Fittings.
   - ASTM F794 Standard Specification for Poly (Vinyl Chloride) (PVC) Profile Gravity Sewer Pipe and Fittings Based on Controlled Inside Diameter.
   - ASTM D2321 Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications
   - ASTM D3034 Standard Specification for Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
   - UNI-B-6 Recommended Practice for Low-Pressure Air Testing of Installed Sewer Pipe.
6. **PVC Sewer Materials**: The following described materials are approved for use in PVC pipe sewer construction.
7. **Pipe and Fittings**: Sanitary sewer pipes shall be PVC and conform to: ASTM D3034 SDR 35 for sizes 8 inches to 15 inches in diameter; ASTM F789 for sizes 8 inches to 18 inches (Solid Wall);
8. ASTM F679 for sizes 18 inches to 36 inches (Solid Wall); ASTM F949 for sizes 8 inches to 36 inches (Profile Wall); ASTM F749 for sizes 8 inches to 48 inches (Profile Wall);
9. ASTM F1803 for sizes 18 inches to 60 inches (Profile Wall).
10. **Gaskets**: Gaskets shall comply with ASTM F477. It shall consist of a properly vulcanized high grade elastomeric compound. The basic polymer shall be natural rubber, synthetic elastomer, or a blend of both. The gasket shall be the only element depended upon to make the joint flexible and water-tight.
11. **Lubricant**: The lubricant used for assembly shall have no detrimental effect on the gasket or on the pipe. Lubricants shall be in accordance with the manufacturer's recommendations.
12. **Acceptance**: Acceptance of the pipe, fittings, and other associated sewer material shall be based on full compliance with these Detail and Technical Specifications.
13. **Certification**: A manufacturer's certification that the material was manufactured and tested in accordance with these Detail and Technical

Specifications together with a report of all test results shall be furnished at the time of shipment.

14. **Receiving, Storage and Handling**: The Contractor shall follow the procedures and recommendation for receiving, storage, and handling contained in the CMWU storage guidance, "Handbook of PVC Pipe", and as recommended by the manufacturer.
15. **Receiving**: Pipes not conforming to the requirements of these Detail and Technical Specifications and pipes damaged in transit shall be rejected by the Engineer.
16. **Storage**: Pipe shall be stored in unit packages provided by the manufacturer. The unit packages shall be supported by racks to prevent damage to the underside of the pipe. Supports shall be spaced to prevent pipe bending. Stored pipe shall be covered with an opaque material to prevent exposure to direct sunlight while permitting adequate circulation of the air above and around the pipe to prevent excessive heat accumulation. Pipe determined to have been damaged in storage shall be rejected.
17. **Handling**: Construction equipment shall be operated in a safe and cautious manner so as to prevent damage to the pipe. Blows to the pipe causing impact damage shall be prevented. Pipe and fittings shall not be thrown, dropped, or dragged.
18. **Jointing Pipe**: Assembly of all joints shall be in accordance with the recommendations of the manufacturer. Proper jointing may be verified by rotation of the spigot or with a strap wrench. If unusual joining resistance is encountered or if the insertion mark does not reach the flush position, the joint shall be disassembled, inspected for damage, the joint components re-cleaned and the assembly steps repeated
19. **Test requirements**
    - Air Pressure Test,
    - Infiltration Test, and
    - Deflection Test

3.1.5 Cast Iron Pipes

A. The pipe shall at all times be handled with approved equipment designed to prevent damage to exterior coating. Bare cables, chains, hooks, metal bars or narrow skids will not allowed to come in contact with either exterior coating or interior lining.

B. If damage occurs to any pipes, fittings, or pipe accessories in handling, the damage shall be immediately brought to the Engineer's attention. The Engineer shall prescribe corrective repairs or rejection of the damaged items.

C. The contractor shall stand the expense of repairing or replacing the same. Coating materials ready for use shall always be kept on site when pipe lying is going on.

3.1.6 Glass Reinforced Polyester (GRP) Pipes

A. Pipes 600mm and smaller may be packaged as a unit. Manufacturer's instruction for handling unitized loads should be strictly followed. When handling single pipes, use pliable straps, slings, or rope to lift. Do not use steel cables or chains to lift or transport the pipe. Do not lift pipes by passing a rope through the section end to end.

B. Maximum stack height is approximately 2 meters. Strap pipe to the vehicle over the support points using pliable straps or rope. Using steel cables or chains is prohibited without adequate padding to protect the pipe from abrasion. Also, maximum diametrical deflection must not exceed the values in Table 4.1 below.

Table 4.1- Maximum Storage Deflection

Stiffness Class SN	Maximum Deflection (% of Diameter)
2,500	2.5
5,000	2.0
10,000	1.0

Bulges, flat areas, or other abrupt changes of curvature are not permitted.

C. Unloading the pipe is the responsibility of the Contractor, he should be sure to maintain control of the pipe during unloading. Guide ropes attached to pipes or packages will enable easy manual control when lifting and handling. Spreader bars may be used when multiple support locations are necessary. Do not drop, impact, or bump the pipe, particularly at pipe ends.

D. If at any time during handling or installation of the pipe, any damage occurs, the pipe should be segregated and not used.

3.1.7 Steel Pipes

A. Considering all above mentioned general instructions, steel pipe shall be transported from the coating plant to the job site on padded bunks with nylon tie-down straps or padded banding to adequately protect the pipe and coating.

B. The steel pipe lining must be Sulphide resistant.

C. Coated pipe shall be handled, stored and shipped in a manner that will prevent damage to the coating. Pipe shall be handled with wide belt slings or rubber padded forklifts. Chains, cables or other equipment likely to cause damage to the pipe or coating shall not be used.

D. No metal tools or heavy objects shall be permitted to come into contact unnecessarily with the finished coating. Workmen will be permitted to walk upon the coating only when necessary, in which case they shall wear shoes with rubber or composition soles and heels. All pipe and fittings, specials and couplings shall be examined before lying, and no piece shall be installed which is found to be defective. Any damage to the coatings shall be repaired as acceptable to the Engineer.

E. If any defective pipe is discovered after it has been laid, it shall be removed and replaced with a sound pipe in a satisfactory manner by the Contractor, at his own expense.

3.2 Stacking and Storage of Pipes

3.2.1 General

A. Pipes stored in the field shall be arranged in piles in such a manner that the pressure of the pipes placed on each other will not cause deformation of the pipe or damage to the coating.

B. The Supply Contractor shall properly stack the pipes in the storage yard of the Owner and the stacks shall be laid out in a regular pattern and the limits of each stack marked to that the movement of cranes and vehicles is restricted to access tracks between stacks and the control of delivery and removal pipes is facilitated.

C. The number of tiers of steel and ductile iron pipe stacks shall be as per the Manufacturer's instructions and approval of the Engineer and each pipe, including those in the bottom course, shall bear evenly upon not less than three timbers with an aggregate width not less than 300 mm. The pipes shall be stacked parallel to each other and arranged so that in each course all sockets are at one side and in the next course all spigots are on the other side.

D. The timbers supporting each course of pipes in a stack shall be of uniform thickness and stiff enough for the pipes to be rolled across the stack and shall be supplied by the Contractor at his own expense.

E. The outermost pipes in each course shall be secured against rolling by sandbags or by wedges.

F. Where the pipes are to be delivered and stacked by the Supply Contractor on designated sites lying on the pipeline route, unless it is otherwise specified elsewhere, the areas where the pipes are to be stacked shall, if required, be graded flat by the Supply Contractor at his own expense to provide a firm even surface, and kept free from loose stones, rubble or waste liable to damage the pipe coating.

3.2.2 Ductile Iron Pipes

A. Materials, when stored, shall be kept safe from damage. The interior of all pipes, fittings and other appurtenances shall be kept free from dirt or foreign matter at all times.

B. Pipe shall not be stacked higher than the limits recommended by its manufacturer. The bottom tier shall be kept off the ground on timbers, rails, or concrete. Pipe in tiers shall be alternated. At least two rows of 100mm x 100mm (4 in x 4 in) timbers shall be placed between tiers and chocks affixed to each end in order to prevent movement.

C. Gaskets for mechanical and push-on joints to be stored shall be placed in a cool location out of direct sunlight. Gaskets shall not come in contact with petroleum products. Gaskets shall be used on a first-in, first-out basis.

3.2.3 Concrete Pipes

A. In distributing the material at the site of the work, each piece shall be unloaded opposite or near the place where it is to be laid in the trench.

B. The Contractor shall keep the pipe and appurtenances clean during the progress of the work. Dirt, debris or other foreign material shall be removed from the interior of the pipe before installation. All openings in the pipeline shall be plugged watertight with standard cast iron test plugs, expandable type sewer plugs or other means approved by the Engineer at the end of each day's operations or whenever the workmen are to be absent from the work area. The use of burlap, wood or other similar temporary plugs will not be permitted. All surface or ground water shall be prevented from entering the pipe and shall be removed from the trench. Should water nevertheless enter the trench, laid pipes shall be secured against lifting.

C. Rubber rings for pipe joints shall be stored and protected in a proper manner to prevent deterioration.

3.2.4 PVC and PE Pipes

A. While stored, pipe shall be adequately supported from below at not more than 900mm intervals to prevent deformation. The pipe shall be stored in stacks no higher than that given in table 4.2 :

Table 4.2 Rows of pipes

Pipe Diameter	Max. No. of Rows Stacked
200mm or less	**5**
300 to 530mm	**4**
600 to 760mm	**3**
840 to 1220mm	**2**

B. Pipe and fittings shall be stored in a manner which will keep them at ambient outdoor temperatures and out of the sunlight. Temporary shading as required to meet this requirement shall be provided. Simple covering of the pipe and fittings which allows temperature build-up or direct or indirect sunlight will not be permitted.

C. If any defective item is discovered after it has been installed, it shall be removed and replaced with an exact replacement item in a satisfactory manner by the Contractor, at the Contractor's own expense. All pipe and fittings shall be thoroughly cleaned before installation and the interior shall be kept clean until testing.

3.2.5 Cast Iron Pipes

A. The Contractor shall keep the pipe and appurtenances clean during the progress of the work. Dirt, debris or other foreign material shall be removed from the interior of the pipe before installation. All openings in the pipeline shall be plugged watertight with standard cast iron test plugs, expandable type sewer plugs or other means approved by the Engineer at the end of each day's operations or whenever the workmen are to be absent from the work area. The use of burlap, wood or other similar temporary plugs will not be permitted

B. Rubber rings for pipe joints shall be stored and protected in a proper manner to prevent deterioration.

C. Material found to be defective or damaged shall be rejected and removed from the Work. Spigot ends shall be examined with particular care as this part is the most vulnerable to damage from handling. Any damage to exterior protective coatings shall be repaired before the pipe is laid in the trench. In case of damage to the interior protective coating or lining, the said pipe or fitting shall be laid aside for inspection by the Engineer, who will prescribe corrective repairs or rejection. Where a portion of a length of pipe is damaged, the damaged part shall be cut off in an approved manner and discarded and the remaining sound portion may be used. Any materials which fail or become damaged will be deemed to have been caused by the Contractor's negligence in handling and must be replaced with new or repaired as the Engineer decides without cost to the Owner.

3.2.6 Glass Reinforced Polyester (GRP) Pipes

A. All pipes should be inspected upon receipt at the job site to insure that no damage has occurred in transit. Depending on length of storage, amount of job site handling and other factors that may influence the pipes condition, the Engineer may respect the pipe just prior to installation.

B. If the load has shifted or indicates rough treatment, carefully inspection should be made. Generally, an exterior inspection will be sufficient to detect any damage, but if pipe size permits, an interior inspection of the pipe surface at the location of an exterior scrape may be helpful to determine if the pipe is damaged. If any imperfection or damage is found, immediately the effected pipes should be segregated and disposed of the site.

C. It is generally advantageous to store pipe on flat timber to facilitate placement and removal of lifting slings around the pipe. When storing pipe directly on the ground, the area should be flat and free of rocks and other potentially damaging debris. All pipes should be checked to prevent rolling in high winds.

D. If it is necessary to stack pipes, it is required to stack on flat timber support at maximum space centres 6 meter spacing (3 meter for small diameter) with a maximum overhang of 2 meters. Chock the pipes to maintain stability and separation. Insure no pipes contact other pipes, so vibration during transport will not cause abrasion. Insure the stack will be stable for conditions such as high winds, unlevel storage area or other loads. Stacking of pipes larger than 1400mm diameter is not permitted.

E. Rubber ring gaskets, when shipped separate from the couplings, should be stored in the shade in their original packing and should not be exposed to sunlight except during the pipe joining. Also, the gaskets must be protected from exposure to greases and oils which are petroleum derivatives, and from solvents and other deleterious substances.

F. Gasket lubricant should be carefully stored to prevent damage to the container. Partially used buckets should be resealed to prevent contamination of the lubricant.

3.2.7 Steel Pipes

Stored pipe shall at all times be supported on sand bags, or other suitable support. Bags shall be of sufficient size to prevent contact of the pipe coating with the ground or any other obstruction. Rolling the pipe on the coated surface will not be permitted.

4 Materials supplied by the Owner

A. In case the pipes and ancillary fittings, specials and valves are to be supplied by the Owner the latter shall supply to the contractor free of charge at his stores or at the place indicated in the Particular Conditions and Specifications, the required quantities of different pipes of various diameters together with the respective fittings, specials, adapters and valves as outlined in the Particular Conditions and Specifications and the Contractor shall load transport and unload the materials so supplied at the site of works and shall be responsible for proper unloading, stacking and storing .

B. The pipes shall be unloaded from the trucks in an approved manner and the Contractor shall take utmost care not to damage the pipes or any of the materials so supplied. Any damage caused to the materials in loading, transport and unloading at the site of works shall be repaired by the Contractor at his own expense in accordance with the Engineer’s instructions and to his satisfaction.

C. Material irreparably damaged shall be replaced by the Contractor at his own expense or charged to his account.

D. The Contractor shall stack the pipes in a secure, safe and approved manner and in a way to allow easy handling.

E. Pipes found damaged before handling them over to the Contractor shall be counted and stacked by the Contractor separately each diameter aside and the damage of each pipe shall be fully described. Such pipes shall not be used in the works unless and until the Contractor has used all the sound pipes delivered to him and is so ordered by the Engineer.

F. The Contractor will be required to sign the vouchers for the materials supplied to him, and shall keep proper stores book to show at any time the quantity of materials received and those which have taken from the stores for use in the works. The Engineer or his representative shall have the right to inspect at any time the store books, and to check the materials in the stores and on site of works to satisfy themselves that everything is in order and the Contractor will be required to account for any discrepancy found.

G. The Contractor shall at his own expense provide and constantly maintain day and night watching and shall be responsible for the theft or loss for any materials supplied to him by the Owner whether theft occurred from the stores or from the site of works. Any materials so found missing shall be immediately replaced by the Contractor at his expense.

H. On completion of works, the materials used in the works shall be counted and / or measured and the balance shall be handed over by the Contractor to the Owner at his indicated storage yard. The loading, transport, unloading and proper stacking of materials shall be carried out in accordance with the relative clauses of the Specifications and shall be at the Contractor's expense.

I. Any materials not accounted for shall be replaced by the Contractor at his own expense or shall be charged to the Contractor's account C.I.F. site plus 20% as the Engineer deems it suitable.

3.3 Pipe laying in Trenches

3.3.1 General

A. Pipes and fittings will be installed in strict accordance with the Manufacturer's Specifications and instructions to the satisfaction and approval of the Engineer.

B. The pipe route shall be determined by the Engineer. The Engineer reserves the right to vary or abandon any part or parts of the routes of pipelines indicated on Drawings and the contractor shall lay the pipes in accordance with any such variations which the Engineer may issue.

C. The Contract Drawings show the approximate lines and levels to which the pipeline is to be built and are subject to amendments by the Engineer on site. Before setting out any sections of the pipeline, the Contractor or his representative shall make an inspection of the site in company with the Engineer and obtain from him his instructions in this respect.

D. All pipes, curves, bends and other specials shall be laid accurately in accordance with the alignment, levels and gradients so determined, so that the top of the pipe is not less than the minimum specified depth below the finished ground level along the pipeline. Changes in gradient and the numbers of air valves and wash-out valves will be the minimum necessary to secure efficient operation and economy in excavation.

E. The Contractor shall provide the surveying instruments, surveyors, skilled staff and everything necessary for setting out the works to line and level and for checking the accuracy

of pipe-laying and jointing. He shall attend upon the Engineer and provide him with such assistance as may be necessary to enable him to check the setting out of the works.

F. The finished pipeline shall run straight between bends or curves and a uniform gradient shall be accurately maintained between changes of gradient shown on the drawings or authorized by the Engineer.

G. The bottom of the trenches shall be graded and prepared to provide a firm and uniform bearing throughout the entire length of pipe and bell holes shall be provided. The Contractor shall inform the Engineer sufficiently in advance when the formation levels of the trenches are ready for inspection. No pipe lying will be allowed until the bottom of trenches have been inspected and approved by the Engineer and the depths of the trenches and the kind of excavation have been recorded and agreed upon by both the Contractor and the Engineer.

H. As a general rule, water pipes and sewers should not be laid in the same trench. They should be laid in separate trenches at least 3m apart in horizontal direction. If local conditions, such as in very narrow streets, do not permit the horizontal minimum separation of 3m, this distance could be decreased but the bottom of the water pipe must be kept at least 500 mm above the top of the sewer. But if the vertical separation of not less than 500 mm cannot be obtained, concrete encasement shall be provided to sewer pipe as shown on the Drawings.

I. The pipe shall be positioned and bedded in the trenches in an approved manner and properly aligned. Before being positioned, each pipe shall be thoroughly examined to ensure that it is free from defects and shall have all dirt removed from the inside thereof. The Contractor shall cut the pipes if and where needed to the required length and shall thread, chamfer or bevel the cut ends of pipes as the case may be and shall supply and install all fittings, specials and adapters as may be necessitated for the proper execution of the works and shall joint the pipes in accordance with the Specifications and to the Engineer's Satisfaction.

J. All pipe shall be sound and clean before laying. Good alignment shall be preserved in laying. The deflections at joints shall not exceed that recommended by the manufacturer. Fittings, in addition to those shown on the Drawings, shall be provided.

K. Any injury to the protective coating of the pipes from any causes during the construction of the pipeline shall be repaired by the Contractor at his own expense to the satisfaction of the Engineer.

L. At the end of each day's work a strong watertight plug or other approved means shall be firmly fixed in each open end in order to exclude all foreign materials.

M. In order to prevent the pipes from "creeping" from the mechanical joints and to protect the welds against thermal stresses, which are specially dangerous when pipe laying is done in summer, the following instructions shall be strictly adhered to :

N. Lowering-in and jointing of sections shall be done, as far as possible; in the early hours of the morning.

O. As soon as the tack-welds have been completed, in the case of overhead weld joints, or as soon as the bolts have been tightened, where sections are connected by mechanical joints, the first stage backfill (between joints) shall be executed, so that no more than one section at a time will remain uncovered in the trench.

P. Lowering-in and/or placing of welded sections on temporary supports shall be done carefully so as to prevent any damage from being done to existing coating or paint.

Q. The method employed for lowering-in shall be subject to the Engineer's approval.

3.3.2 Ductile Iron Pipes

A. Ductile iron pipe and fittings shall be installed in accordance with requirements of AWWA C600 except as otherwise specified or shown on the Drawings.

B. Fittings, in addition to those shown on the Drawings, shall be provided when required by the site utility conditions. When cutting pipe is required, the cutting shall be done by abrasive saw. Any damage to the lining shall be repaired to the satisfaction of the Engineer. Cut ends of pipe to be used with a bell shall be bevelled to conform to the manufactured spigot end. Joints shall be made in strict accordance will the manufacturer's instructions.

C. Restrained joint or suitable tie-rods shall be provided where there is a possibility of pulling the joint under pressure. Concrete anchors and thrust blocking shall be provided where there is thrust forces resulting from change of pipe direction in either horizontal or vertical planes. Thrust block bearing area against the soil shall be as shown on the Drawings.

D. After installation, the pipe shall be tested for compliance with the Specifications. Furnish all necessary equipment and labour for the pressure test and leakage test on the pipelines.

E. Submit detailed test procedures and method for Engineer's review. In general, testing shall be conducted in accordance with AWWA C600.

3.3.3 Concrete Pipes

A. The pipes shall be laid accurately to line and level and jointed in an approved manner. The pipes shall be laid on the backfilled and finished bedding of the trench, and special hollows be made for the joints. The spigot part of the pipe shall be placed below the grade line to avoid any cracks between the pipe and the spigot.

B. The whole inside and outside area forming the joint of pipe and fittings shall be thoroughly cleaned before laying Every precaution shall be taken to prevent foreign material from entering the pipes. During laying operations, no debris, tools, cloth or other materials shall be placed in the pipe.

C. After placing a length of pipe in the trench, the spigot end shall be centred in the socket (or corresponding) and pipe forced home and brought to correct line and grade. The pipe shall be secured in place with approved backfill material tamped under it except at the joint. Pipe and fittings which do not allow a sufficient and uniform space for joints shall be removed and uniform space provided. Precautions shall be taken to prevent dirt from entering the joint space. Pipes shall be laid such that the whole body of the pipes is in contact with the bedding. All pipeline must be inspected and approved by the Engineer before they are covered.

3.3.4 PVC and PE Pipes

A. No single piece of pipe shall be laid unless it is straight. The centreline of the pipe shall not deviate from a straight line drawn between the centers of the openings at the ends of the pipe by more than 1.5mm per 300mm of length. If a piece of pipe fails to meet this requirement check for straightness, it shall be rejected and removed from the site. Laying instructions of the manufacturer shall be explicitly followed.

B. If any defective pipe is discovered after it has been installed, it shall be removed and replaced with a sound pipe in a satisfactory manner at no additional cost to the Owner. All pipe and fittings shall be thoroughly cleaned before installation, shall be kept clean until they are used in the work and when laid, shall conform to the lines and grades required. Pipe and fittings shall be installed in accordance with requirements of the manufacturer, and AWWA C605 or as otherwise provided herein.

C. When cutting pipe is required, the cutting shall be done by machine, leaving a smooth cut at right angles to the axis of the pipe. Cut ends of pipe to be used with a bell shall be bevelled to conform to the manufactured spigot end.

D. The Engineer may examine each bell and spigot end to determine whether any performed joint has been damaged prior to installation. Any pipe having defective joint surfaces shall be rejected, marked as such and immediately removed from the job site.

E. Each length of the pipe shall have assembly mark aligned with the pipe previously laid and held securely until enough backfill has been placed to hold the pipe in place. Joints shall not be "pulled" or "cramped". Deflection in horizontal or vertical alignment shall not perform without the approval of the Engineer's Representative as to the extent of the deflection. In no case shall such deflection be done at the pipe joint. If any bending is required it should be done at the central portion of the pipe and not exceeding the limits specified by the manufacturer. Whenever the required deflection exceeds the permissible limits, the contractor shall install proper bends in the line and anchor same as required. Care should be exercised to lay the pipe in such manner as to minimize the high and low points in it.

F. Before any joint is made, the pipe shall be checked to assure that a close joint with the next adjoining pipe has been maintained and that the inverts are matched and conform to the required grade. The pipe shall not drive down to grade by striking it. Bell or coupling holes shall be formed so that, upon being placed only the pipe barrel is in contact with the trench bottom.

G. Jointing of PE pipes will be made using electro-fusion method. During jointing with electro-fusion, care should be taken that joints are not moved before the cooling process has been completed.

H. For PVC pipes, flexible joints with spigot and sockets sealed with rubber rings or gaskets will be used. Spigot ends shall be centralized within sockets, and shall be pushed into the socket, strictly following the manufacturer's instructions, until reach the depth of the entry mark. The pipe should never be over inserted.

I. Precautions shall be taken to prevent flotation of the pipe in the trench.

J. When moveable trench bracing such as trench boxes, moveable sheeting, shoring or plates are used to support the sides of the trench, care shall be taken in placing and moving the boxes or supporting bracing to prevent movement of the pipe, or disturbance of the pipe bedding and the backfill. Trench boxes, moveable sheeting, shoring or plates shall not be allowed to extend below top of the pipe. As trench boxes, moveable sheeting, shoring or plates are moved, pipe bedding shall be placed to fill any voids created and the backfill shall be recomputed to provide uniform side support for the pipe.

K. Joints shall be made in strict accordance with the manufacturer's instructions.

3.3.5 Cast Iron Pipes

A. The pipes shall be laid accurately to line and level and jointed in an approved manner. The pipes shall be laid on the backfilled and finished bedding of the trench, and special hollows be made for the joints. Socket pipes shall normally be laid with the socket at the higher end to facilitate the making of the joints. Supporting wooden construction shall not be placed under pipes.

B. The whole inside and outside area forming the joint of pipe and fittings shall be thoroughly cleaned before laying every precaution shall be taken to prevent foreign material from entering the pipes. During laying operations, no debris, tools, cloth or other materials shall be placed in the pipe.

C. After placing a length of pipe in the trench, the spigot end shall be centered in the socket (or corresponding) and pipe forced home and brought to correct line and grade. The pipe shall be secured in place with approved backfill material tamped under it except at the joint. Pipe and fittings which do not allow a sufficient and uniform space for joints shall be removed and uniform space provided. Precautions shall be taken to prevent dirt from entering the joint space. Pipes shall be laid such that the whole body of the pipes is in contact with the bedding. All pipeline must be inspected and approved by the Engineer before they are covered.

3.3.6 Glass Reinforced Polyester (GRP) Pipes

A. GRP pipe, like virtually all pipes made with petrochemicals, can burn and is, therefore, not recommended for use in applications which are exposed to intense heat or flames. During installation, care must be taken to avoid exposure of the pipe to welder's sparks, cutting-torch flames or other heat / flame / electrical sources which could ignite the pipe material. This precaution is particularly important when working with volatile chemicals in making lay-up joints, repairing or modifying the pipe in the field.

B. The type of installation appropriate for GRP pipe varies with pipe stiffness, cover depth and native soil characteristics. The native material must adequately confine the pipe zone backfill to achieve proper pipe support. However, the designated type of installation, as stipulated by the manufacturer shall be followed, and consequently, the permissible must not be exceeded.

C. The bed must be over-excavated at each joint location to ensure that pipe will have a continuous support and does not rest on the coupling. However, this area must be properly bedded and backfilled after the joint assembly is completed.

D. GRP pipe sections are typically joined using double bell couplings. Other jointing systems such as flanges, mechanical coupling and lay-up joints may also be used with GRP pipes.

E. The manufacturer's instructions for installation should be strictly followed. The coupling grooves and the rubber gasket rings must be thoroughly cleaned to insure no dirt or oil is present. Insertion the gasket into the groves should be done with uniform pressure to insure for well distributed compression of the gasket. Tapping with rubber hammer will be helpful to use. Next, using a clean cloth, apply a thin film of lubricant to the rubber gaskets as per manufacturer's instructions. Petroleum base lubricant shall not be used.

F. Immediate backfilling after joining is desirable as it will prevent two serious hazards - floating of pipe and thermal movements. During backfilling, the granular material should flow completely under the pipe to provide full support. A blunt tool may be used to push and compact the backfill under the pipe, without raising the pipe up. Proper backfilling compaction of each layer is important to ensure that the pipe will have an adequate support. Care must be taken to avoid excessive compactive effort above the pipe crown, which may cause bulges or flat areas.

3.3.7 Steel Pipes

A. The Contractor shall regulate his equipment and construction operations such that the loading of the pipe does not exceed the loads for which the pipe is designed and manufactured.

B. Except as otherwise provided herein, pipe and fittings shall be installed in accordance with the requirements of AWWA M11.

C. The Contractor shall permit and aid in the inspection of the coating on the underside of the pipe at the time of installation and shall repair any damage before lowering the pipe into the trench. While being laid, the pipe shall not be rolled, skidded, or otherwise moved, when it contacts with the ground at any point.

D. The method of jointing the pipe shall be in strict accordance with the manufacturer's instructions. The Contractor shall arrange for the manufacturer to supervise the installation of at least the first three standard joints and the first restrained joint. Pipe shall be laid with bell ends upstream, unless otherwise approved by the Engineer.

E. As soon as the pipe is in place and before the come-along (if used) is released, granular fill shall be placed to the top of the pipe for at least one half the length of the pipe. Not until this backfill is placed shall the jacks or come-along (if used) be released. If any motion at joints can be detected, a greater amount of backfill shall be placed before pressure is released.

F. Before bedding of galvanized pipes, in situ cold bitumen coating, of minimum thickness (0.5 mm) should be applied for underground installations, and extended at least 200 mm for pipes partially laid above the ground.

G. Field joints shall be wrapped in accordance with AWWA C209. The joints shall be cleaned, primed and wrapped with two wraps of tape with a 0.89mm (35 mils) thickness each and holiday tested. When the alternative extruded polyethylene coating is used, field joints shall be coated in accordance with AWWA C216.

H. The Contractor shall have on hand a sufficient supply of assorted short pipe lengths, adapters and any other fittings necessary to prevent delays in pipe laying.

I. Restrained joints shall be installed to the limits indicated on the Drawings or as directed by the Engineer in accordance with applicable provisions of the above. Restraining shall be harnessed coupling or field welded.

J. Pipes shall be installed true to alignment and with rigidly supported anchors adequately designed for the worst loading conditions. After installation, the piping shall be tested in accordance with applicable provisions of AWWA C600.

3.4 Pipe Welding

3.4.1 Welding Methods

A. All welds shall be made by the manual shielded metal-arc method. The welding procedure to be applied by the Contractor shall be submitted to the Engineer for approval before any commencement of the Work. All requirements as to the quality of the welds shall apply equally to roll welding and position welding. All welds shall be made only by welders having passed the welders' qualification test. The Contractor will not be allowed to use a piece-work system on welding work, but there shall be no limitations to the amount of work a welder may produce during one day, provided that the welds meet all the requirements of the specification.

B. The use of welding machines with two outlets will not be permitted; every welder shall work with his own machine.

3.4.2 Electrodes

A. Electrodes used on welding work shall have a diameter of 4 mm and 3.25mm and shall approximately meet the requirements of ASTM Specification A 233 as last revised. Generally, with D.C. generators, class S 6010 electrodes shall be used. In any event, the electrodes proposed by the Contractor shall be subject to the Engineer's approval prior to their use.

B. Electrodes shall be stored in unopened original containers in such a manner as to prevent absorption or loss of moisture or mechanical damage to the coating. Electrodes in open containers shall be protected against moisture. Electrodes that have been damaged, become moist or otherwise deteriorated shall be rejected.

3.4.3 Cleaning of Pipes

A. Pipe ends to be welded together shall be thoroughly cleaned of any dirt, oil, residues of paint and asphalt, and any other foreign matter that may adversely affect the quality of the weld. Paint and oil residues shall be removed with kerosene or benzene.

B. Before welding the root bead, the cleaning pig with the cable attached to it shall be introduced into the pipe last laid before the new pipe. When the root bead has been completed, the pig shall be extracted by means of the cable; in passing the seam the pig will remove all metal bubbles and slag that have entered the interior of the pipe.

3.4.4 Welding Positions

The welds shall be made either by roll welding or position welding. Roll welding will be permitted, provided alignment is maintained by the use of skids and roller dollies supporting two or more lengths of pipe. Position welding shall be done with the pipes resting on skids at the proper height over or alongside the trench, so as to permit completing the weld on the whole circumference.

3.4.5 Weather Conditions

No welding shall be done when adverse weather conditions such as rain, mist, sand storms, or strong winds may affect the quality of the welds. The Engineer will decide in each case whether weather conditions permit welding to be done.

3.4.6 Cutting and Preparing Pipes for Welding

A. The cut shall be made with an approved mechanical pipe cutter and in conformity with the pipe manufacturer's recommendations. The edges of the cut shall be clean, true and square. The edges of the cut together with those parts of the pipes from which the coating has been removed shall be given two coats of bituminous paint and the internal lining repaired, if damaged, to the approval of the Engineer. When the cut pipe is to be inserted in a "Tyton" type joint it shall be bevelled for 10 mm at 30ؑ to pipe axis to remove sharp or rough edges.

B. The Contractor shall be solely responsible for the provision of all equipment necessary for cutting and preparing pipes.

C. Spare cut lengths shall as far practicable be used elsewhere in the pipeline.

3.4.7 Welding of Joints

A. The number of beads in each weld seam shall not be less than two, and their thickness shall not exceed 3.0mm.

B. In butt welds, the thickness and number of the beads shall be so adjusted that the height of the weld reinforcement shall be not less than 0.8mm and not more than 1.5mm above the pipe surface. The width of the cover bead shall be approximately 3.0mm more than the width of the groove before welding. In fillet welds the thickness of the throat shall be at least (0.707) of the pipe wall thickness cutting back of the edge of the bell shall be kept to a minimum. All weld metal shall be thoroughly fused to the parent metal and to the previously placed weld metal.

C. After the completion of each bead, the weld shall be thoroughly cleaned of all scale, slag, or dirt. All spots on the weld where electrodes are changed shall also be cleaned.

3.4.8 Jointing of Line Sections

A. Pipes shall be connected to each other by welding as specified above, while they are placed on suitable supports on the trench bottom or on the ground beside the trench. The places of welded joints should be wrapped according to the instructions of the manufacturer.

B. The length of sections to be welded together before lowering shall be as determined by the Engineer. The position of every pipe or elbow in the section shall be such that, when the section has been lowered to the trench bottom, the longitudinal seams will be located between the figures 10 and 2 on the clock face, so that repairs on the seams can be done in the trench without necessitating deep excavation.

C. Before being connected to the line, each pipe and each elbow shall be cleaned on the inside.

3.4.9 Repair of Weld Defects

A. The Engineer may permit repairs of defects in the root or filler beads to be made, but any weld that shows evidence of repair work having been done without such permission may be rejected.

B. Pinholes and undercuts in the final bead may be repaired, but such repairs shall be subject to the Engineer's approval. Undercuts not exceeding 1.0mm in depth will not be considered as defects.

C. Before repairs are made, the defective areas shall be removed by chipping, grinding, or flame gouging. All slag and scale shall be removed by wire brushing. When cracks are found, the entire seam shall be cut and rewarded.

D. The Contractor shall clearly mark with oil paint on top of the pipe any defect that may be discovered in the pipe or weld.

3.4.10 Radiographic Tests

A. Radiographic tests shall be performed at locations specified by the Engineer of weld seams. If these primary tests should not give satisfactory results, the Engineer will conduct additional radiographic tests to ascertain the quality of the welding work. All weld defects discovered by the tests shall be repaired as directed by the Engineer and all repaired welds shall be retested.

B. The routine radiographic tests will be carried out at the Owner's expense. Should, however, the Engineer assess it necessary to conduct additional tests because of the defective quality of the welds, the cost of all such additional tests will be charged to the Contractor's account. The Contractor shall also bear the cost of repair of all welds found defective under test as well as the cost of resetting such repaired welds.

3.5 Above Ground Pipe laying

A. In addition to all specifications here before mentioned for each type of , the following instructions shall be considered for the above ground pipes :

a) All pipes and fittings exposed to view shall have its surface prepared, finish painted and marked in accordance with the manufacturer's instructions and as required by the Engineer in identifying pipe contents, direction of flow and all else required for proper finish painting and marking of pipe.
b) Concrete inserts for hangers and supports shall be furnished and installed in the concrete as it is placed. The inserts shall be set in accordance with the requirements of the piping layout and jointing method and their locations shall be verified from approved piping layout drawings and structural drawings.

3.6 Joints Installation

3.6.1 General

A. Joints shall have natural or synthetic rubber rings maintained in place in such manner as to ensure watertight joints during the specified tests, and the subsequent life of the installed pipes. The ring shall be highly resistant to deterioration in contact with sewage.

B. The joint material shall further more comply with the requirements of the B.S, ASTM or DIN.

C. No cementations or adhesive material shall be used to construct or make repairs at the joints.

3.6.2 Flanged Joints

A. The flanges shall be scraped clean and correctly positioned and the component parts including any insertion ring cleaned and dried. Insertion rings shall be fitted smoothly to the flange without folds or wrinkles. The faces and bolt holes shall be brought fairly together and the joints shall be made by gradually and evenly tightening bolts in diametrically opposed positions. Only standard length spanners shall be used to tighten the bolts.

B. The protective coating, if any, of the flange shall be made good when the joint is completed.

3.6.3 Mechanical Joints

A. Before installing mechanical joints, the pipe ends shall be cleaned of any paint, asphalt and dirt and their perfect roundness shall be ensured for a distance of not less than 200 mm from the edge.

B. Joint rings shall slide freely into the pipes. Forcing on of rings by hammer blows will not be permitted.

C. Rubber gaskets shall be protected against sunlight until immediately before installation. Where a "bored Dresser" is required, the ridge in the central ring shall be removed by turning on lathe in the shop or by chiseling if the work is done in the field. Removing the ridge by flame gouging is strictly prohibited.

D. Where shown on the drawings or required by the Engineer, Dresser couplings shall be fitted with anchors. The shape and method of installation of these anchors shall be as shown on the drawings.

E. Every Dresser coupling shall be bridged for cathodic protection as shown on the drawings (see clause 6.2).

3.6.4 Fabrication of Steel Fittings

Fabrication of fittings by welding pieces of pipes is not accepted. The fabrication shall be done as follows:
a) Elbows must be fabricated by forging or by hot or cold forming of pipes.
b) Reducers must be fabricated by hot or cold forming and annealing of pipes.
c) Tees must be fabricated by forming of pipe or by hot or cold forming and annealing of pipes.
d) Caps must be fabricated by hot or cold stamping or forging of plates heat treated.
e) The fabricated pieces shall be of the same thickness as the used pipe.

3.6.5 Connections to Existing Mains

A. Where connections are to be made to any part of the existing mains the Contractor must make all necessary arrangements with the Engineer and have all necessary material, plant and labour in readiness on the ground and shall complete the work as rapidly as possible with the minimum of inconvenience to consumers. The actual connection to an existing main will be the Contractor under the close supervision of the Engineer.

B. All connections to an existing main should be through manholes.

4 House Connections

A. House connection shall be extended inside the property of the customer at a distance of 1m inside the lot of the satisfaction of the Engineer. The pipe should be sleeved with a suitable sleeve material where it passes through the boundary wall and as indicated on the Drawings.

B. A stop valve shall be installed adjacent to the meter on the entry side as indicated on the Drawings, to work as an isolating valve for maintenance purposes.

C. The Engineer will issue instructions regarding size, location and fittings for each service connection.

D. All service connections shall be subjected to a hydrostatic pressure test in the presence of the Engineer's Representative. Sterilization of the service connection will be carried out at the same time as the main to which it is connected.

5 Protection of Joints

A. All buried steel and ductile iron flange joints, flange adapters and couplings shall be protected by wrapping with "Denso Tap" or similar approved material.

B. The joints shall be thoroughly cleaned to remove all loose rust and extraneous matter and thoroughly and adequately wrapped with the protective tape to the satisfaction of the Engineer.

6 Hydrostatic Test

6.3.1 General

A. After completing the installation of a sewer line or a section of the line, and before backfilling is carried out, a hydrostatic test of the line shall be made.

B. The test pressure shall be 1.0 meter head of water at the highest point of the section under test. The length of each section to be tested shall not exceed 100 meters and the pressure at the lowest point shall not exceed 10 meters head of water for gravity lines.

6.3.2 Procedure

A. Whenever possible, testing of sewers shall be carried out from manhole to manhole. Short branch sewers connected to a main sewer between manholes may be tested as one system with the main sewer. Long branch sewer shall be tested separately.

B. Both ends of the Sewer to be tested, as well as inlets and outlets to manholes and other connections in between shall be sealed effectively. At the upper end of the sewer a gauge glass shall be connected to the sealing plug to enable the observation of the water level during the test. The gauge glass should have an inner diameter of about 50 mm and shall be provided with a mark located at 1.0 meter above the top of the sewer. An air vent and a cock should also be installed at the same end for release of air during the filling of water for the testing. The air vent shall be connected to the sewer so that all air can be released. The trench shall be kept free of all kinds of water during the test.

6.3.3 Duration of Test

The pipe shall be filled with water for a period of minimum 2 hours and maximum 24 hours before the test is assumed to begin to allow for a soaking period and a complete release of air. If 25 hours have passed with water in the pipe, filled or partially filled, without being tested the pipe should be emptied completely and left for 24 hours and then filled again with water and tested within 2-24 hours soaking period, The water level shall be at the mark on the gauge glass during the whole soaking period. The test shall be carried out immediately after the soaking period.

6.3.4 Permissible Leakage

A. Leakage is defined as the quantity of water which must be supplied to the laid pipe during 10 minutes to maintain the specified water level after the pipe has been filled with water and the air expelled. The additional quantity of water filled into the pipe shall be measured with an accuracy of 0.1 litres.

B. The sewer will be accepted in respect of water tightness if the quantity of water added during 10 minutes is less than quantity calculated in accordance with the following clauses (v) and (vi).

6.3.5 Sewer Line With One Pipe Dimension

A. The maximum permissible quantity of water which may be supplied to the line during the test is estimated as follows:

Q = (0.118) (L) (d) Where Q = quantity of water in litres during 10 minutes
L = length of line in meters
d = inner diameter of pipe in meters

B. The maximum permissible leakage in manholes is estimated as 0.35 liters per 10 minutes per meter diameter per meter depth of water inside the manholes.

6.3.6 Sewer Line With Different Pipe Dimensions

A. At sewer lines with more than one pipe dimension the maximum permissible quantity of water Q total, which may be supplied to the line during the test is estimated as follows :

$$Q_{total} = Q1 + Q2 + \ldots \ldots + Qn$$

Where Q total = quantity of water in litres during 10 minutes
Q1. Q2, Qn = quantity of water for respective pipe dimension
Estimated according to clause (v).

6.3.7 Extent of Testing

A. The Contractor shall provide at his own expense all equipment, labour, and materials necessary and carry out testing of 100% of the total lengths of the lines included in the works before covering the pipes. House connections and manholes are not included. 50% percent of the manholes should be tested separately or with the line.

B. Manholes shall be tested before benching is made in manholes and before backfilling and after installation of the steps. A maximum of 5% of the lines shall be tested including house connections after backfilling is complete.

C. The lines to be tested shall be chosen by the Engineer. Should any line tested before backfilling exceeded the permissible Q by more than 5% the Contractor shall after repairing and making good any leaks carry out further tests all as above described and within the specified soaking period. If it continues of fail by more than 5% of permissible Q at the end of the soaking period, the line should be dismantled and reconstructed with new pipes and should be retested, all at the Contractor's expense.

D. The same procedure is applied for lines and house connections that are tested after backfilling but with a tolerance of 15% of permissible Q. Repair and making good, referred to above, is to correct the alignment, level of the pipes or to fix properly any two pipes. Brushing, grouting, cementing or concreting is not allowed neither before nor after the test is run. All tests and retests and repairs shall be at the expense of the Contractor.

7 Field Air Test

7.3.1 General

A. An alternate leak test for sewerage pipe systems may be conducted with air pressure instead of water, if instructed by the Engineer due to shortage of water for testing.

B. Field air test is a low pressure air test which determines the rate of which air under pressure leaves an isolated section of the pipeline. This rate indicates the presence or absence of leaks.

7.3.2 Procedure

A. As with the hydrotest, the section of pipe together with its connected ends of all bends, laterals and wyes should be plugged and braced against internal pressure. One of the plugs provided must have an inlet tap or other provisions for connecting an air hose, the other end of the hose to be connected to the portable air control equipment.

B. Slowly pressurize the system to 24 kPa. The pressure must be regulated to prevent over pressurization (maximum 35 kPa). Allow the air pressure to stabilize for at least 2 minutes while maintaining the pressure at 24 kPa. During this stabilization period, with soap solution

detect any possible leakage. If any plug is found to leak, bleed off the air, tighten the plug and start again.

C. After the stabilization period, adjust the air pressure to 24 kPa and shut-off or disconnect the air supply.

D. The pipeline passes this test if the pressure drop is 3.5 kPa or less during the time periods given in Table 4.3 below.

Table 4.3 Test Time - Field Air Test

Dia. (mm)	Time (min.)	Dia. (mm)	Time (min.)
100	2 1/2	1000	25
150	3 3/4	1100	27 1/2
200	5	1200	30
250	6 1/4	1300	32 1/2
300	7 3/4	1400	35
350	8 3/4	1500	37 1/2
400	10	1600	40
500	12 1/2	1800	45
600	15	2000	50
700	17 1/2	2200	55
800	20	2400	60
900	22 1/2		

7.3.3 Safety Requirements

A. Considerable potential energy is stored in a pipeline under pressure. This is particularly true when air (even at low pressure) is the test medium. Take great care to ensure that the plugs are properly secured. It is also obvious that the pressure in the pipe is completely relieved before the plug is loosened.

B. Under no circumstances should a person be allowed to be inside a manhole while the air pressure is applied to the pipelines

8 Hydrostatic Pressure Test

8.3.1 General

A. The pressurised sewers will be tested by a hydrostatic pressure test. After pipe laying, casting of concrete structures on the line and partial backfill have been completed, the line shall be subjected to a hydrostatic pressure test. The line shall be tested over its entire length or, in the case of long lines, in sections. The pressure test shall only be performed in the presence of the Engineer.

B. The test pressure shall be determined by the Engineer in each case. The required pressure shall be obtained by means of a special pressure pump or by connecting the line to a suitable source of pressure.

8.3.2 Preparations for Pressure Test

C. Filling of the line with water shall not begin until 6-7 days after the last concrete structures have been cast. Prior to filling the line, all joints and structures shall be inspected and the good condition and proper functioning of all valves shall be ascertained. When testing a section not

ending in a valve, the open end shall be bulk headed and securely anchored. The testing installation and the working of the pump shall also be examined.

8.3.3 Filling the Line with Water

A. The line shall not be filled until the Engineer's written approval thereto has been given. The line shall be filled gradually and slowly in order to prevent water hammer or chattering in the pipe and to permit the escape of all air from the pipeline.

B. At the commencement of filling, all blowout valves shall be open, and each valve shall be closed after the water has flushed all dirt that may have accumulated in the pipes.

C. After the filling has been completed, but before the pressure is raised, all valves shall be inspected for water-tightness and all leaks in gaskets and stuffing boxes shall be stopped. Should this inspection show any leaks at the joints or defects in the valves that cannot be repaired while the line is full of water, the line shall be drained and the necessary repairs done. This inspection shall be repeated until all leaks are stopped.

8.3.4 Pressure Test

A. The pipelines of the transmission and water distribution system and all the joints shall be tested by the Contractor at a test pressure as shown in table 4.3 below:

The testing shall be carried out in sections as the pipes are laid.

Table 4.4

Working Pressure Range [atm]	Factor *
0 - 12	1.5
13 - 20	1.25
more than 20	1.1

Test pressure = Working pressure x Factor

B. The length of sections and the procedure of testing shall have the prior approval of the Engineer. The Contractor shall furnish and fix on the pipelines at locations indicated by the Engineer Tees provided with 1/2" stop-cooks for the purpose of releasing the air from the pipelines. After pressure testing of the lines the stop-cook shall be removed and the opening properly plugged.

C. An efficient stop and strutting block shall be placed at the end of the section to be tested. After the pipes have been completely filled with water and all air has been excluding therefrom, the pressure shall be raised by pumping to the specified test pressure as instructed by the Engineer.

D. The pipeline shall be maintained under this pressure for a period of 24 hours, during which period the pressure shall not be allowed to fall below 75% of the test pressure but shall be restored to the full test pressure by such pumping as may be necessary.

E. The test pressure shall be calculated as one and a half times the maximum working head at the lowest point in the section to be tested.

F. The test shall be deemed to be satisfactory if the pipeline holds after the initial 24 hours the specified pressure for a final period of not less than two hours or such final period as is determined on site by the Engineer, with a loss not exceeding (5%) of the total test pressure during this two hours period. No pumping shall be permitted during this final test period.

G. If the test is not successful, the Contractor shall proceed to locate immediately and rectify the defects, after which he shall re-test until a satisfactory test result can be secured.

H. The Contractor shall provide the clean water, all pumps, meters, pressure gauges and other appliances required for the purpose of the test. The Contractor shall also arrange for meters and gauges to be tested for accuracy, if required to do so by the Engineer.

9 Measurement and Payment

9.3.1 Pipes and Fittings

- The construction of sewers of the sewerage collection system and the installation of house connections shall be measured and paid for by the meter run respectively for every kind of pipe and diameter of completed and accepted works in accordance with the Drawings and Specifications to the satisfaction of the Engineer and the unit price for each shall include but not limited to the following :

1. The supply and laying and/or the collection and hauling from the Owner's stores to Site of Work, laying and proper jointing the respective pipeline including all fittings and specials and all incidentals required for the proper laying and completion of the relative pipeline and service lines and connections in accordance with the Drawings and Specifications.
2. All ancillary works relating to the construction of sewerage collection system which are not explicitly mentioned in the Contract but could be inferred there from or which are customarily performed or evidently necessary to carry out the intent of the Drawings and Specifications and all other liabilities and obligations set forth in the tender Documents.

9.3.2 Manholes

The supply and erection of manholes and their necessary incidentals. This will be executed in full details according to the Drawings and Specifications and to the interactions of the Engineer's Representative. The measurement and payment will be made for the completed installed and accepted piece respectively for every type and diameter of the manhole.

9.3.3 Hydrostatic Tests and Air Field Test

The supply of water, pumps and the necessary equipment for execution the hydrostatic testing of the lines, or the source of compressed air, the control equipment and the necessary equipment for execution the field air testing of the lines. The payment will be made on a lump sum basis for the testing of the whole project sewerage system.

9.4 CONCRETE MANHOLES

Concrete manholes shall be constructed at the locations shown on the Drawings, and elsewhere as directed by the Engineer or his .representative. Their shape and dimensions shall conform to those shown on the typical Drawings and the inner dimensions, if not specified otherwise, will be after plastering or otherwise finished surfaces.

2.16.1 Construction of Manholes and Valve Chambers

All manholes shall have reinforced-concrete bases. The Contractor shall construct all manholes, and special structures including transition chambers and outfall structures as indicated on the Drawings and herein specified.
Manhole cover slabs steel mesh as shall be as specified and shown on drawings .Concrete B300 shall be cast to a minimum thickness of 150mm around the concrete blocks for rigidity. Manhole walls (rings) shall be either precast or cast in place reinforced-concrete. In pre-cast construction rubber O-rings are to be placed in all joints except for the joint between the cast in place roof slab and the top wall ring. In below the manhole cover slab shall have removable plus or minus 30cm high concrete ring.
The inverts shall conform accurately to the size of the adjoining pipe. Side inverts shall be curved and main inverts (where direction changes) shall be laid out in smooth curves of the longest possible which is tangent, within the manhole to the center lines of adjoining pipelines all as indicated on the drawings and approved by the engineer.
Cast -In Situ Reinforced Concrete Manhole This type consists of a reinforced concrete (B300) base slab cast on firm ground foundations (so as to prevent any differential settlement), reinforced concrete (B300) walls cast on the base at least 24 hours later with the required openings for installation of pipes in one time or more according to the manhole depth, and reinforced concrete roof slab with the appropriate cover. Reinforcement and dimensions shall be as shown on the Drawings. The forms used shall be tight, proper and smooth. Water stop RX type or equivalent shall be placed when the concrete cast on stages.

2.16.2 Precast Concrete Manhole

This type consists of a cast-in situ or precast reinforced concrete (B300) base with the required openings for installation of pipes installed on a firm ground foundations (so as to prevent any differential settlement), precast concrete (B300) rings of 1 m height or as specified on the Drawings of tongue and groove type for the walls fixed on the base and precast reinforced concrete roof slab with the appropriate cover. Reinforcement and dimensions shall be as shown on the Drawings. The forms used shall be tight, proper and smooth. Joints between the slabs, rings and bases of manholes shall have natural or synthetic rubber ring maintained in place in such manner as to ensure watertight joints during the specified tests and the subsequent life of the installed manholes. The rubber ring shall be highly resistant to deterioration in contact with sewage and shall be seamless and MAGNUFLEX type or equivalent.

2.16.3 Plastering

Where shown on the Drawings or otherwise required, internal surfaces (e.g., cast-in situ manholes) shall be lined or plastered with 1 cm thick cement sand mortar in the proportions of 1: 1 1/2 and steel trowel finished.
The inside plastering may be omitted if steel forms are used and the inside surface of the wall is as smooth as the cement plaster finish or otherwise directed by the Engineer or his representative

2.16.4 Coating

Coating material of 100% Solid Coal Tar Epoxy or equivalent shall be applied to the internal surface of the walls and the roof of Sewerage manholes as shown on the Drawings or otherwise directed by the Engineer or his representative.

2.16.5 Deep Manholes

The upper ring where the depth of manhole is more than 2.0 m or as directed by the Engineer or his representative should be of a cone shape. Concrete encasement for manhole cover shall be constructed according to the Drawings and as directed by the Engineer or his representative. Encasement should be applied where manhole laid in natural ground surface or in the gradient of 1.5% or more in paved area, the manhole neck should be encased as shown on the Drawings with reinforced concrete B300.

2.16.6 Manhole Cover And Grating

The contractor shall furnish all cast-iron frames and covers conforming to the details shown on the drawings, or as herein before specified. As described in the general specifications, the contractor shall submit for approval, detailed shop and working drawings of all casting before fabrication. The castings shall be of good quality, strong, tough, even grained cast iron, smooth, free from scale, lumps, blisters, sand holes, and defects of every nature which would render them unfit for service for which they are intended. All casting shall be thoroughly cleaned and subject to a careful hammer inspection. Manhole covers shall be circular, made of cast iron with cast iron frames, the dimensions and type conforming to B.S 497 or to I.S 489, as shown on the Drawings or requested by the Engineer or his representative. Manhole frames shall be set firmly in cement mortar so that the covers are 1 cm below the final surface. All manhole covers shall be non-ventilated and none rocking. After completion of the Work, cast iron parts of the covers and the frames shall be painted with bitumen paint. Grease shall be placed between the frame and the cover. All water manholes covers shall have the word (WATER) in Arabic and English. Cast iron grating with frame shall be supplied and
or manufactured in accordance with details shown on the Drawings and in accordance with the instructions of the Engineer or his representative. Frame shall be embedded in the concrete of the roof of storm water inlet and Catch basin and depressed 3cm below the final surface. After completion of the Works, cast iron parts of the gratings and frames shall be painted with bitumen paint.

2.16.7 Manholes Steps

Cast iron steps or steel rungs, complying with B.S. 1247 shall be installed by the contractor at manholes up to the depth of 5.0 meters. Ladders shall be installed at all manholes with depths exceeding 5.0 meters. All step irons and ladders shall be coated with glass fabric as shown on the drawings or as directed by the engineer.

SECTION 4 – SEWAGE PUMPING STATION WORKS

1. GENERAL SPECIFICATIONS

1. THE FOLLOWING

In engagement of delivery shall be included:

- Specification and drawings complete each other. Work and delivery mentioned solely in specification or drawing shall be included in offer.
- Delivery and installation of equipment according to specification up to entire finished plant ready for operation.
- Draw up installation drawings in scale, at least 1:50, to be provided by client before start of installation.
- Handling instruction in English and Arabic in three copies.
- Operation instructions in English and Arabic in three copies.
- Certificate of origin.
- As-built drawings, three copies archive constant one copy and one A3-size CAD-files in AutoCAD2005 on CD Rom.
- Installation instructions and installation manuals shall be provided including electrical installation and drawings.
- Fully detailed Operation and Maintenance manuals shall be provided in accordance.
- Test and trim of the plant and training of staff at plant.
- Performance test for all kind of equipment (before final inspection) of delivered equipment.
- At least two visits for service during guarantee time.
- All standards and norms shall be understood as minimum requirements.

General Conditions and Demands

Standards and regulations

All standards and norms shall be understood as minimum requirements unless the corresponding standard, which is in use in Palestine, sets higher requirements, in which case the latter applies.

The contractor is obliged to check that the proposed equipment manufactures are approved to be used in Palestine. This also concerns pipe manufacturer.

Control of dimensions at site

The supplier is deemed to check dimensions and shape of civil construction, embedment pipes etc. before start of manufacturing and erection.

Gates

General

The construction will be well known and adjusted for wastewater pumping station, The constructor will assign locations of fold, spindles and stand for control handle. Frames will be embedded.

Material

The following demands shall be fulfilled if nothing else mentioned:

Frame:	EN 1.4436
Gate:	EN 1.4436
Spindle:	EN 10 088-3—1 .4104+A
Spindle nut:	SS 5444/ LG 4 BS 1400:1985
Rubber sealing strip:	EPDM

Surface conditioning

Control handles and other material not in EN 1.4436 or higher wilt be surface conditioned to stand corrosive atmosphere, for example con trol-device, (Auma) in corrosion class K2.

Tightness demands

Maximum leakage: 5 l/mm per meter length of tightening.

Valves

Where nothing else is mensioned, valves will have the same dimension as pipe. Control shall be possible to do from above floor or catwalk. Valve located underneath floor structure will be provided with lengthened spindle. Valve key will be included.

General: Bidder will state in offer manufacture and material of equipment.

Non-return valves: Non-return valves for air, type slide non-return valve, installation between flanges. Working pressure max 10 bar.
Non-return valves for wastewater will be soft sealed flap non-return valve or Hydraulic Controlled Check Valve according to respectively item.

Material:

Body	Cast Iron	SS-EN 1561-EN-JL 1040
Flap	Stainless steel	EN 104436
Axis	Stainless Steel	EN 1.4436
Packing	Perbunan	

Hand valves: Stop valve for air will if not other mentioned be of butterfly type manufacture installed and fitted between flanges PN10.
Stop valves for wastewater will be of soft sealed gate valve type dimension ϕ50-0900 or Bonneted Knife valves as where mentioned
The Bonneted Knife gate valves shall be designed and tested for 10 PN, one piece body with fully rated, pressure retaining bonnet. The gate shall be tight shut of and withstand the back flow pressure without any damage of the valve, Flanges to be drilled according to ANSI B16.5/ 150

Material of Gate Valves

Body	Nodular Iron	SS-EN 1563/Grade 500/7 BS 2789
Slide	Stainless Steel	EN 1.4436
Seat	EPDM- rubber	

Material of Bonneted Knife valves

Body	Carbon Steel	
Gate	Cast Stainless Steel	304
Seat	Cast Stainless Steel	304
Flanges	Carbon Steel	
Hand Wheel	Cast Ductile	
Stem	Cast Stainless Steel	304

General Specification for Pipes, Valves and Welding Pipes

All pipelines shall be specified in the tender with respect to diameter, material and method of fitting. Limit of delivery according to drawings. Demands in pipe standards will be fulfilled.
All pipes shall be constructed for minimum pressure class PN1O. Minimum thickness of pipes in stainless steel:

Dim mm	Thickness mm
< 300	2.0
300-350	2,5
400-500	3,0
> 500	4,0

Note! Wall thickness shall always be chosen according to the duty of the pipe and for an expected life length of not less than 30 years. Special consideration shall be taken to pipes, which are subject to wear.

Where otherwise not stated in mechanical specification, fixing arrangements such as consoles etc. are to be made of stainless steel EN 1.4436, in such a way that secure fixing is achieved at empty basin/full pipeline or full basin/empty pipeline. At risk of couple action, protection is to be applied by installation of suit able insert etc. or exchange to a higher quality in material.

Required compensators, pipe bends etc. are to be included.

Pipes to be fixed by concrete molding are to be equipped with flanges and arrangements for connection at limit of delivery.

Pipes for sludge and water to be made of stainless steel EN 1.4436.

Pipes for air to be made of stainless steel, EN 1.4436.

Pipes are to be equipped with collars and loose flanges made of silumin or hot galvanized steel, also bolts screws and nuts made of stainless steel EN 1.4436.

Joints in ground and under water to be made of stainless steel EN 1 .4436.The piping systems are to be equipped with joints in such a way that dismantling of equipment easy can be done.

Standard pipes and pipe details shall be used.

Where nothing else is mentioned, pipelines fittings shall have the same dimension as pipe. Control shall be possible to do from above floor or cat walk. Valve located underneath floor structure shall be provided with lengthened spindle. Valve key shall be included.

Necessary cones for installation of pumps, flow meters etc. shall be included.

Connections for flushing and empty the pipe system including ball valves, Φ25 mm, shall be included on suction and pressure side of pumps.

Pressure switches and transmitters included in specifications for in instrumentation to be connected to small pipes with ball type valves included in mechanical equipment specification. Necessary attachment details to include in mechanical equipment supply.

Open ends of pipes shall immediately be covered by completely selected protection cover.

Pipes for polyelectrolyte and chemicals indoors in shall be made of rigid polyvinyl chloride or glass reinforced plastic. Pipes for chemicals in tanks and ground flexible hose shall be of polyvinyl chloride.

Sludge pipes shall be equipped with installations that make flushing of pipes possible for example polyp lug

All pipes shall be equipped with manual air release valves at high points.

Air pipes to be insulated to avoid risk of people safetly. Temperature may not exceed 50°C.

Connections to pipes in ground shall be manufactured from the stainless steel pipes are adapted to the pipe in ground. The adoption can be made in two different ways; by flange or by sleeve joint.

Welding

All welding shall be done by approved welder at licensed company according to valid standards, American Society of Mechanical Engine (ASME) codes, or other standard providing an equivalent or higher level of quality and standards for pipes. These standards must be followed for all welding i.e. welding of pipes, joining of fittings and suspension attachments etc.

The purchaser will pay for all X-ray testing. If any defects will occur the contractor has to pay for all X-ray re-test and extended X-ray test. Testing will be done as sample survey during welding working period but minimum 10 % length of welds will be examined, at least two joints and 0,4 m length of welds.

If defects will occur that states that the welding can not be approved the testing shall increase to further more 10 % of the total length of the welds but minimum two joints and 0,4 m length of the welds. If all joints in the increased examination are approved no further testing will be done. Defects shall be repaired and the repaired joints shall be X-ray tested once more, or any approved alternative testing method in accordance to international standerds.

If some of the joints in the extra testing is not approved all joints shall be X-ray tested. Defect joints shall be repaired and X-ray tested once more.

To be approved welding shall be done according to standard green (3) without root defects, X-ray class 1 (Collection of reference Radio- graphs of Welds in Steel) or other standard providing an equivalent or higher level of quality.
All welding of pipes shall be done by the TIG-welding method including use of protection gas.

The supplier is responsible for defects that will occur later at joints or other welds that are not X-ray tested.

After welding in stainless steel material joints shall be cauterized and passivated to the same corrosion resistance quality as for the stainless steel material that has been used.

The supplier shall purchaser and how what type of cauterization and passivation method the supplier is going to use. Welding activities shall not begin before approval from purchaser of the above-mentioned method.

Only stainless steel tools shall be used in contact with stainless steel material. Tools for stainless steel shall not be used in contact with other materials.

At transport, lifting activities etc. of stainless steel material only stainless steel material shall be used.
General Specifications for Electrical Equipment
Electric motors shall be of manufacture ABB or similar. Cooling R (Sealing, lP55, according to EN 60034-5 (not standard for submersible pumps) and connection to 400 V, 50 Hz, 3-phase alternating current.
In the tender type, make, power, speed, start up current, efficiency and efficiency factor at all load are to be stated.
Power rating will exceed the highest output by at least 10 %.
All standards and norms shall be understood as minimum requirements unless the corresponding standard, which is in use in Palestine, sets higher requirements, in which case the latter applies.
Erection of electrical cables is excluded from this delivery if not other stated.
Control boards, for operation and control are included where stated. All gauges and/or electrical operation units are to be included in the delivery.
Delivered electrical equipment shall fulfill demands according to Swedish standard EN 60204-1 (Safety of mechanical equipment — Electrical equipment of mechanical equipment, General demands).

General Specifications for Installation and Marking

In specification stated material shall be of installed by experienced, skilled mechanics to a plant ready for working. Necessary attachments shall be included in offer.
Equipment such as valves, spare equipment, bolts, packing material, brace, cantilevers, hanger rods etc. which is to be required to put the plant in ready working shall be included.
Where nothing else is mentioned, pipelines fillings will have the same dimension as pipe. Control shall be possible to do from above floor or cat walk. Valve located underneath floor structure will be provided with lengthened spindle. Valve key will be included.
Supplied electrical equipment is to be erected by supplier of mechanical equipment but electrically connected by other supplier if not other stated in this tender document.
Holes for erection shall be made by the supplier.
Necessary engineer visits shall be included.
The permanent plant staff will be present during the erection period to get knowledge about the equipment installed.
Spare equipment shall be marked with position number to secure be located in the right place.
Before marking of equipment co-ordination shall be done between con tractors and purchaser.
Each object shall be marked by the same position as in specification.
Marking will be done by constant material and text and with satisfactory attachment. Text will be written in English and Arabic and only accepted abbreviations shall be used.
Marking will be located in visible place. If equipment is hidden marking will be doubled or completed by reference sign.
Marking and technical documentation have to correspond to the requirements.
All equipment shall be marked at delivery. If marking is not done at installation, temporary marking shall be arranged.

Electrically operated hoist and trolley (EH)

Equipment:	The electrical operated hoist includes the following equipment: - Fixed I Beam - Electrically operated hoist and trolley *The price include Control Panel with all required accessories to complete the job*
Manufacture/type:	Yale or any other equivalent product.
Location:	Above wet well champers and Above Grit Removal Trap
Media:	Unscreened Domestic and Industrial Wastewater
Capacity:	1000 kg or as specified in the BOQ

Mechanical Screen

Design:	I beam fixed to the concrete frames above the wet well and above the grit removal trap, and reaching 1.5 m out from the wall, with electrically operated hoist and trolley. Chain lifting height: 15mR, Lifting speed not less than 8m /min Voltage = 380V , Noise emission <u>General</u> The assembly shall be suitable for lifting the heaviest single item of equipment within the working area. <u>Runway beam hoist</u> I beams shall be supplied complete with all fixings, fishplates, bolts and end stops.
Pos/marking:	*The price include Control Panel with all required accessories to complete the job*
Equipment: Manufacture/type:	Mechanically raked vertical screen Siniaver or any other equivalent product
Location:	In concrete channel Maximum head loss, 60 mmWC.
Bar thickness:	6 mm.
Distance between bars:	25 mm – 50 mm.

Design:	Channel depth: (CD)	1,500 mm or as specified in BOQ
	Maximum water depth in front of screen:	1,000 mm or as specified in BOQ
	Channel width: (CW)	600 mm or as specified in BOQ
	Screenings discharge level above concrete (S.L)	
Material:	Stainless Steel, EN 1.4436	

Hand Raked Bar Screen

Pos/marking:	**WWHBS (Hand Raked Screen)**
Equipment:	Hand Raked Screen.
Manufacture/type:	Local Manufacturer
Location:	Bypass Channel
Bar thickness:	10 mm.
Distance between bars:	25 mm -50 mm.
Design:	Bar Screen Dimensions: Bar screen width: 600 mm Bar screen height (vertical): 1100 mm Inclination Angel: 60^{o} Channel depth: (CD) 1500 mm Channel width: (CW) 600mm Maximum water depth in front of screen: 1,000 mm Screen will be equipped with two vertical channel rails and side wheels to facilitate screen lifting to the level of the first flour slab to be manually cleaned and to retain back to its original location in the channel.
Material:	Stainless steel EN1.4436

Container (WWSC)

Pos/marking:	**Container**
Equipment:	Container for screenings and grit.
Location:	At the end of screening compactor discharge pipe. Container volume approx. 1 m^3 The first: Screenings from mechanically raked bar screen. The second: grit and sand from the grit basket. Container shall be provided with wheels. Cover shall be provided with: ▪ Support in Stainless Steel EN 1.4301. Drapery around cover, from lower edge covers to floor. The drapery shall be possible to move to side. Suspension attachment in Stainless Steel EN 1.4301.
Media:	Stainless Steel EN 1.4436 Drapery in plastic tarpaulin.

Sluice Gates (WWSG)

Manufacture/type:	SINIAVER or any other equivalent product.
Location:	Inlet Chamber & Screen –sand trap Chamber; wet pit , WWSG01 Between the bar screen channel and the wet pit chamber. WWSG02 Mechanical bar screen channel outlet WWSG03 Hand racked bar screen channel outlet upstream and down stream WWSG04 Mechanical bar screen channel inlet

Measurement:

WWSG01

Width of opening	500 mm
Height of opening	500 mm
Water depth (max)	1,000 mm
Installation depth	below ground floor
Installation type	wall mounted

WWSG 02-03-04

Width of opening	600 mm
Height of opening	1,000 mm
Water depth (max)	1,000 mm
Installation depth	below ground floor
Installation type	Channel mounted

Material:

Frame:	EN 1.4436
Gate:	EN 1.4436
Spindle:	EN 10088-3 — 1 .4104+A
Spindle nut:	SS 5444/ LG 4 SS 1400:1985
Rubber sealing strip:	EPDM

Design:

The construction shall be well known and adjusted for Wastewater Pumping station. The constructor shall assign locations of fold, spindles and stands for control handle. All necessary equipment for a complete function of the gate shall be included.

Channel mounted sluice gates shall be impeded in concrete walls and floors (three sides). The gates shall be able to carry a unilateral water pressure of 2.0 mwc. The gates shall be bolted to the concrete wall.

The spindle should be extended from the sluice gate frame level to the indication level required in addition to the length required above this level to install operator and its driving wheel. The spindle should be supported by brackets along its height at an interval of at maximum of two meters.

Digital signals from objects and switches shall be delivered with potential free contacts.
Analogous signals form objects and transmitters shall be delivered with twin lead, 4-20 mA, 24 V DC connection.
Maximum noise emission from each equipment, 70 dBA, measured 1 m from respectively equipment "free field". By "free field" means noise emission only from the equipment without disturbances from other noise emissions or noise reflections.

Flow meter (WWFM)

Pos/marking	Designation
WWFM01	Flow meter, main pressure pipe from wastewater pumps, at Pumping Station.

Location:	Pumping Station.
Manufacture/type:	Clamp-on and In-Line Transit-Time and Doppler Electro Magnetic flow meter siemens,Flygt or any equivalent *The price include Control Panel with all required accessories to complete the job*
Media:	Wastewater.
Working pressure:	0-16bar
Ambient Pressure	From 0 ^{o}C to 60 ^{o}C

Air release valves (WWARV)

Manufacture/type:	Air release valve manufacture A.R.I D-020 or any other equivalent product.
Media:	Wastewater.
Design:	Air release. Spring loaded joint between the stem and upper float, to ensure that vibrations of the lower float will not unseal the automatic valve. Release of air will occur only after the accumulation of enough air. Self cleaning mechanism Drainage out enable removal of excess fluids. Excess pipes to floor drain or pump sump to be included.
Working pressure:	0-10 bar
Material:	Body: SS-EN 1561 — EN-JL1040Stem, Float: EN1.4436

Pos/marking	Designation
WWARV01-2	Single air release valves, at discharge pipes from wastewater pumps to force main

* The works should include combine the Air Release Valve outlets into a pipe leads to the wet pit.

Combination Air release valves

Manufacture/type:	Combination air release valve manufacture Val-Matic, model 1803VBS - 1812VBS/48A or approved equivalent.
Media:	Wastewater.
Design:	Combination air release (vacuum breaker & Air Release). Spring loaded joint between the stem and upper float, to ensure that vibrations of the lower float will not unseal the automatic valve. Release of air will occur only after the accumulation of enough air. Self-cleaning mechanism Drainage out enable removal of excess fluids. Excess pipes to floor drain or pump sump to be included.
Working pressure:	0-10 bar
Material:	Body & Cover: Cast Iron ASTM A126 Class B Class 125 and 250 Trim: Bronze, ASTM B584, C83600 Coating: Universal Alkyd Primer

Pos/marking	Designation
WWCARV01,2	On the bypass of the flow meter at the force main line, double acting (air release-vacum break)
WWCARV03	At the end of the force main, double acting (air release-vacum break)

Gate valves (WWGV)

Manufacture/type: Hakohav or equivalent Gate Valve.

Location:

Pos/marking	Number	Designation
WWGV01 WWGV02	2	On the discharge pipe from pumps to the force main.
WWGV03 WWGV04	2	Before the air release valve on the discharge pipes from pumps to the force main force

WWGV05 WWGV06	2	Before pressure gauge on the discharge pipes from pumps to the force main.
WWGV07 WWGV08	2	Between the discharge pipe on the flushing pipe
WWGV09 WWGV10	2	On the force main after and before flow meter.
WWGV11	1	On the Bypass of flow meter on the force main.
WWGV12	2	Before air release valve on the flow meter bypass pipe.
WWGV13,14,15	3	On the second branch of the sand flushing pipe
WWGV16	1	On the first branch of the sand flushing pipe
WWGV17	1	On Drainage Valve manhole at the end of force main.

Non-Return (Check) valves (WWCV)

Manufacture/type: Hydraulic Controlled Check Valve manufactures A.R.I or any equivalent product.

Design: Composed of two major parts: Single shaft tilting check valve and a hydraulic control system.
Nominal pressure maximum 10 bar.
Removable cover.
Oil servo system.
Flap held open by hydraulic system to minimize Head loss.
Limit switch
Local Control Box

	Number	Designation
WWCV01 WWCV02	2	Non-return valves, at discharge pipes from wastewater pumps to the force main

Pressure Gage (WWPG)

Manufacture/type: Pressure Gage that intended for adverse service conditions where pulsating or vibration exists (with liquid filling), used for Hydraulics & compressors, suitable for gaseous or liquid media that will not obstruct the pressure system.

Design:

- Vibration and shock resistant (with liquid filling)
- 7/16” -20 SAE connection
- Pressure ranges up to 0-16 Kg/cm2
- EN 837-1
- ASME B40.100

	Designation
WWPG01 WWPG02	Pressure gage on the discharge pipes from pumps to the force main.

Sand Basket (WWSB)

Manufacture/type: Local Manufacture

Design:

- The basket has a shape of rectangular prism
- The main Skelton of the basket is made of stainless steel profiles at its eight edges that are welded together to form the basket main frame. The profiles are 40x40x2 mm
- The frame is covered by stainless steel plates perforated with 1mm holes and

distributed at 5 mm (centre to centre) in all direction.

- The bottom outlet of the basket has a stainless steel gate with two leafs (80x75 cm) used for sand discharge from the bottom.
- The basket handle is made of stainless steel profiles (40x40x2 mm) and has a stainless steel hock.

Dismantling Joint (WWDJ)

Manufacture/type: Waste water dismantling joint manufactures A.R.I or any equivalent product.

Pos/marking	Number	Designation
WWDJ01	1	Between the discharge pipes on the flushing pipe
WWDJ02,3	2	On the discharge pipe from pumps to the main force
WWDJ04,5,6	3	On the force main and bypass

Technical Specification

1 –EXCAVATION, EARTH WORKS AND ROAD WORKS

1.1 GENERAL

The Contractor shall carry out all excavations, filling, backfilling and all other earthworks required in whatever material may be encountered.

The Works shall be executed accurately to the dimensions, levels, lines and profiles as indicated on the drawings or directed by the Engineer.

The Contractor shall reconstruct to the proper level and profile any filled areas which settle or spread during the execution of the work or during the maintenance period.

The Contractor shall drain and dewater the underground water to a level below the excavation by lowering the water table with a proper drainage and dewatering system approved by the Engineer.

1.2 SOIL INFORMATION

The Contractor shall be deemed to have visited the Site of Works and satisfied himself as to the nature of the ground and made him conversant with the local conditions to be encountered during the execution of the Contract. The contractor is requested to perform a soil test to determine the nature and bearing capacity of the soil surface if indicated clearly in the contract documents.

1.3 MATERIALS

1.3.1 Backfill and Fill

Backfill and fill shall be a structurally sound material such as; gravel or native soil free of rocks with size more than 5cm, lumps, vegetables and other organic materials obtained from suitable excavated material and/or from approved borrow pits.

1.3.2 Water

Water shall be clean potable water as specified under “Concrete Work”

1.3.3 Concrete

Concrete used as fill for making up the correct level areas of over-excavation shall be, where required by the Engineer of Class “B” as specified under “Concrete Work”.

1.3.4 Hardcore

Hard-core under floor paving, etc. (Where shown on the drawings or as directed by the Engineer) shall consist of tough, sound and durable rubble stones (maximum 150mm), free from coatings, clays, seems or flows of any character. Fine aggregate for blinding the interstices of hard-core bed shall be as described in “Concrete Work”.

1.3.5 Agricultural Soils, Gravel and Sand Fill

Agricultural soil shall be first choice top soil rich in organic materials and free from roots, stones and rubbish suitable for plantation and shall be obtained from an approved source. Gravel fill shall consist of graded gravel 50mm down to 20mm and blinded with clean coarse sand.

1.4 SITE PREPARATION

1.4.1 Existing Public Utilities

The Contractor shall ascertain the whereabouts of all existing public utilities on the site, both above and below ground. Such utilities shall be removed, sealed or rerouted in a manner prescribed by the Public Authorities concerned at the Contractor's own expense. The Contractor shall also be held responsible for all damages entailed on any of the public utilities adjacent to the Site resulting from the Works.

1.4.2 Removal of Existing Structures and Other Obstructions

This work shall include, but not be limited to, the removal of existing structures and other obstructions interfering with the works. The salvaging of any of these materials for the use of the Employer shall be as directed by the Engineer and unwanted materials shall be disposed off the Site in a satisfactory manner at the Contractor's expense.

1.4.3 Cleaning and Grubbing

The Contractor shall perform the clearing and grubbing (if any) of top soil consisting mainly of loose soil, vegetable and organic matters, drift sand, unsuitable soil and rubbish by scarifying the areas to be excavated to a minimum depth of 300mm from the natural ground level. All materials resulting from the above operations shall be removed from the Site, loaded and transported and off loaded spread and leveled to approved dumps as directed by the Engineer.

1.5 SETTING-OUT

The Contractor shall stakeout the work as shown on the Drawings and secures the Engineer's approval of his stakeout before proceeding with construction. If, in the opinion of the Engineer, modification of the line or grade is advisable before or after stake-out the Engineer will issue detailed instructions in writing to the Contractor for such modification and the Contractor shall revise the stake-up for further approval in accordance with the relevant Clause of the Conditions of Contract.

1.6 EXCAVATION

1.6.1 General

Excavation in any material whatsoever found including rock to reduce levels and to form foundations, bases, trenches, septic tanks, pools, pits and the like to depths shown on the drawings or as directed by the Engineer.

Completely remove all existing obstructions in the line of excavations such as wall, slabs, curbs, steps and the like.

When removing any trees and roots with diameter more than 80 mm, should be rooted out to a depth of up to 500 mm then re-filled with approved material in layers. Also when mass rocks and other obstacles are found, the same mechanism of rooting and backfilling should be carried out at the expense of the contractor.

Trimming the sides of excavations to the required profiles and levels as well removing all loose material should be executed prior to consecutive process.

Level and well ram and consolidate surface of ground and bottom of all excavations to receive concrete foundations, beds, etc.

Bottoms of excavations shall be approved by the Engineer's Representative before any concrete is laid.

Should the Contractor excavate deeper than is shown on the drawings or required by the Engineer's Representative, to obtain a solid bottom, he must fill up excavation to the proper level with concrete Class B at his own expense.

1.6.2 Excavation in Rocks

Rock shall be defined as boulders, exceeding 0.25m3 in volume or any kind of stone or rock formation which in the opinion of the Engineer's Representative requires for its removal drilling and blasting wedging, sledging or barring or breaking up with power-operated hard tool..

The definition shall exclude any soft or disintegrated rock which can be removed with a hard pick or mechanical excavator or shovel or loose, shaken or previously blasted rock or broken stone in rock fillings or elsewhere.

Blasting by explosives shall not be permitted without obtaining the written approval of the Engineer. If such approval is given the Contractor shall be solely responsible for:-

1. Obtaining permits, keeping record.
2. Storing permits, keeping record.
3. Taking all necessary precautions in compliance with the regulations pertinent to the use of Explosives.
4. Any damage that may occur due to the blasting operations where rock is encountered it shall be carefully excavated and the Contractor shall not be entitled to additional compensation unless otherwise specified in the Bills of Quantities.

1.7 PLANKING AND STRUTTING

The terms "planking and strutting" will be deemed to cover whatever methods the Contractor elects to adopt for shoring the sides of excavation and also for planking and strutting the excavations against the sides of adjoining buildings, public roadways, etc… The Contractor will be held responsible for shoring the sides of all excavations, adjoining building and the like and no claim for additional excavation, concrete or other material or workmanship will be considered in this respect.

In the event of any collapse of the excavations, the Contractor shall re-excavate and re-instate such excavations at his own expense. No additional excavations will be paid or should the Contractor batter the sides of the excavations.

1.8 KEEPING EXCAVATIONS FREE FROM WATER

All excavations shall be kept clear of water by pumping or bailing or by well-point dewatering, but the latter system shall not be employed if any danger exists of withdrawing water from the foundations of the adjoining buildings and such water shall be discharged clear of the works and the method adopted shall in no way contravene the regulations of the Local Authorities.

The system or systems to be employed shall be approved by the Engineer. Such approval if given shall not waive the Contractor's responsibilities and liabilities under the Contract.

Particular attention shall be paid to the installation of sheeting and shoring as may be necessary for the protection of the work and for the safety of personnel and public.

1.9 STORING OF SUITABLE EXCAVATED MATERIAL

During excavation, materials suitable for backfill and fill shall be stockpiled on the Site at sufficient distance from the sides of the excavation to avoid overloading and prevent caverns or mixing with the concrete during the construction of foundations.

1.10 DISPOSAL OF UNSUITABLE AND SURPLUS EXCAVATED MATERIAL

Upon the order of the Engineer, all unsuitable and surplus excavated materials shall be immediately removed.

Loaded and transported off the site area by the Contractor to approved dumps and he shall abide by the relevant local regulations.

1.11 EXCAVATION FOR FOUNDATIONS AND SUB-STRUCTURE

The Contractor shall excavate to reach a suitable strata accepted by the Engineer or as shown by the Drawings during excavation for foundations, the bottom layer of excavation of minimum 200mm in thickness, shall be left undisturbed and subsequently removed manually only when the concrete in blinding is about to be placed in order to avoid softening or deterioration of the surfaces of the excavation.

Bottom of all excavations shall be formed to correct levels as shown on the Drawings or as directed in writing

1.12 EXCAVATION FOR TRENCHES

1.12.1 General

The Contractor shall provide all forms and bracings, and excavate trenches necessary to install all drainage, sewer water supply, electrical and telephone cables to the lines and grades complete in strict conformity with these specifications, applicable drawings and/or as directed by the Engineer.

1.12.2 Grading

The bottom of the trenches shall be accurately graded to provide uniform bearing and support for each section of the pipe on undisturbed soil at every point along its length, except for the portions of the pipe where it is necessary to excavate for bell-holes and for proper sealing of joints. Bell-holes and depressions for joints shall be dug after the trench has been graded.

Care shall be taken not to excavate below the depths indicated. Where rock shall be excavated to the required depth, uneven surface of the bottom trench shall be excavated 15mm deeper. Such depth, if in rock, shall be back-filled with concrete Class "B" as specified under "Concrete Work" and when in earth, shall be back-filled with approved sand at the Contractor's own expense.

Whenever unstable soil, which in the opinion of the Engineer, is incapable of properly supporting the pipe or duct is encountered in the bottom of the trench, such soil shall be removed to the depth required and the trench back-filled to the proper grade with sand, fine gravel or other suitable material approved by the Engineer.

The width of the trench for Drainage at and below the top of the pipe shall be such that the clear space between the barrel of the pipe and the trench wall shall be 20mm on each side of the pipe. The width of the trench above that level may be as wide as necessary for sheeting and bracing and the proper performance of the work.

Trench for Water Supply System shall be of a depth to provide minimum cover over the top of 300mm and avoid interference of water lines with other utilities. Width of trench shall be a maximum of 200mm on each side of the pipe.

The width of trenches for electrical and telephone cables shall be as specified in their relative section. Banks may be sloped or widened to facilitate placement of cables, but not to an extend that will cause interference with other utilities.

Excavation for appurtenant structures for manholes, septic tank, percolating pit and similar structures shall be sufficient to allow a minimum of 300mm of clear space between their outer surfaces shoring timbers which may be used to protect the banks.

1.13 BACKFILL AND FILL

Approved suitable excavated material as specified under "MATERIALS" shall be used in the backfilling and filling next to footings, foundations underground structures, under sub-floors, etc... and shall be laid in layers not exceeding 250mm and compacted with compaction equipment, as approved by the Engineer. Moisture content shall be adjusted as directed by the Engineer and 97% of dry weight compaction accordance to ASTM: D1557-70 shall be achieved.

At least one sample of core pit must be taken from each 100 m2 in buildings for each layer of backfill.
Heavy equipments should not work or pass through within the structural boundary of the building during the backfilling process.

Should the quantity of the excavated material be not sufficient for the process of backfill and fill, the Contractor shall obtain the quantity required of such backfill and fill from approved borrow pits and transport same to the Site of work at his own expense if not itemized in the

bills of quantities.

No backfill shall be executed until the footings, foundations, etc., have been inspected, measured and approved by the Engineer.

Trenches should be backfilled until all required tests are performed and until the Engineer has verified that the Utility systems have been installed in accordance with the Specifications and the Drawings. The backfill in the pipe zone must be placed and completed so as to provide and maintain adequate and even support around the pipe wall. If mechanical compaction equipment is need, care must be taken to prevent direct contact with the pipe.

1.14 BED OF HARDCORE

The bed of hardcore where shown on the Drawings or as directed by the Engineer shall be of an approved rubble stone as specified under "MATERIALS" and shall be laid under floor paving. The rubble stone for hardcore shall be hand-packed with sharp edge upward and wider (natural face) laid on the ground. The interstices of hardcore bed shall be filled with approved fines, wetted sufficiently and well consolidated. The thickness of the hardcore bed shall be as shown on the Drawings.

1.15 PLACING OF AGRICULTURAL SOIL, GRAVEL AND SAND

The agricultural sifted soil as specified under "MATERIALS" shall be spread in the flower boxes and beds to the thickness shown on the Drawings after thorough watering and on a bed of 100mm thick graded gravel blinded with clean coarse sand to the satisfaction of the Engineer.

1.16 EXCAVATIONS OF CUTTINGS IN CARRIAGE WAYS

1. Hauling of material from cuttings or borrow pits to the embankments or other areas of fill shall proceed only when sufficient compaction plant is operating at the place of disposition to ensure compliance with the requirements of specifications.

2. Any excess depth excavated below formation level tolerance shall be made good by back filling with suitable material of similar characteristics to that removed, compacted in accordance with specification.

3. The slopes of cuttings shall be cleared of rock fragments which move when prized by a crow bar.

4. Construction traffic shall not use the surface of the bottom of a cutting unless the cutting is in rock or the Contractor maintains the level of the bottom surface at least 30cm above formation level. Any damage to the sub-grade arising from such use of the surface shall be made of good by the Contractor at his own expense, with material having the same characteristics as the material which has been damaged.

1.17 FILLING AND FORMING OF EMBANKMENTS AND OTHER AREAS OF FILL

1. Embankments and other areas of fill shall be formed of material defined as "suitable material"

2. All earthworks material placed in or below embankments, below formation level in cuttings or else wherein the works shall be deposited and compacted as soon as practicable after excavation in layers of thickness appropriate to the compaction plant used or as a permitted departure therefore. Embankments shall be built up evenly over the full width and shall be maintained at all times with a sufficient camber and a surface sufficiently even to enable surface water to drain readily from them. During the construction of embankments, the Contractor shall control and direct constructional traffic uniformly over their full width. Damage to compacted layers by constructional traffic shall be made good by the Contractor.

3. In areas of shallow filling where after removal of topsoil the ground level is within 30cm of formation level constructional traffic shall not use the surface unless the Contractor brings up and maintains the surface level at least 30cm above formation level. Any damage to the sub-grade arising from such use shall be made good by the Contractor at his own expense with material having the same characteristics as the damaged materials.

1.18 COMPACTION OF EMBANKMENTS AND OTHER AREAS OF FILL

1 All materials used in embankments and as filling elsewhere shall be compacted as soon as practicable after deposition.

2 Variation from the method of compaction stated below or the use of plant not included therein will be permitted only if the Contractor demonstrates at site trials that a state of compaction is achieved by the alternative method equivalent to that obtained using the approved methods. This procedure shall be agreed and approved by the Engineer.

3 The Engineer may at any time carry out comparative field density tests determined in accordance with B. S. 1377 test No. 14 on material, which he considers has been, inadequately compacted. If the test results when compared with the results of similar tests made on adjacent approved work in similar materials carried out in accordance with specification, show the state of compaction to be inadequate and this held to be due to failure of the Contractor to comply with the requirements of the Contract, the Contractor shall carry out such further work as the Engineer may decide is required to comply with the terms of the Contract.

4 The Contractor shall not less than 24 hours before he proposes to carry out compaction processes during periods of overtime, apply in writing to the Engineer for permission to do so.

1.19 MEASUREMENTS

All measurement of cut, backfill and fill of different materials should be using the engineering calculations or otherwise mentioned in the other contract documents or as directed by the Engineer.

2 -CONCRETE WORKS

2.1 SCOPE

This section describes and specifies work required for plain and reinforced concrete, including formwork intended to be used for the Project under the Contract in accordance with the Drawings, Bills of Quantities and as directed by the Engineer.

At the beginning of each month, the Contractor shall submit to the Engineer his concreting programme for that month, stating the pouring dates, so that adequate checking and supervision can be provided before and during the pouring operation. No pouring shall be allowed unless the Engineer has been given a week-advanced notice of the intention to pour.

2.2 APPLICABLE TESTS AND CODES

Prior to commencement of concrete work, the Contractor shall submit samples to the Engineer before sending them to the laboratories for testing, to establish the probability of the materials passing tests for specified requirements.

After the Engineer is convinced that the samples with their sources are truly representative samples and sufficient materials are available on the Site for the completion of all concrete works under the Contract, the samples shall be approved and sent to the laboratories for testing. Upon the Engineer's request, the Contractor shall have the tests made, at his own expense in the laboratories approved by the Engineer.

All concrete aggregates, cement and water shall be sampled and tested as frequently as deemed necessary by the Engineer. All tests samples shall be obtained in accordance with the latest editions of the American Society for Testing and Material (ACI) Code or any equally approved standard.

2.3 MATERIALS

2.3.1 Cement

2.3.1.1 General

Cement shall be Portland Type originating from approved manufacturers in sealed and labeled bags, each 50 kgs. Not capacity, name and brand of the manufacturer shall plainly be identified thereon and delivered to the site in good condition. Cement delivered in bulk shall be accepted only if a central mixing plant is used. The Quality of cement shall conform to the Standard Specification for PORTLAND CEMENT of ASIM Designation: C150-74 Type I- for use in general concrete construction and Type V- for use when high sulphate resistance is desired.

2.3.1.2 Storage of Cement

All cement shall be stored in suitable weatherproof and approved storage sheds which will protect the
cement from dampness. Storage sheds shall be erected in locations approved by the Engineer.
Provision for storage shall be ample, and the consignment of cement as received shall be separately stored in such a manner as to provide easy access for the identification and

inspection of each consignment. Cement shall be used in the order of its delivery to site, new deliveries shall not be used unless the cement from earlier deliveries has be completely used. Stored cement shall meet the test requirements at any time after storage when a re-test is ordered by the Engineer all the expense of the Contractor.

The Contractor shall keep accurate records of the deliveries of cement and of its use in the work.
Copies of these records shall be supplied to the Engineer in such form as may be required.

2.3.1.3 Rejection

The Contractor shall notify the Engineer of dates of delivery so that there will be sufficient time for sampling the cement either at the mill or upon delivery.

The provisional acceptance of the cement at the mill shall not deprive the Engineer of the right to reject on a reset of soundness at the time of delivery of the cement to the site.

Package of cement varying by 5 percent or more from the specified weight shall be rejected and if the average weight of packages in any consignment, as shown by weighing 50 packages taken at random, is less than that specified, the entire consignment shall be rejected and the Contractor shall remove it forthwith from the Site at his own expense and replace it with cement of satisfactory quality.
Stale cement or cement reclaimed from cleaning bags shall not be used and cement which for any reason has become partially set, or contains lump or caked cement, shall be rejected.

2.3.2 Aggregates

2.3.2.1 General Requirements

All aggregates shall consist of tough, hard, durable uncoated particles. The Contractor shall be responsible for the processing of this material to meet the requirements of the Specifications. Approval of aggregate quality and/or gradation shall not waive the responsibility of the Contractor to provide concrete of having the minimum strength specified.

2.3.2.2 Storage

Coarse and fine aggregates shall be delivered and stored separately on site in such a manner as to prevent segregation and contamination or the admixture of foreign materials. Aggregate which has become segregated or contaminated with foreign matter during storage or handling will be rejected and shall be removed and replaced with material of acceptable quality at the Contractor's expense.
Aggregates of the quality and colour selected shall be stored in sufficient quantity to avoid interruption of concreting work at any time.

2.3.3 Fine Aggregate

2.3.3.1 General Requirements

All fine aggregate shall conform to Standard Specification for Concrete Aggregates of ASIM Designation: C-33 and also to the detailed requirements give in Table 2-1 (appended here below). It shall not contain harmful materials such as iron pyrites, coal, mica, and shale.

Alkali, coated grains, or similar laminated materials such as soft and flaky particles, or any material which may attack the reinforcement, in such a form and in sufficient quantity to affect adversely the strength and durability of the concrete. Fine Aggregate passing sieve No. 4 shall not contain any voided shells.
Fine aggregates shall be washed thoroughly with de-mineralized water to ensure compliance with the appropriate requirements and limitations of the specifications.

The Contractor shall provide and maintain for this proposes sand-washing plant and equipment.

Fine Aggregate from different sources of supply shall not be mixed or stored in one pile nor used alternately in the same class of construction or mix.

Table 2-1: Detailed requirements for Fine Aggregate

Sieve Analysis	
Grading Sieve	**Percent of Passing**
3/8	100
No. 4	95- 100
No. 8	80- 100
No. 16	50- 85
No. 30	25- 60
No. 50	10- 30
No. 100	2- 10
No. 200	0- 3
Fineness modulus	2.50- 2.15
Organic Impurities	The color shall have an intensity not darker than two-thirds the intensity of the standard color solution. (Not darker than Plate 2 as determined by the Standard Method of Test for Organic Impurities in Sands for Concrete of ASTM Designation C - 40
Chlorides soluble in dilute Nitric Acid	Not more than 0.10 percent by weight when expressed as sodium chloride (NACL).
Total Acid soluble sulphates	Not more than 0.50 percent by weight when expressed as sulpher trioxide(S03)
Silt	Not more than 2 percent
Mortar strength	Compression ration less than 95 percent
Soundless	Weighted average loss when subjected to 5 cycles of the soundless test using magnesium sulfate, not more than 10 percent

2.3.4 Coarse Aggregate

2.3.4.1 General Requirements

All coarse aggregate for concrete shall conform to Standard Specifications for Concrete Aggregates of ASTM Destination: C-33 Coarse aggregate shall consist of gravel, crushes gravel, or crushed stone, having hard, strong durable pieces, free from adherents. It shall not contain harmful materials such as iron pyrites, coal, mica, alkali, laminated materials, or any material which may attack the reinforcement, in such a for or in sufficient quantity to affect adversely the strength and durability of the Concrete. Coarse aggregates shall be washed thoroughly with de-mineralized water to ensure compliance with the appropriate requirements

and limitations of the specifications. The Contractor shall provide and maintain for this purpose approved washing plant and equipment.

2.3.4.2 Deleterious Substances

The amount of deleterious substances shall not exceed the following limits:

Max. Permissible Limit Percent by Wt.:	
Soft fragments	2.00
Coal and lignite	0.50
Clay lumps	0.25
Materials passing the No.200 sieve	1.00
Thin or clognated pieces (length greater than 5 times average thickness)	4.00
Other local deleterious substances	0.00
Chlorides soluble in dilute Nitric acid when expressed as Sodium Chloride (NaCL)	0.05
Total acid soluble sulphates when expressed as sulpher trioxide (S03)	0.50

2.3.4.3 Percentage of Wear

Coarse aggregate shall conform to the following requirements:
Percentage of wear, Los Angeles test, not more than (30)

2.3.4.4 Grading

Coarse aggregate, when tested according to the requirements of ASTM, shall meet the following gradation and shall be uniformly graded within the limits stated in Table 2-2 here below:

Table 2-2: Grading Analysis for Coarse Aggregate

ASTM	Percentage by Weight Passing		
	Grading (3/4" to No.4)	Grading (1" to No.4)	Grading (2" to No.4)
2 ½ inch	--	--	100
2 inch	--	--	95- 100
1 ½ inch	--	100	--
1 inch	100	95- 100	35- 70
¾ inch	95- 100	--	--
½ inch	--	25- 60	10- 30
3/8 inch	20- 55	--	--
No. 4	0- 10	0- 10	0- 5
No. 8	0- 5	0- 5	--
No. 200	0- 1	0- 1	0- 1

2.3.5 Combined Aggregate

Approved fine and coarse aggregate on each batch of concrete shall be combined in proportions as approved by the Engineer, according to test results giving the required compressive concrete stress as specified per type of Concrete.
The combined aggregate gradation using the ¾ in. to No. 4 gradation shall be used for concrete members with reinforcement to close or permit proper placement and consolidation

of the concrete. Change from one gradation to another shall not be made during the progress of the work unless approved by the Engineer. Such changes are admitted only after being proved by test results.

2.3.6 Aggregate for Mortar

2.3.6.1 General Requirements

Aggregate for motor shall conform to the Standard Specification for Aggregate for Masonry Mortar of ASTM Designation: C-144 and shall consist of hard, strong, durable uncoated mineral or rock particles, free from injurious amounts of organic or other deleterious substances.

2.3.6.2 Organic Impurities

Fine aggregate for mortar when subjected to the Calorimetric test for organic impurities and producing a color darker than the standard color shall be rejected.

2.3.7 Water

2.3.7.1 Quality of Water

Water for mixing of concrete shall be fresh, clean and free from injurious amounts of oil, acid, or any other deleterious mineral and/or organic matter. It shall not contain chlorides such as sodium chloride in excess of 700 ppm. It shall not contain any impurities in amount sufficient to cause a change in the time of setting of Portland cement of more than 10 percent, nor a reduction in compressive strength of mortar of more than 5 percent compared to results obtained with distilled water.

The PH of the water for mixing and curing of concrete shall not be less than PH 4.5 or more than PH 8.5.

2.3.7.2 Tests for Water

When required by the Engineer the quality of the mixing water shall be determined by the Standard Method of Test for quality of water to be used in concrete, as specified in B.S. 3148: 1959 Tests for Water for Making Concrete.
In sampling water for testing, care shall be taken to ensure the containers are clean and that samples are representative.

2.3.7.3 Admixtures

Admixtures in concrete shall be used only when approved by the Engineer and shall conform to the requirements of the ASTM Standard Specifications Designation c-494-68 for Water Reducing and Retarding Admixtures, and C-260-69 for Air entraining Admixtures for Concrete, and waterproofing and watertight.

The Contractor shall ensure that the admixture supplied for use in the work is equivalent in composition to the admixture subjected to test under this Specification. Tests shall be made whenever practicable using the cement, aggregates, admixtures proposed for specific work, because the specific effects produced by chemical admixtures may vary with the properties of

the other ingredients of the concrete.

The specific effects produced by chemical admixtures may vary with the properties of the other ingredients of the concrete.

Admixture that contains relatively large amounts of chloride shall accelerate corrosion of reinforcing steel and shall be the cause of rejection.

Water reducing and retarding admixtures shall comply with the physical requirements of ASTM tests and shall be approved in writing by the Engineer.

When the admixture is delivered in packages or containers, the proprietary name of the admixture, the type and the weight or volume shall be plainly marked thereon. Similar information shall be provided in the shipping advises accompanying packaged or bulk shipments of admixtures.

The admixture shall be stored in such a manner as to permit easy access for proper inspection and identification of each shipment, and in a suitable weather-tight store that will protect the admixture from dampness.

Costs of such admixtures, sampling and testing shall be at the Contractor's expense.

2.4 COMPOSITION OF CONCRETE

The cement content, coarse aggregate size, water content, consistency and the approximate weights of fine and coarse aggregate (saturated surface-dry basis) for the class of concrete shall be within the requirements of Table 2-3 (I) and Table 2-3 (II) Below.
The weight of fine and coarse aggregate given in Table 2-3 (II) below is based on the use of aggregates having bulk specific gravities, in a saturated surface-dry condition, 2.65-5%. For reasonably well graded materials of normal physical characteristics, the use of the below indicated proportions, together with specified water content to obtain the required consistency, will result in concrete of the specified cement content, plus or minus two (2) percent.

For aggregate having specified gravities outside the ranges indicated in the Table 2-3 (II) below, the weights shall be corrected by multiplying the weights shown in Table 2-3 (II)below by the ration of the specific gravity of the aggregate and 2.65.

The relative weights of fine and coarse aggregate per sack of cement given in Table 2-3 (II) below are based on the use of natural sand having a fineness modulus within the range of 2.70 and 2.90 and methods of placing which do not involve high frequency vibration. When sharp, angular manufactured sands, or extremely coarsely graded sands are used, the relative amount of fine aggregate should be increased. For finer sands the relative amount of fine aggregate should be decreased. In general, the least amount of sand which will insure concrete of the required workability for the placing conditions involved should always be compensated for by changing the weight of coarse aggregate in the opposite direction by a corresponding amount.

Table 2-3 (I): Requirements of concrete composition

Class of concrete	Compressive strength at 28 days (in Kg/cm^2) Cube	Minimum cement content (Kg)	Coarse aggregate size	Max. water content (Liter per Bag)	Consistency range in slump (mm)	
					vibrated	non vibrated
A	250	375	¾ inch or 1 inch- No. 4 as required by the Engineer	27	50- 100	75- 125
B	200	350	Ditto	27	50- 100	33- 125
C	150	250	2 inch- No. 4	30	25- 50	50- 75

Table 2-3 (II): Requirements of concrete composition- Continue

Class of concrete	Cylinder compressive strength at 28 days (kg/ cm^2)	Approximate Weight (Saturated Surface-Dry) of Fine and Coarse Aggregate per Sack (50Kgs) of Cement			
		Rounded coarse aggregate		Angular coarse aggregate	
		Fine (Kg)	Coarse (Kg)	Fine (Kg)	Coarse (Kg)
A	250	40	170	95	150
B	210	95	180	100	160
C	140	140	370	160	340

Table 2-3 (II) is given for indicative purposes and is not binding.

The total sodium chloride content of any materials used for making concrete shall be less than:

- For mass concrete..... 1.5 percent
- For reinforced concrete..... 0.7 percent

Expressed as a percentage, by weight of the cement.

In calculations made under the provisions of this clause, any chloride, other than sodium chloride in the materials shall be converted to the equivalent of sodium chloride and be added to the amount of sodium chloride. The sulphate content shall not exceed 0.03 percent by weight of the cement.

2.5 PROPORTIONS

2.5.1 General

After the materials provided by the Contractor have been accepted for the works, the proportions and equivalent batch weights shall be determined which will produce concrete having not less than the strength required.

2.5.2 Trial Mixes

The actual proportions shall be determined on the basis trial mixes made by the Contractor and conducted with the content being determined by means of yield test in accordance with American Society for Testing Material (ASTM) Designation (C-138). The proportions will be

such as to required (within a tolerance of plus or minus one (1) percent, the cement content shown in Table I as the minimum cement content, provided, however, that if the materials supplied by the Contractor are of such a nature or are so graded that proportions based on the minimum cement content cannot be used without exceeding the maximum allowable water content specified in Table I, the proportions will be adjusted so as to require the least amount of cement which will produce concrete of the required plasticity and workability without exceeding such maximum allowable water content. No additional compensation will be made for the increase in quantity of cement required.

2.5.3 Contents

The mixes required will be designated in kilograms of fine and coarse aggregate exclusive of free water, per sack (50 Kilograms) of cement and in liters of total mixing water per sack of cement on the basis of the required amount of cement per cubic meter of concrete.

2.5.4 Batch Weights

Since the proportions are designated in terms of aggregate in surface-dry condition, the equivalent batch weights to be used in the work shall be corrected periodically to take into account the actual moisture content of the aggregates at the time of use.

2.6 CONCRETE COMPRESSION AND SLUMP TESTS

2.6.1 Cubical Test

The Compression Strength of Concrete shall be obtained according to cubical tests locally done. Test cubes made in the field shall have a dimension of 15cm, At least 3 separate batches of concrete shall be made for trial and these shall be tested for compliance with the requirements of the table below, at least 3 test cubes being made from each batch of concrete. Once a mix is approved no substantial change in the materials or proportions of materials being used shall be made without the approval of the director of works who may then require further trial mixes to be produced. The compressive strength of the concrete will be taken as the arithmetic mean of the strength of all the cubes tested.
The following table 2-4 will be used to compare test results:

Table 2-4: Compressive Strength results of samples of concrete at 28 days. (Mixed by Weight)

Kind of Concrete	Mean value At 28 days Kg / cm^2	Minimum Individual Value at 28 days Kg / cm^2	Mean value At 28 days Kg / cm^2	Minimum Individual Value at 28 days Kg / cm^2
	In case of 3-4 samples taken		In case of 5 samples or more	
B - 150	185	130	175	130
B - 200	240	170	230	170
B - 250	300	215	290	215
B - 300	360	255	345	255
B - 350	420	300	405	300

Test at 7 days must not be less than 75% of the required strength at 28 days

2.6.2 Slump Tests

Slump tests shall be carried out periodically to ensure the appropriate water cement ratio in accordance with the Standard Method of Test of Slump of Portland Cement Concrete of the ASTM Designation: C-143.

2.6.3 Test of Hardened Concrete in the Structure

Where the results of specimens indicate that the concrete does not meet specification requirements, core boring tests conforming to the current issue of ASTM Designation: C-42 shall be performed, as directed by the Engineer, all at the Contractor's expense.

1. Hardened concrete is identical to specifications if the results of specimens test follow the conditions:
   - At least the average compressive strength of samples testing coincides the required design strength for the concrete.
   - No compressive strength of any of the sample specimens deviates from the required design strength for the concrete by (85%).
   - Cubes are standard size (150 × 150 × 150) mm and age (28) days mainly to the requirements of comparing strength. The nominal compressive strength is the minimum value of all the values of the testing samples, which does not allow the existence of values lower than more than (5) percent of the number of sample tests.
   - The contractor to submit to the supervisor written reports from an authorized laboratory for all of the tests carried out according to specifications and within period of not more than (24) hours of the implementation of the testing.

2. If the cube tests fail to pass the above; Core Specimens must be carried out at (3) specimens for each sample of hardened concrete which had not achieved the conditions of the sub-item mentioned above. Note that taking the specimens, water treatment and testing are in accordance with the requirements of American Standard (ASTM -C 42), this is coincided to the concrete specifications if the test results match following conditions:
   - At least the average compressive strength of the specimens of a sample is (85%) of the strength provided by the design.
   - At least the compressive strength of an individual specimen from a sample is (75%) of the strength provided by the design.

3. If test results fail to pass the condition stated in item (B) of this section, found not conform to these specifications, and must then be completely removed from the site at the expense of the contractor, as the same contractor bears full responsibility for any damage that might be caused to the sound elements as a result of the demolition and removal.

4. As exception to what is stated in paragraph (C) of this section, for the slabs and beams only, if the average value of compressive strength of the samples equivalent to the standard cubes (150 * 150 * 150) mm is not less than (150Kg/cm2); loading test might be carried out only upon the client request and at the contractor's expense to ensure the ability of the concrete elements to bear loads according to engineer and the designer. If the elements pass the load test, then the slabs and beams are considered structurally accepted.

5. Loading Test
   - Load test must be carried out at the site for the slabs and beams of reinforced concrete that are under the age of (56) days by authorized and experienced laboratory in that field.
     The loads must be equivalent to that part of the actual dead loads and shall be placed on the slabs and beams prior to loading the total loads by (48) hours and remain until the end of the test.
   - The slabs and beams must be loaded by a total of (0.85) multiplied by (1.4 Dead Load + 1.7 Live Load) Less Dead Load actually performing (48) hours before. Special devices should be placed at the bottom of slabs and beams to measure deflection. These devices should be installed on fixed frames to ensure the stability of these devices, and the preliminary readings to be taken prior to process of loading. The loads must be placed gradually and systematically for (24) hours, without causing any vibrations or shocks and batches of not less than (4) equal installments, and then taking the readings , which identifies the maximum deflection; that is the difference between this reading and reading pre-loading. Then the loads are lifted and left unloaded for two (24) hours, the readings are taken for the final deflection which determines the value of self-retrieval as the difference between this reading, and reading pre-lift.

6. Passing the test
   - The structural elements could succeed in passing the test, if not exceed the maximum deflection (D) in mm as per the formula:

     D = (50 L2) / h

     Where:
     L = Span loaded in meters of the following values: the distance between the centers of supports or clear span loaded plus the height of the structural element which is smaller.
     h = height of the structural element (mm)
   - The slabs and beams fail to pass the test if wide cracks appear or signs of failure during the test, or if they do not achieve the value of deflection (D).

2.7 MEASUREMENT OF MATERIALS

Materials shall be measured by weight, except as otherwise specified or where other methods are specifically authorized by the Engineer. The apparatus provided for weighing the aggregates and cement shall be suitably designed and constructed for this purpose. Each size of an aggregate and the cement shall be weighed separately. The accuracy of all weighing devices shall be such that successive quantities can be measured to within 1% of the desired amount. Cement in standard packages (sack) need not be weighed. The mixing water shall be measured by a measuring device susceptible of control accurate to plus or minus half percent of the capacity of the tank but not exceeding 2 liters. All measuring devices shall be subject to the Engineer's approval.

Where volumetric measurements are exceptionally authorized by the Engineer for projects where the amount of concrete is small, the weight proportions shall be converted to equivalent volumetric proportions. In such cases, suitable allowance shall be made for variations in the moisture condition of the aggregates, including the bulking effect in the fine aggregate.

2.8 MIXING OF CONCRETE

2.8.1 General

Unless otherwise authorized by the Engineer, concrete shall be machine mixed.

The mixing of concrete or mortar shall not be permitted when the temperature is above 40 C or when the temperature is below 5 C.

2.8.2 Mixing on Site

Concrete shall be thoroughly mixed in a batch mixer conforming to the requirements of B.S. 1305 Batch type concrete mixers which will ensure a uniform distribution of the materials throughout the mass.

The mixer shall be equipped with adequate storage and a device for accurately measuring and automatically controlling the amount of water used on each batch. Preferably mechanical means shall be provided for recording the number of revolutions for each batch and automatically preventing the discharge of the mixer until the materials have been mixed within the specified minimum time.
The entire contents of the mixer shall be removed from the drum before materials for a succeeding batch are placed therein.

All concrete shall be mixed for a period of not less than 1 ½ minutes after all materials, including water, are in the mixer. During the period of the mixing the mixer shall operate at the speed for which it has been designed, but this speed shall be not less than 14 nor more than 20 revolutions per minute.

The first batch of concrete material placed in the mixer shall contain sufficient excess of cement, sand and water to coat the inside of the drum without reducing the required mortar content of the mix. Upon the cessation of mixing for a considerable period, the mixer shall be thoroughly cleaned.

2.8.3 Truck Mixing

Truck mixers, unless otherwise authorized by the Engineer, shall be of the revolving drum type, watertight, and so constructed that the concrete can be mixed to ensure a uniform distribution of materials throughout the mass. All solid materials for the concrete shall be accurately measured in accordance with Section C.7 and charged into the drum at the proportioning plant.
Except as subsequently provided, the truck mixer shall be equipped with a tank for carrying mixing water. Only the prescribed amount of water shall be placed in the tank unless the tank id equipped with a device by which the quantity of water added can be readily verified. Truck mixers may be required to be provided with means by which the mixing time can be readily verified by the Engineer.

The maximum size of batch in truck mixers shall not exceed the maximum rated capacity of the mixer as stated by the manufacturer and stamped in metal on the mixer. Truck mixing shall be continued for not less than 50 revolutions after all ingredients including the water, are in the drum. The speed shall not be less than 4 r.p.m., nor more than a speed resulting in a

peripheral velocity of the drum of 70 meters per minute.
Nor more than 100 revolutions of mixing shall be at speed in excess of 6 r.p.m. Mixing shall begin within 30 minutes after the cement has been added either to the water or aggregate. When cement is charged into a mixer drum containing water or surface-wet aggregate and when the temperature is above (33 C) is used this limit shall be reduced to 1245 minutes; the limitation on time between the introduction of the cement to the aggregates and the beginning of the mixing may be waived when, in the judgment of the Engineer, the aggregates are sufficiently free from moisture, so that there will be no
harmful effects on the cement.

2.8.4 Partial mixing at the Central Plant

When a truck mixer provided with adequate mixing blades is used for transpiration, the mixing time at the mixing plant may be reduced to 30 seconds and the mixing completed in the truck mixer. The mixing time in the truck mixer shall be as specified under the Section C.8.3 for truck mixing.

2.8.5 Plant Mix

Mixing at a central plant shall conform to the requirements for mixing at the Site and shall conform to
the applicable requirements of the Standard Specification for Ready-Mixed Concrete of ASTM Designation: C-94.

2.8.6 Time of Hauling and Placing Concrete

If the distance from the mixing plant to the construction Site is so great that between the time of mixing and pouring the concrete, the temperature is below 40 C and the traveling time is more than 30 minutes, truck mixers must be employed.

When truck mixers are used, concrete shall be discharged and placed in its final position in the forms within thirty (30) minutes after water is first added to the mix.

2.8.7 Delivery

The rate of delivery of concrete during concreting operations shall be such as to provide for the proper handling, placing and finishing of the concrete. The rate shall be such that the interval between batches shall not exceed 20 minutes. The methods of delivering and handling the concrete shall be such as will facilitate placing with the minimum of re-handling and without damage to the structure of the concrete.

2.8.8 Re-tempering

The concrete shall be mixed only in such quantities as are required for immediate use and any concrete which has developed initial setting shall not be used. Concrete which has partially hardened shall not be re-tempered or remixed.

2.9 HANDLING AND PLACING CONCRETE

2.9.1 General

Prior to pouring concrete in any structure, the Contractor shall secure a written order to commence from the Engineer. In preparation for the placing of concrete all sawdust, chips, and other construction debris and extraneous matters shall be removed from the interior of forms, struts, stays and braces, serving temporarily to hold the forms in correct shape and alignment, pending the placing of concrete placing has reached an elevation rendering their service unnecessary. These temporary members shall be entirely removed from the firms and not buried in the concrete. Concrete shall be placed so as to avoid segregation of the materials and the displacement of the reinforcement. The use of long troughs, chutes and pipes for conveying concrete from the mixer to the forms shall not be permitted unless the authorization in writing of the Engineer is obtained. In case an interior quality of concrete is produced by the use of such conveyers, the Engineer may order discontinuance of their use and the substitution of a satisfactory method of placing. Open troughs and chutes shall be of metal lined and shall be of rounded cross section to avoid the accumulation of concrete in corners. The chutes shall be equipped with baffles or be in short lengths that reverse the direction of movement. The slope shall be steep enough (1 vertical to 2 or 2 ½ horizontal) to permit flow requiring a slump greater than specified or required for placement.
All chutes, troughs and pipes shall be kept clean and free from coating of hardened concrete by thoroughly flushing with water after each run. Water used for flushing shall be discharged clear of the structure. When placing operations would involve dropping the concrete more than 1.50 meter, it shall be deposited through sheet metal or other approved pipes. As far as practicable, the pipes shall be kept full of concrete during placing and their lower ends shall be kept buried in the newly placed concrete. After initial setting of concrete, the forms shall not be jarred and no strain shall be placed on the ends of reinforcement bars which project.

2.9.2 Hot Weather Concreting

The temperature of concrete when placed shall not exceed 27 °C when the relative humidity is 50 percent or less and shall not exceed 32 ° C for values of relative humidity between 50 percent and 70 percent, the max temperature of concrete shall be found by interpolation.
In lieu of above, the temperature of concrete when placed shall not exceed 32 ° C, regardless of the relative humidity.
The Contractor shall comply with the above requirements by the following procedures:-

- Cooling the mixing water and/or replacing 50% of the mixing water by crushed ice. When crushed ice is used it shall be stored at a temperature that will prevent formation of lumps. The ice shall be completely melted by the time mixing is completed.

- Shading aggregate stockpiles and/or keeping moist by sprinkling then with water.

- Cement shall not be used if its temperature exceeds 77 °C.

- Painting the mixer drum white and spraying it with cool water or shading the mixer from direct sunrays.

- Maintaining the mixing time and delivery time to the minimum acceptable.

- Sprinkling of forms sub-grade and reinforcement with cool water prior to placement of concrete.

Water reducing and retarding admixture shall be used in all concrete work when the temperature of concrete exceeds 27 ° C. The water cement ratio inclusive of free surface moisture on aggregates and any admixtures shall be kept to a minimum.

2.9.3 Vibrating Concrete

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

- Vibration shall be internal unless special authorization of other methods is given by the Engineer or as provided herein.

- Vibration shall be of a type and design approved by the Engineer. They shall be capable of transmitting vibration to the concrete at frequencies of not less than 4500 impulses per minute.

- The intensity of vibration shall be such as to visibly affect mass concrete of 25mm slump.

- Contractor shall provide a sufficient number of the vibrators to properly compact each batch immediately after it is placed in the forms.

- Vibration shall be manipulated so as to thoroughly work the concrete around the reinforcement and embedded fixtures, and into the corners and angles of the forms.

- Vibration shall be applied only by experienced operators under close supervision, at the point of deposit and in the area of freshly deposited concrete. The vibrators shall be inserted and withdrawn out of the concrete slowly. The vibration shall be of sufficient duration and intensity to thoroughly compact the concrete, but shall not be continued so as to cause segregation. Vibration shall not be continued at any point to the extent that localized areas of grout are formed.

- Application of vibration shall be at points uniformly spaced and not farther apart than twice the radius over which the vibration is visibly effective.

- Vibration shall not be applied directly or through the reinforcement to sections or layers of concrete which have hardened to the degree that the concrete ceases to be plastic under vibrations. It shall not be used to make concrete flow in the forms over distances so great as to cause segregation, and vibrators shall not be used to transport concrete in the forms.

- Vibrator shall be supplement by such spading as it necessary to ensure smooth surface and dense concrete along form surfaces and in corners and locations impossible to reach with the vibrators.

- The use of implements such as compressors which are likely to disturb or disarrange reinforcement or formwork shall not be permitted.

Concrete shall be placed in horizontal layers not more than 300mm thick as hereinafter provided. When less than a complete layer is placed in one operation, it shall be terminated in

a vertical bulkhead. Each layer shall be placed and compacted before the preceding batch has taken initial set to prevent injury to the green concrete and avoid surfaces of separation between the batches. Each layer shall be compacted so as to avoid the formation of a construction joint with preceding layer which has taken initial set.

When the placing of concrete is temporarily discontinued, the concrete after be coming firm enough to retain its form, shall be cleaned of laitance and other objectionable material to a sufficient depth to expose sound concrete. To avoid visible points as far as possible upon exposed faces, the top surface of the concrete adjacent to the forms shall be smoothed with a trowel.
Immediately following an approved discontinuance of placing concrete all accumulations of mortar splashed upon the reinforcement bars and the surfaces of forms shall be removed. Dried mortar chips and dust shall not be puddle into the unset concrete. If the accumulations are not removed prior to the concrete becoming set, care shall be exercised not to injure or break the concrete steel bond at and near the surface of the concrete while cleaning the reinforcement bars.

2.9.4 Joints

Expansion joints shall be formed in the positions indicated and to the details shown on the Drawings or otherwise ordered by the Engineer. The expansion joints shall be filled with bitumen impregnated fiberboard to its full depth and width. The filling will be permitted to be used as permanent formwork only for the second casting. Where the fiberboard is exposed, it shall be cut back for a depth of at least 1cm. from the chamfered edges, filled and pointed with a resilient liquid poly sulphide polymer sealant. Whenever the placing of the concrete is discontinued other than at the expansion faces, this discontinuity shall form a construction joint. Construction joints are to be made only along a horizontal or vertical plane except that in the case of inclined or curved members they shall be at right angles to the principal axis. Care shall be taken to prevent offsetting of the joint and to ensure water tightness. The joints shall in every way satisfy the requirements of the Engineer, and be in accordance with the Drawings.

Unless otherwise shown on the Drawings, construction joints will not be allowed in the supported portion slabs, beams and beam like members. At construction joints the laminate film and porous layer of the already set concrete shall be removed and the surface keyed by hacking and then wire-brushed and thoroughly cleaned. Immediately before adding the new concrete, the surface it to be thoroughly wetted and a 1-cm thick coating of a fresh cement/sand mortar (having the same proportion of cement/sand as concrete in the mix) applied to the surface. The new concrete is then to be well compacted into the old.

The number of construction joints should be kept as few as possible consistent with reasonable precautions against shrinkage. Concreting should be carried out continuously up to construction joints.
Where it is necessary to introduce construction joints, careful consideration should be given to their exact location, which should be indicated on the drawings.

2.10 PRECAST HOLLOW CONCRETE BLOCKS [HOURDIS] FOR RIBBED SLABS:

2.10.1 Material and Manufacture

Aggregate shall be so sized, graded, proportioned and thoroughly mixed in a batch with such proportions of cement and clean water as to produce a homogeneous concrete mixture. However, in no case shall the proportion of cement in the mixture be less than five (5) standard [each weighing 50 Kgs] per cubic meter of concrete.
Pre-cast hollow concrete blocks (hourdis) for a ribbed slab shall be manufactured in approved vibrated, machine.
If for any reason the strength requirement is not achieved, cement shall be increased at the Contractor's own expense. The blocks shall be cured for twelve (12) consecutive days and shall be at least twenty-one (21) days old before incorporation in the Works. The blocks shall be of an approved pattern of withstanding a compressive force applied at the ends of 30 kgs/cm2 based on the gross sectional area of the block obtained without deducting voids.

The blocks shall be hard, sound, durable, sharp, clean with well defined arises, free from cracks and flaws or other defects and of the dimensions shown on the Structural Drawings. The blocks shall be obtained from an approved local factory.

2.10.2 Workmanship

Pre-cast hollow concrete blocks (hourdis) shall be laid exactly in a line with the cells on the long dimensions.
Close edge blocks shall be used at the end; the dimensions of the ribs and size of reinforcing bards shall be exactly according to the Structural Drawings, In narrow width specially made half blocks shall be used and full block shall not be used along their length (with the calls along the long dimensions of the rib.)

The blocks are to be laid on adequate forms. All blocks shall be cleaned and thoroughly wetted with clean water before the concrete is poured and labourers shall not be allowed to walk on them. Any block found to be defective or damaged during concreting operations shall be removed and replaced before pouring the concrete, all at the contractor's expense.

2.11 FORMWORK

2.11.1 General

The Contractor shall be responsible for the design and stability of the formwork. The contractor shall submit a full program of work indicating the various phases for the erection and removal of forms and the manner in which he intends to execute all concrete works.

2.11.2 Material

All forms shall be of wrought lumber and shall be built mortar tight and of sufficient, rigidity to prevent distortion due to the pressure of the concrete and other loads incident to the construction operations. Forms shall be constructed and maintained so as to prevent warping and the opening of joints due to shrinkage of the lumber.

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 Contractor shall take into consideration the effect of vibration on the formwork, and shall be responsible for any damage or default resulting thereof.

2.11.3 Workmanship

Forms shall be inspected by the Engineer prior to installation of reinforcement
The number of spacing of the form struts and braces shall be such that the forms will be braced rigidly and uniformly lock joints between form sections shall be free from play or movement.

The shape, strength rigidity, water tightness and surface smoothness of re-used forms shall be maintained at all times. Any warped or bulged lumber must be resized before being re-used. Forms which are unsatisfactory in any respect shall not be re-used.

Metal tie rods or anchorages within the forms shall be so constructed as to permit their removal to a depth of at least 40mm from the face within injury to the concrete. In case ordinary wire ties are permitted, all wires, upon removal of the forms, shall be cut back at least 10mm.

From the face of the concrete with chisels or nippers for green concrete, nippers are necessary. All fittings for metal ties shall be of such design that the cavities produced upon their removal are the smallest possible.

The cavities shall be filled with non-shrinkage material mortar and the surface left sound, smooth, even and uniform in colour.

All forms shall be treated with special approved oil and saturated with water immediately before placing the concrete. For members with exposed faces, the forms shall be treated with approval material to prevent the adherence of concrete.

Any material which will adhere to or discolour the concrete shall not be used.

The contractor shall provide means for accurately measuring the settlement of the forms during placement of the concrete and shall make all necessary corrections as directed by the Engineer way release the contractor of his responsibility for the correctness of these schedules.

All reinforcement shall be placed strictly in accordance with the drawings and as instructed in writing by the Engineer. Nothing shall be allowed to interfere with the required disposition of the reinforcement, and the Contractor shall ensure that all parts of reinforcement are placed correctly in position and are temporarily fixed where necessary to prevent displacement before or during the process of tamping and ramming the concrete in place. The ties, links or stirrups connecting the bars shall be taut so that the bars are properly braced the inside of their curved part small be in actual contact with the bars, around which they are intended to fit.
Placed correctly in position and are temporarily fixed where necessary to prevent displacement before or during the process of tamping and ramming the concrete in place.

The ties, links or stirrups connecting the bars shall be taut so that the bars are properly braced the inside of their curved part small be in actual contact with the bars, around which they are intended to fit.

2.11.4 Removal of Form-work

In the determining of the time for removal of forms, consideration shall be given to the location and character of the structure, the weather and other conditions influencing the setting of the concrete and the materials used in the mix. In general, the forms of any positions of the structure shall not be removed until the concrete is strong enough to prevent injury to the concrete when the forms are removed. Unless otherwise directed by the Engineer forms shall remain in place for the following specified period of time:

- Centering under beams : 21 days
- Floor slabs : 21 days
- Walls, columns, sides of beams and other vertically formed surfaces : 3 days

Method of form removal likely to cause overstressing of the concrete shall not be used. In general, the forms shall be removed from the bottom upwards. Forms and their supports shall not be removed without the written approval of the Engineer. Supports shall be removed in such a manner as to permit the concrete to uniformly and gradually take the stresses due to its own weight.

Centers shall be gradually and uniformly lowered in such a manner as to avoid injurious stresses in any part of the structure.
The Contractor shall include in his prices for any formwork which may have to be left in position due to the impossibility of removal of same.

2.12 REINFORCEMENT

2.12.1 General

The contractor shall prepare for his own use bar bending schedules from the information given on the drawings and in these specifications. These schedules shall be submitted to the Engineer for approval which shall in no way release the contractor of his responsibility for the correctness of these schedules.

All reinforcement shall be placed strictly in accordance with the drawings and as instructed in writing by the Engineer. Nothing shall be allowed to interfere with the required disposition of the reinforcement, and the contractor shall ensure that all parts of reinforcement are placed correctly in position and are temporarily fixed where necessary to prevent displacement before or during the process of tamping and ramming the concrete in place. The ties, links or stirrups connecting the bars shall be taut so that the bars are properly braced the inside of their curved part small be in actual contact with the bars, around which they are intended to fit. Placed correctly in position and are temporarily fixed where necessary to prevent displacement before or during the process of tamping and ramming the concrete in place.

The ties, links or stirrups connecting the bars shall be taut so that the bars are properly braced the inside of their curved part small be in actual contact with the bars, around which they are intended to fit.

2.12.2 Type and Quality of Steel Reinforcement

1. Hot-Rolled Steel Plain Rods and Bars

Hot rolled steel plain rods and bars shall conform to the strength requirements and minimum elongation of the Standard Specification for Deformed Billet-Steel Bars of Grade 40 with minimum yield strength 2400Kg/cms (35000 psi) for concrete Reinforcement of ASTM Designation (A-615) or equivalent.

2. Deformed Steel Rod and Bars

Deformed steel and bars shall conform to the requirements of the Standard Specification for Deformed Billet-Steel Bars of grade 60 with minimum yield strength 4200 kg/cm2 (60000 psi) for concrete reinforcement of ASTM Designation (A-615) or equivalent.

2.12.3 Wire

Wire for bending reinforcement bars shall be of soft black annealed mild steel wire. The diameter of the Wire shall not be less that 16 S.W.G. (1.6mm) and the binding shall be twisted tight with proper pliers. The free ends of the binding wire shall be bent inwards.

2.12.4 Order Lists

Before ordering material, all order lists and bending diagrams detailed in accordance with the latest revision of AGI Building Code shall be furnished by the contractor for the approval of the Engineer, and no material shall be ordered until such lists and steel bending diagrams have been approved. The approval of order lists and bending diagrams by the Engineer shall in no way relieve the contractor of his responsibility for the correctness of such lists and diagrams. Any expenses incurred to the revision of material furnished in accordance with such lists and diagrams to make and comply with the design drawings including cut and waste shall be borne by the contractor.

2.12.5 Protection of Material

Steel reinforcement shall be protected at all times from injury. When placed in the work, it shall be free from dirt, detrimental scale, paint, oil, loose, rust, grease or other foreign substances.

2.12.6 Fabrication

Bar reinforcement shall be bent to the shapes shown on the Drawings and Steel Bending (Diagrams), bending dimensions and scheduling of bars for the reinforcement of concrete. All bars shall be bent cold, unless otherwise permitted by the Engineer. No bars partially embedded in concrete shall be bent except as shown on the plans or specifically permitted by the Engineer.

2.12.7 Placing and Fastening

All steel reinforcement shall be accurately placed in the position shown on the drawings and firmly held during the placing and setting of concrete. Bars shall be tied at all intersections except where spacing 300mm in each direction, in which case alternate intersections shall be tied.

Distance from the forms shall be maintained by means of stays, blocks ties, hangers, or other approved supports. Blocks for holding reinforcement from contract with the forms shall be pre-cast mortar blocks of approved shapes and dimensions or approved metal or plastic chairs. Metal chairs which are in contact with the exterior surface of the concrete shall be galvanized. Layers of bars shall be separated by pre-cast mortar blocks or by other equally suitable devices. The use of pebbles, pieces of broken stone or brick, metal pipe and wooden blocks

shall not be permitted. Reinforcement in any member shall be placed and then inspected and approved by the Engineer before the placing of concrete begins. Concrete placed in violation of this provision may be rejected and its removal is required.

2.12.8 Splicing

All reinforcement shall be furnished in the full lengths indicated on the drawings. Splicing bars, except where shown on the drawing, will not be permitted without the written approval of the Engineer. Splices shall be staggered as far as possible.
Additional splices, other than those shown on the drawings; and allowed by the Engineer, shall be at the contractor's own expense.
The cost of all supports for holding reinforcement bars shall be borne by the Contractor.

2.13 CURING AND PROTECTION

2.13.1 Water Curing

All concrete shall be cured for a period of time required to obtain the full-specified strength but not less than seven (7) consecutive days. Unformed surfaces shall be covered with sand burlap, or other approved fabric mats kept continually wet. If the forms are removed before the end of the curing period, curing shall be continued as on the uniformed surfaces. When burlap, sand or other approved fabric materials are used, they shall not cause any undesirable finish such as rough surface and discoloring where exposed to light. Unhardened concrete shall be protected from heavy rains or flowing mechanical
injury and the Contractor shall submit for the Engineer's approval his construction procedure which is designed to avoid such an eventually. No fire or excessive heat shall be permitted near or in direct contact with concrete at any time. Water for curing shall conform to Section 2.3.6.

2.13.2 Curing with Curing Media

Curing medium shall meet all requirements of the specifications for Liquid Membrane-Forming Compounds for Curing Concrete of ASTM Designation: C-309 and test for water retention by concrete curing materials of ASTM Designation: C-156.
The compound shall be applied to the concrete surface by means of a sprayer, roller or lamb's wool applicator and shall be sprayed on. Ample time shall be allowed for the concrete surface to harden and to prevent any damage. The compound shall give a drying time not to exceed thirty minutes, and shall be applied undiluted directly from the manufacturer's labeled container in accordance with the manufacturer's directions and to the satisfaction of the Engineer.

The compound shall be completely compatible with adhesives, joint sealants and cement grout.

2.13.3 Payment

No separate payment shall be made for curing with water or with curing media. The cost of such curing shall be deemed to be included in the Unit Prices of "CONCRETE WORK".

2.14 CONCRETE [FAIR FACE] EXPOSED SURFACES

2.14.1 Formwork

Formwork for exposed concrete surface shall conform to the applicable requirements of Section C 14, in addition to those Specifications.
All concrete surfaces that are to be left exposed to view as a finished surface except for pre-cast concrete units, shall be produced by vertical metal shuttering.

The quantity of the surface of concrete exposed to view shall be consistent throughout the project and the following methods shall be adopted to obtain the required finish.

Metal forms of an approved type for pre-cast units

The Contractor may submit alternative proposals for the Engineer's approval if he so desires.

The Contractor is to submit to the Engineer for his approval shuttering details and sequence of operation relating to fair face concrete work. Sample panels shall be constructed for all their face concrete finishes and following the Engineer's approval the panels will remain on site and constitute a standard which must be maintained throughout the duration of the Contract.

2.14.2 Coating Forms with Mineral Oil

In addition to the above forms or linings, the forms shall be coated before placing reinforcement with an
approved colourless mineral oil free of kerosene.
All surplus oil on form surfaces and any oil on reinforcing steel shall be removed.

2.14.3 Samples and Workmanship

The Contractor shall submit for approval a sample panel not less than 600x1200mm to demonstrate the quantity of the exposed concrete produced by forms at his own expense.
The quantity of the finished work shall be measured against the quality of the approved sample panel and the work of inferior quality shall be repaired or replaced as directed by the Engineer without any additional cost.

The quality of the finished surfaces shall be uniform in colour and consistency, whether in colour or in texture, in any of the finished surfaces, the Engineer may order the repair or the demolition of the portion of concrete work and the reconstruction of same at the expense of the contractor and the contractor shall have no right to claim for any expenses or time delay incurred.

Alternatively the Engineer may order the contractor to plaster all exposed surfaces and bush-hammer the entire area of, concrete in the project so as to render all exposed surfaces of concrete consistent throughout the project at the contractor's own expense.

2.15 MONOLITHIC SMOOTH FINISH SURFACES

All concrete surfaces which are not in acceptance condition and which are required to be surface-finished as designated herein, shall be rubbed to a smooth and uniform texture with a carborundum brick and clear water as soon as the forms are removed and the concrete is ready to hone. The loose material formed on the surface shall be removed as soon as it dries by rubbing the surface with burlap or other approval material. A cement wash shall not be used.
Concrete surface shall be free from honeycombing, air holes, fins and projections arising from defective mixings, placing or formwork. When the formwork has been stuck off, the surface of concrete shall be left untouched until inspected by the Engineer. Any defective concrete work shall at the discretion of the Engineer be demolished completely and rebuilt or cut out and made good with concrete of the same proportions as the original. Such rectifications shall be to the satisfaction of the Engineer and at the Contractor's own expense.

3 -BLOCK WORKS

3.1 SCOPE

These specifications cover the supply of materials manufacture and workmanship of concrete blocks intended to be used for the construction of block wall, partitions, facings, etc., required for the project in accordance with the Drawings, Bills of Quantities and as directed in writing by Engineer.

3.2 MATERIALS

3.2.1 Cement

Cement for solid or hollow blocks and mortar shall be Ordinary Portland Cement ASTM Designation C 150-74 and white cement ASTM: C 91-71.

3.2.2 Aggregates

Aggregate for solid and hollow concrete blocks and mortar shall conform to the requirements for fine aggregates in the following Table 3-1:

Table 3-1: Aggregate Percentage Passing for Blocks

Sizes BS sieve No.	Sieve Opening (inch)	Sieve opening (mm)	% Passing
1/8	0.125	3.00	95-100
7	0.095	2.40	80-100
14	0.047	1.20	60-100
25	0.024	0.60	30-100
52	0.012	0.30	0.5- 100
100	0.006	0.15	0.0- 0.1

Note: The above figures represent the limits of percentages (by weight) passing sieves of the sizes mentioned.

3.2.3 Water

Water to be used in block work shall conform to the requirements specified for water in the "Concrete Work" Section.

3.2.4 Lime

Lime shall be non-hydraulic lime compiling in all respects with B.S. 890, and shall be prepared in accordance with the appropriate requirements of British Standard Code of Practice 121: Part 1: 1973, latest revision.

The contractor must satisfy himself by analysis or otherwise that the ground lime is not adulterated or air-slaked.

Factory-produced, dry, hydrated, non-hydraulic or semi-hydraulic lime ready for use, shall be mixed with sand and made into coarse mix or be soaked to putty by mixing with water and

allowing to stand not less than (16) sixteen hours before use.

The lump or ground non-hydraulic or quick-lime shall be slaked, run to putty and matured for not less than two (2) weeks.

3.3 MANUFACTURE OF CONCRETE BLOCKS

1. Aggregate shall be so sized, graded, proportioned and thoroughly mixed in a batch mixer with such proportions of cement and water as to produce homogeneous concrete mixture. However, in no case shall the proportion of cement in the mixture be less than 165 kg per cubic meter of concrete.

2. Pre-cast concrete blocks shall be manufactured in approved vibrated machines. If for any reason the strength requirements are not achieved, the cement shall be increased at the contractor's own expense. The water used in the mix shall be clean and of a sufficient quantity to allow complete hydration of the cement without providing an excess when molding.

3. Concrete blocks shall be hard, sound, durable, sharp, rectangular shape, clean with well define arises free from racks and flaws or other defects. Concrete blocks shall be either obtained from an approved local factory.

4. Blocks manufactured on the site shall be cured in the shade by being kept thoroughly moist with water applied by sprinklers or other approved means for a period of at least seven (7) days. The blocks shall be stocked on a clean and level platform free from earth or other impurities during the curing process, and shall be stocked in honey-comb fashion after curing. The blocks shall not be used prior to one (1) month after the date of manufacture.

5. Concrete blocks (solid or hollow) shall be of the following dimensions:-

   Height = 200 mm + 1 % Tolerance
   Length = 400 mm + 1 % Tolerance
   Width = As required + 1 % Tolerance
   Web thickness = not less than 20 mm for block (40*20*10)/ or
   not less than 25 mm for block (40*20*15)/ or
   not less than 30 mm for block (40*20*20)

   The nominal width of blocks shall be as indicated on the Drawings and as directed by the Engineer.

6. Hollow concrete blocks shall comply with the following requirements: -
   Compressive Strength at <u>Twenty Eight (28) Days</u> Over Gross-Sectional Area: -

   Solid Blocks:
   60 kgs/cm^2 average of 12 blocks
   50 kgs/cm^2 minimum for any block

   Hollow Blocks:
   35 kgs/cm^2 average of 12 blocks
   30 kgs/cm^2 minimum for any block

7. Water Absorption
   20% or less of dry weight

8. The contractor shall supply minimum 12 blocks from each supplying quantity up to 20,000 blocks or in case of change the manufacturer for testing the blocks before starting the masonry works. The all needed tests shall be on the contractor expenses.

9. The design of the cavities and webs of the hollow concrete blocks shall be submitted to the Engineer prior to manufacture. The thickness of the face shell and of the membrane of solid portions shall be nowhere less than 20mm. The combined thickness of the solid portions shall be not less than one fourth (1/4) of the width and length of the block respectively.

10. Concrete blocks for ribbed slabs shall be of the following dimensions:-

Length L (mm)	Height H (mm)	Width B (mm)	Minimum web thickness (mm)	
			For 3 eyes	For 2 eyes
400 Or 500	140	200- 300	20	----
	150	200- 300	20	22
	170	200- 300	20	22
	200	200- 300	20	22
400	250	200	22	22
500	350	200	25	----
+3 mm	+1 mm	+5 mm for one consignment	----	----

The nominal width of blocks shall be as indicated on the Drawings and as directed by the Engineer.

11. Weight of concrete blocks for ribbed slabs are specified as follows:-

Length L (mm)	Height H (mm)	Width B (mm)	Max Specific Weight (kg/m3)	
			For 3 eyes	For 2 eyes
400 Or 500	140	200- 300	1100	---
	150	200- 300	1100	---
	170	200- 300	1000	850
	200	200- 300	1000	850
400	250	200	1000	850
500	350	200	950	---

12. blocks for ribbed slabs shall comply with the following requirements: -
    Flexural Strength at Twenty Eight (28) Days Over Gross-Sectional Area: -

P (N) =2B minimum average of 6 blocks
P (N) =1.8B minimum for any block
Which;
P is the concentrated flexural load (N)
B is the width of the block (mm)

3.4 MORTAR

1. Mortar shall be prepared in the following proportions with the addition of the minimum quantity of clean water for workability:

2. Cement and sand mortar (1:3) mix, shall be composed of one part cement to three parts of sand by volume.

3. Hydrated lime up to 1/4 (one quarter) by volume of the dry cement may be added for bedding blocks, upon the approval of the Engineer, to improve workability without appreciably reducing the strength.

4. The ingredients for cement and sand shall be measured in the proper clean gauge boxes and the mixing shall be carried out by means of an approved mechanical batch mixer.

5. In the cast of cement-lime mortar, the sand and lime shall be mixed first and the cement added. It shall be assumed that the lime has not increased the bulk of the sand.

6. Cement mortars shall be used within thirty (30) minutes after mixing. Hardened mortars shall not be used in the work and shall, upon the request of the Engineer, be immediately removed form the site.

3.5 WORKMANSHIP

1. Block test results and approval from the engineer must be taken before starting the block work.
2. All block work shall be set out and built to the respective dimensions, thickness and heights shown on the drawings and/or instructed in writing by the engineer.

3. All walls and partitions, where shown on the drawings without indicating the type of the block to be used, shall be built in hollow concrete blocks, unless otherwise directed in writing by the engineer.

4. The blocks shall be well buttered with mortar before being laid and all joints shall be in uniform manner and shall not exceed soaked before being used and the tops of wall left off shall be wetted before work is recommenced. All blocks shall, no one portion being raised more than 1.20 m above in one day, and wall of partition necessarily left at different levels, must be racked back. All perpendiculars, quoins, internal and external angles, etc. properly bonded together and leveled round. All block work shall be plumbed vertically.

5. The surface of the walls and partitions prepared for plastering shall have the joints raked out 50 mm into the face of the wall to form key for the plaster.

- All walls and partitions shall be properly cured by sprinkling water for a period not less than three (3) days after completion of laying the course.
-

The accepted verticality tolerance must be within the following:

For every 3m height	+ 6 mm Tolerance
For every floor up to 6m height	+ 11 mm Tolerance
For 12 m height and more	+13 mm Tolerance
For boundary wall, expansion joint and decoration	+ 6 mm Tolerance

3.6 Concrete infill

Block work shall be bonded to concrete columns, wall and the like with concrete infill B250. block must be stopped in graded shape (10-15 cm from the concrete face) one 8 mm bar must cast in columns during casting with total length 40 cm fixed every 42 cm horizontally, in addition to two vertical 10 mm bars.

The prices inserted in the Bills of Quantities for the masonry works and payment thereof shall be based on net finished specified dimensions of the work and shall include the cost of all testing, mix design, trial mixes, construction, concrete infill and transporting, placing compacting, curing, surface finishing, protection, construction and expansion joints and all labors and materials and tests.

4 -PLASTER WORK

4.1 GENERAL

This section of the specifications covers plaster work related with the drawings, bill of quantities, and as directed by the engineer.

The contractor shall attend upon other trades and protect all work specified under this section from damage during subsequent operations, make good any defects, clean away debris upon completion and through out leave all work in perfect condition to Engineer's satisfaction.

Damaged or defective materials shall not be used in the works.

Any defective materials or materials damaged during or after installation shall be removed and replaced at the contractor's expense.

All materials shall be of approved made, and samples shall be submitted for engineer's approval. These materials shall include but not be limited to all kinds of cements, sand, additives, metal lath, galvanized plaster beads, and galvanized wire mesh.

4.2 Gypsum Plaster

4.2.1 MATERIALS

The cement and water used for plastering shall comply with BS specifications. The sand for plastering shall be clean, fine sand and shall be chemically and structurally stable. The sand shall be sieved and graded in accordance with the Table of Grading given below "table 4-1":

Table 4-1: Aggregate Percentage Passing for Plastering

BS Sieve No.	SIZE Inches	Approximate Millimeters	% PASSING	
			Undercoat	Finish Coat
7	0.095	2.4	95-100	100
14	0.047	1.2	80-95	95-100
25	0.024	.6	30-55	30-85
52	0.012	.3	5-50	5-50
100	0.006	.15	0-10	0-10

Note: The above figures represent the limits of percentages (by weight) passing sieves of the sizes mentioned.

The gypsum plaster shall be of the hemi-hydrate type with a controlled setting time. The resultant plaster shall be chemically inert when set, be capable of being toweled to a smooth surface and shall be highly resistant to cracking and crazing. Imported lime shall be of the hydrate type.

4.2.2 Mixing

The mixing shall be done mechanically. With regard to the lime mortars gauged with cement, the addition, just before use of the cement to small quantities of the lime/sand mix shall preferably take place in a mechanical mixing shall continue for such time as will ensure uniform distribution of materials and uniform color and consistency. It is important to note that

the quantity of water used shall be carefully controlled. Gypsum plaster shall be mixed in a clean pail or other approved vessel. The required amount of water shall be placed in the pail and the plaster added gradually and allowed to soak for 5 minutes. It shall then be stirred to a uniform consistency free from lumps and no more material shall be mixed than can be used in half an hour.

4.2.3 Workmanship

All plastering shall be executed in a neat workman like manner. All races except circular work shall be true and flat and angles shall be straight and level or plumb. Plastering shall be neatly made good up to metal or wood frames and skirting and around pipes or fittings. Angles shall be rounded to 5-mm radius. Surfaces of undercoats shall be well scratched to provide a key for finishing coats. Screed marks or making good on under-coats shall not show through the finishing coats. Surfaces described as trawled smooth shall be finished with a steel or celluloid trowel to a smooth flat surface free from trowel marks. Surfaces described as floated shall be finished with a wood or felt float to a flat surface free from trowel marks.

All tools, implements, vessels and surfaces shall at all times be kept scrupulously clean and strict precautions shall be taken to prevent the plaster or other materials from being contaminated by pieces of partially set material which would tend to retard or accelerated the setting time.

4.2.4 Internal & External Plaster

4.2.4.1 Samples

The contractor shall provide samples for all plaster layers before starting work within appropriate time to get approval by the engineer.

4.2.4.2 Preparation of Surfaces

All surfaces, to be plastered, shall be clean and free from dust, loose mortar and all traces of salts are to be- thoroughly sprayed with water, but all free water shall be allowed to dry and disappear from the surface before the plaster is applied.

All small openings in walls resulted from electrical and plumping establishments shall be closed using (1:3 cement: sand) mortar.

Plastering shall not be commenced until the background has been suitably prepared. Block work joints shall be deeply raked out, efflorescence brushed off and all dust and foreign matter removed.

Where cement plaster is to be applied to surfaces shall first be dashed with a mixture of Portland cement and sand (1:1) mix to form a key. All surfaces shall he thoroughly sprayed with water and this shall be allowed to thoroughly dry out before the next coat is applied.

Before plastering is commenced all junctions between differing materials shall be reinforced. This shall apply where walls join columns, where brick walls join block walls and similar situations where cracks are likely to develop and as directed by the engineer. The reinforcement shall consist of strip of galvanized wire mesh (10 to 15mm hexagonal mesh) 15cm wide which shall be plugged, nailed or stapled as required at intervals of not exceeding

40cm at both edges.

On all external surfaces and on all smooth internal surfaces spatter dash of cement and sand which shall contain 500 kgs of cement per one cubic meter of sand shall be applied and allowed to dry before rendering is commenced.

The contractor can use either (hyrib) or (expanded metal) type. The (hyrib) shall fix using overlapping and compressing method, but the expanded metal shall fix using strong nails.

The Contractor shall form vertical guide screeds 5cm wide.
The spacing shall not exceed 1.50 meters.

The screeds shall be plumb and in the same plane with each other. The sides of the screed shall be left rough to bond ~ with plaster, the surface shall be smooth.

The finished surface shall be true and shape and angle even in all directions, with straight arises free of cracks and trowel marks and to the entire satisfaction of the Engineer.

4.2.4.3 Application of Internal Coats

The internal plaster consists of 3-coats which are:

- First layer: (Key Coat)

This layer "Key Coat" is not less than 3 mm with (1:1) cement: sand mortar. This layer must be done by force throw out the mortar to all surfaces. It must be curing for minimum 3-days to keep it moist.

- Second layer: Base-Coat (Rendering)

Base coat shall be done for one wall in same time by using vertically ruler with 10cm width, starting from floor to roof.
When applied to masonry or to concrete surfaces the base coat shall be applied with sufficient force to prevent air pockets and to secure a good bond.
The base coat thickness shall not less than 13mm, with (1:3:0.25) cement: sand mortar: lime.
The base coat shall be lightly scratched in both directions to provide a key for the finishing coat and shall be kept moist with a fog spray for minimum 3 days and then allowed to dry out.

- Third layer: Finishing Coat

Shall not be applied until the rendering or base coat has seasoned for seven days, just before the application of the finish coat, the rendering or base coat shall be wetted evenly with a fog spray.
Finishing coat thickness is about 3mm with (1:4:0.50) cement: sand mortar: lime.
The used sand shall consist of about 50% of soft sand (selisi sand).
Where cement plaster with a smooth troweled finish is specified or indicated on the drawings, the finish coat shall be first floated to a true even surface, then troweled in a manner that will force the sand particles down into the plaster and with the final troweling, leave the surface finished smooth and free from, rough areas, trowel marks, checks or other blemishes.
Cement plaster in all other spaces, where a smooth finish is not specified or noted on the drawings, shall be given a sand float finish or a uniform texture, as approved by the engineer.

The finish coat shall be kept moist with a fog spray for at least two days, and thereafter shall be protected against rapid drying until properly and thoroughly cured.
Plaster shall be made good up to frames and skirting and around fittings and pipes. Angles shall be rounded to a 5mm radius.

4.2.4.4 Application of External Coats

The external plaster consists of 4-coats which are typically specify as same as internal plaster except that the second layer is the concrete coat. Concrete coat thickness is 5mm, with (1:2) cement: sand mortar and shall be kept moist with a fog spray for minimum 2 days and then allowed to dry out. Then base coat and finishing coat are same as in internal plaster.

4.2.4.5 Proportions for Internal and External Plaster

Screeds shall be laid and ruled as necessary to allow for a total thickness of 13-15mm for internal and external plaster and the rendering shall be applied to the required thickness.

4.2.4.6 Tyrolean Plaster (Fine Grain)

The Tyrolean plaster shall be executed to the extent shown on the drawings and as directed by the engineer.

The contractor shall set up samples of different degrees of fineness for the engineer's approval prior to commencement of Tyrolean work. The engineer may choose different degrees of fineness for different parts of the works and the contractor shall allow for this in his rates.

4.2.4.6.1 Mixing

Cement and aggregate for each batch shall be accurately measured and mixed dry until evenly distributed and the mass is uniform in color. All batches shall be of such size that. They can be entirely used within half an hour. Mechanical mixers of an approved type shall be used for mixing Tyrolean plaster, except when hand mixing of small batches is specifically approved by the engineer. Mechanical mixers, mixing boxes and tools shall be cleaned after mixing each batch and kept free of Tyrolean mortar from previous mixes. Water content shall be maintained at a minimum. Mixing shall be continued until plasticity is obtained.

4.2.4.6.2 Proportions

Proportions of materials for Tyrolean, by volume shall be as follows:
Finish Coat

1 part of white Portland cement
3 parts fine selected aggregate (Quartz)

4.2.4.6.3 Workmanship:

Surface to receive Tyrolean shall be clean, free from dust, dirt, oil, or other particles that might interfere with a satisfactory bond. Surface to receive Tyrolean shall be evenly dampened (not soaked) with a fog spray before Tyrolean is applied. If surfaces become dry in spots, the dry areas shall be dampened again to restore uniform section. Tyrolean coats shall be applied continuously in one general direction without allowing mortar to dry at edges. Edges to be jointed shall be dampened slightly to produce a smooth confluence. Tyrolean, unless otherwise shown or specified, shall be two coats work not less than 5mm. thick

All exterior corners of Tyrolean shall be slightly rounded. Tyrolean on soft surfaces shall be pitched forward to form a drip

Surface of the scratch coat shall be dampened several hours before the finish coat is to be applied. Additional dampening at time of application shall be by fog spraying. Dampening by brush will not be permitted. When measured with a 2 meter long, straight edge applied in all directions, the finish surface shall not vary from a true plane by more than 1.5mm. The finishing coat shall be applied by means of a proper spraying machine and the degree of the finishing coat shall be determined by the engineer.

4.2.4.6.4 Curing:

As soon as the finish coat has taken its initial set, the Tyrolean shall be protected against direct rays of the sun or rapid drying for at least 10 days. During this time Tyrolean shall be kept moist by frequent fog, spraying. Care shall be taken to prevent staining of the Tyrolean.

4.2.4.6.5 Acceptance and Repairing:

Tyrolean with cracks, blisters, pits, checks or discoloration will not be accepted. Tyrolean shall be clean and sound and in accordance with the requirements of the specifications. After all other related work has been completed, pointing around trim and set work and repairing of damaged portions shall be performed to the satisfaction of the engineer. Repairs shall match existing Tyrolean in texture and color to the satisfaction of the engineer.

4.3 False ceiling from galvanized mesh and plastering

1. Fixing the approved galvanized mesh as temple from metal rods with diameter 8mm every 25cm in both sides which must weld with each other by electrical weld.
2. Check up the fixing mesh to ensure it's horizontally is good. Then covering it by 3-coats of rough plaster with 1cm thickness for each coat. Each coat shall be lightly scratched in both directions and wait until it dry to start with the second coat. The third coat is fine plaster coat with thickness 0.5cm. The final thickness for 3-coats is 3.5cm.
3. The used mortar for all 3-coats shall consist of (1:3) cement: sand mortar with adding laxative approved material.

The metal grid system shall be a patent system suitable for use with in-situ plaster and expanded metal lathing and shall have flat metal hangers to suit suspended ceilings depths as shown on the drawings and described in the Bill of Quantities. The system shall include all main and cross runners, necessary splicer, hangers, clips and wall mounting next to walls. The system shall be installed complete in accordance with the manufacturer's instructions.

5 -TILING WORKS

5.1 Materials

Portland cement, fine aggregate and water shall be as previously specified in section 3, concrete works.

The colour pigments shall be of an approved manufacture, lime-proof and non-fading and complying with British Standard No. 1014: 1942.
The marble chipping shall be of an approved quality in irregular pieces varying for 0.047″ to 3/8″ in size defending on the effect required. The pieces should preferably be roughly cubical in shape and flaky shaped pieces shall not be used.
The granite chipping shall be of an approved quality graded from ½″ down with not more than 5% fine material passing a No. 100 sieve.

Marble and granite aggregates shall comply generally with table and granite aggregates shall comply generally with table of grading. In connection with marble aggregates, the percentages are approximate only. The actual grading should be selected to produce the surface effects required as shown in table 5-1.

Table 5-1: Aggregate Percentage of Passing for Tiles

B.S. Sieve No.	Sieve opining		Percentage of Passing	
	inch	mm		
-	½	13	100	-
-	3/8	10	59-100	59-100
-	3/16	5	30-60	25-60
7	0.095		20-50	5-30
14	0.047	1.2	15-40	0-10
25	2.40	0.6	10-30	-
52	0.012	0.15	5-50	-
100	0.006	0.3	0-5	-

Note: The above figures represent the limits of percentages (by weight) passing sieves of the sizes mentioned.

5.2 Mixing

Materials for in-situ paving and locally manufactured tiles shall be measured separately in approved gauge boxes on a clean, dry, level surface.
Materials shall be mixed either by hand or machine as previously specified in Section 3, concrete works.

5.3 Proportions

The following mixing table 5-2 shall be strictly adhered to in all castrations will be permitted only when demanded by the particular Specification for individual works or prior written consent of the Engineer.

Table 5-2: Mixing of Tiles composites

Nominal mix	Cement Kilos	Fine Aggregates Cu.M.
1:1	1442	1.00
1:2	721	1.00
1:2 ½	577	1.00
1:3	476	1.00
1:4	361	1.00
1:5	289	1.00

5.4 Granolithic Paving

These shall consist of a (1:2) mix-one part Portland cement to two and half parts of granolith aggregate mixed with sufficient water to give a suitable plasticity for laying. The paving shall be laid immediately following the concrete sub-base. If these paving are laid on a matured concrete sub-see the concrete shall first well cleaned wetted and brushed with a Portland cement grant.

To produce a wearing the granolithic mixture shall be tamped in with a wood float and trawled twice with a steel trowel to produce a smooth finish.
The paving shall be laid in alternate bays not exceeding 9 square meters in area and the bays shall be separated by expansion strips of brass or other approved material.
Covering them with Hussein wet for seven days shall cure granolithic paving.

5.5 Cement and sand paving

These shall consist of a (1:3) mix-one part of Portland cement to three parts of sand mixed with sufficient water to give a suitable plasticity for laying. The paving shall be laid immediately following the concrete sub-base. If laid on a matured concrete sub-base the same precautions should be taken as described for granolithic paving above.
The paving shall be laid in bays as prescribed above for granolithic paving.
Cement and sand paving intended as a wearing surface shall be troweled twice with a mechanical steel trowel to produce a smooth finish. Two coats of sodium silicate solution shall be brushed on.
Cement- sand paving shall be cured as described above for granolithic paving.

5.6 Cement and sand tiles

These shall be formed with a (1:2) mix of white or colored cement, or in white cement with a colour pigment added, and sand applied as a facing not less than 7 ½ mm thick to a Portland cement and sand (1:5) mix backing. The tiles shall be cast in heavy metal moulds under pressure to the proportions and sizes shown in the following table 5-3.

Table 5-3: Grinding of Granite and Marble Chipping

B.S. Sieve No.	Sizes of sieve		Percentage passing by Weight	
	mm	Inches	Granite Chipping	Marble Chipping
-	13	½	100	-
-	10	3/8	95-100	95-100
-	5	3/16	30-60	25-60
7	2.4	0.095	20-50	5-30
14	1.2	0.47	15-40	0-10
25	0.6	0.24	10-30	-
52	0.3	0.12	5-50	-
100	0.15	0.006	0-5	-

It is essential that closer grading limits be selected for the marble chipping if a consistent and uniform surface texture is desired.
Coloured cement and sand skirting to match tiles, 7cm or 10cm with chamfered top edges shall be produced in the same way as the tiles using the same mixes.
All cement and sand tiles shall be cured by totally immersing them, after the initial set has taken place, in a tank of clean water for at least 24 hours.
Cement and sand tiles shall be laid and bedded direct on to a concrete sub-floor on a cement and sand 1:4 mix screed. This screed shall be laid and bedded direct on to a concrete sub-floor on a cement and sand 1:4 mix screed. This screed shall be 2 ½ cm thick in the castoff 2 ½ cm tiles and 3cm thick in the case of 2cm tiles. The total thickness of cement and sand screed and tiles shall not exceed 5 cm. All tiles shall be laid with square joints.
All cement and sand tiles shall be cured by totally immersing them after the initial set has taken place I a tank of clean water for at least 24 hours.
All tiling shall be grouted up on completion immediately, care being taken to fill all joints completely. The grout shall consist of net cement of a color to match the tiling. Any surplus grout shall be cleaned off the face of tiling and surrounding surfaces immediately and all tiling shall be carefully cleaned off.

5.7 Terrazzo Tiles

These shall be formed with a (1:2 ½) mix of white or colored cement or white cement with a colour pigment added and granular marble chipping applied as a facing not less than 10 mm thick to a Portland cement and sand 1:5 mix backing.
The tiles shall be cast in heavy metal moulds under pressure to the proportions and sizes shown in the following table 5-4.

Table 5-4: Terrazzo Tile Dimensions

Size (cm)	Min Wear Surface(mm)	Size tolerances (mm)	Total Thickness (mm)
20x20	10	±0.5	20
25x25	12	±0.5	25
30x30	15	±1.0	30
40x40	15	±1.0	30
Skirting	6	±0.5	10

Tiles shall be cured as for cement and sand tiles and then ground, filled and polished before distribution to Site. Grinding shall be done wet by means of a No. 80 carborundum stone. Filling shall be carried out with neat cement grout of the same colour as the facing mix and this

shall be worked into the surface with a wooden shaper to fill all voids and air holes. Surplus grout shall be removed with a dry cloth. After a minimum period of 24 hours polishing shall be carried out wet by means of a No. 140 carborundum stone.
Terrazzo skirting 7cm, 10 cm or 20 cm high with chamfered top edge shall be produced in the same way as for tiles using the same mixes.
The contractor has to clean the place prior to starting the tiling works and get the approval from the engineer to laying clean sand 5 cm
Terrazzo tiles shall be laid and bedded on a cement and sand (1:4) mix screed. This screed shall be 2 ½cm thick in the case of 2 ½ tiles and 3cm thick in the case of 2cm tiles. The total thickness of the cement and sand screed and tiles shall not exceed 5cm. All tiles are laid with square joints.
Terrazzo tiles shall be laid only if it's age more than 28 days from that the date of manufacture.
The tiles shall be laid dry and tamped into the slurry to form a level surface. Joints shall be even and not more 3 mm wide in both directions.
All tilling shall be grouted up on completion immediately, care binge taken to fill all joints completely. The grout shall consist of neat cement of a colour to match the tilling. Any surplus surfaces immediately and all tilling shall be carefully cleaned off.
All terrazzo surfaces shall be polished on completion. Large areas such as floors shall be wet polished by means of approved machines using No. 140 carborundum wheel. Any surface too small for convenient machine polishing may be polished by hand using a No. 140 carborundum stone and water. Care must be taken during any polishing operation not to damage any angles or arises.
Terrazzo covering to items such as sills, treads and risers to steps, skirting etc., shall generally be applied in accordance with the foregoing specification except that the thickness of the facing shall be at least 12mm thick as the following table 5-5:

Table 5-5: In-Situ Terrazzo Dimensions

Item	Min Wear Surface(mm)	Total Thickness (mm)
Stair Tread	20	50
Stair Riser	12	20
Stair Skirting	12	20
Sill	20	50
Threshold	12	30

Terrazzo stair treads should be reinforced with at least 2 longitudinal bars Ø6mm and 3 transversal bars for each and glass joints will be installed along the cast in situ terrazzo.

5.8 Marble Paving

Marble paving shall generally be 2-3 cm thick the size, type and pattern that be as stated in the particular specification, BOQ and/or shown on the drawings.
The marble slabs shall be fixed solid on a bed of cement and sand 1:4 mix 3cm thick tight joints grouted in lime putty. Protective slurry of putty at least 3mm thick shall be applied to the marble paving and subsequently cleaned off.

Treads to stairs shall be 3cm thick fixed solid on a bed of cement and sand 1:4 mix 3cm thick 5 cm width of the treads need to be roughened. Risers to stairs shall be 2cm thick fixed solid on a backing of cement and sand 1:4 mix 3cm thick. Window sills shall be 3cm thick fixed solid on a bed of cement and sand 1:4 mix 3cm thick. Skirting shall be 1cm thick in lengths equal to the tile length, fixed solid on a backing of cemented sand 1:4 mix 2cm thick. Joints in skirting

shall be arranged to coincide with joints in adjacent paving. Rounded arises, noising and moldings shall be adequately protected by means of timber casing or lime putty ceilings. Treads, risers, skirting and windows sills shall be grouted and protected in a manner similar to paving.
The exposed faces and edges of all marble shall be polished smooth and be free from scratches or other defects.

5.9 Marble linings

Marble linings to walls, columns and the like shall generally be 2cm thick and the size, type and pattern shall be as stated in the particular specification, BOQ and/or as shown on the drawings. The marble slabs shall be cut square/rectangular and true and shall be uniform in shape and thickness. Patterns and moldings shall be accurately formed in accordance with the Drawings.
The marble slabs shall be fixed with copper or galvanized steel cramps and hooks and plaster raps leaving an air space of 12mm behind the slabs to prevent transfer of soluble salts from the backing materials. The cramps shall be 2 1/2cm x 5mm x 10mm girth one end and turned down and grouted into mortise in marble and the other and built into wall set 45cm apart in each bed. Mortises shall be accurately and carefully cut and all joints shall be thoroughly grouted.
Exposed edges and molding shall be protected by means of timber casings or lime putty coatings.
The exposed edges and faces of all marble shall be polished smooth and shall be free from scratches or other defects.

5.10 Generally

All paving shall be protected from damage during subsequent operations and shall be well washed and thoroughly cleaned before handing over.

5.11 Terrazzo Tiles Testing

The test sample should be randomly selected so that 0.5 per one thousand but not less than 6 tiles per 500 m^2. Each sample of 12 tile will be tested 6 tiles for flexural strength, 3 tiles for Water absorption and 3 tiles for Wear resistance .In case two tiles or more of the sample don't match the specification, then the whole shipment is rejected. But if one tile failed, then replication of the test should be proceeded.
The Terrazzo tiles, steps and cast in situ Terrazzo must be tested according to the international standards and as follows: -

- Specific Gravity: not less than 2.5
- Water Absorption: Absorption should not be more than 8% by weight for each sample.
- Flexural Strength: It should not be less than 5 N/mm2 for each sample.
- Wear Resistance: Rate of wear resistance should not be more 2mm on average for 3 samples of each batch. However, each sample should not have wear resistance over 2.5 mm.

5.12 Tiles and Cladding

All the tiling & cladding works will be executed according to the drawings and instructions and will be tested to control the quality of the materials as mentioned in the general specifications. *Unless otherwise said in the BOQ and drawings, the tiling will be:*

Terrazzo tiles (local production):

- Terrazzo (marble chips) floor tiles size 25x25x2.5cm.
- Terrazzo (marble chips) skirting 1x7cm.

Marble Works:

- Local marble (Class A) 3cm thick will be used for WC doors entrances, main entrances and any other places indicated in the contract documents.
- Local marble (Class A) copings 3cm thick will be used for staircases and roof parapets.
- Local or imported marble 30x60x2cm tiles or any size requested by the engineer will be used for flooring.
- Colored marble or granite 2.0cm thick with sizes as requested by the engineer.
- Windows sills will be local marble 3 cm thick (Class A).

The kitchen cabinets :

- Local marble 2cm thick (Class A) will be used for shelves, floor and back of the kitchen cabinets and 3cm thick for vertical dividers and the worktop will be from approved marble or granite, the cupboard leaves will be of colored aluminum.

West Bank stone: -

- West Bank stone of Class A will be used as shown in the drawings, specifications of stone works and the engineer's instructions.

5.13 Marble and Granite

The test sample should be randomly selected so that not less than one tile per 100 tiles.
The marble and granite must be tested according to the international standards and as follows: -

- Specific Gravity: not less than 2.5
- Water Absorption: Absorption should not be more than 0.75% by weight for each sample.

5.14 Ceramic, Glazed and Quarry Tiling.

Samples of tiles shall be submitted to Engineer for approval of quality and color prior to order.
Clay floor quarries and fitting shall be in accordance with BS 1286 Type A and the thickness and size shall be as stated in the Drawing, BOQ or as per the engineer approval.
Ceramic floor tiles and fitting shall be in accordance with BS 1286 Type B and the thickness and size shall be as stated in the Drawing, BOQ or as per the engineer approval.

Glazed ceramic floor tiling shall be of the type, thickness and size as stated in the Drawing, BOQ or as per the engineer approval.

The tiles shall be true to shape, flat, free from flaws, cracks and crazing, and keyed on the reverse side and shall be a manufacture approved by the engineer.

Semi-dry cement and sand (1:4) mortar shall be spread not less than 4 cm thick as tiles bedding.
Cement and sand mortar bed (1:3) not more than 2 cm shall be laid. Any admixture to the

mortar must be approved before used.
The contractor shall ensure that when fixing tiles with thin bed adhesive, the base to receive tiles is clean level and dry, no loose and friable areas and surface dusting.
Tiles shall be firmly tamped into motor to form a level surface. Joints shall be even and not more 3 mm wide in both directions using spacer lug tiles or spacer pegs.
Joints shall be continuous and extended vertically.

The tiles shall be grouted up with white or colour cement motor worked well into joints when bed is sufficiently firm to prevent disturbances of the tiles; surplus grout shall be cleaned off from faces of tiles.
Where tiling abuts against wood or metal frames or other tiling at angles and round pipes etc., it shall be carefully cut and fitted to form a neat joints. Open irregular joint with cement and sand or plaster will not be permitted.
Tiles shall be cleaned off and polished once completion.

5.15 Glazed Ceramic Wall Tiling

Walls tiles shall be in accordance with BS 1281 first quality and a minimum thickness of 6mm.
The tiles shall be true to shape, flat and free from flaws, cracks and crazing and keyed on the reverse side and shall be of a manufacture approved by the engineer.

The tiles shall be immersed in water for 6 hours or until saturation tightly together to drain with end tiles turned.
Key layer cement and sand (1:2) then scratched screed (1:4 mix) should be applied preceding to tiles installation.
Ceramic floor tiles shall be soaked and bedded in cement and sand mortar (1:3 mix) with addition of an approved plasticizer.

Tiling shall be carried out to the levels indicated on the drawings in a first class workmanship.
The render coat shall be wetted sufficiently to prevent it absorbing water from the bedding coats.
Thickness of finished bedding shall be not less than 6 mm nor more than 12 mm.
Each tiles shall be buttered evenly with motor and tapped firmly into position so that the bed is solid throughout.
Joints shall be even and not more than 3 mm wide using spacer lug tiles or spacer pegs.
Joints shall be continuous both horizontally and vertically.
Tiles shall be fixed to a finished surface that is plumb and true to +/- 2mm in any 2 m.
Tiles shall be neatly cut and fitted around pipes and other obstructions.
Tiles shall be grouted up to not less than 24 hours after fixing tiles to porous surfaces and not less than 3 days after fixing to impervious surfaces.
Tiles shall be cleaned off and polished upon completion.

5.16 Ceramic Tiles Testing

The test sample should be randomly selected so that 6 per one thousand or less but not more than 15 tiles for every delivery. In case two tiles or more of the sample do not match the specification, then the whole shipment is rejected. However, if one tile failed, then replication of the test should be preceded.

- Water Absorption: Absorption should not be more than 4% and 0.3 by weight for semi glazed and full glazed ceramic respectively.
- Flexural Strength: It should not be less than 5 N/mm^2 and 6.5 N/mm^2 for semi glazed and full glazed ceramic respectively.
- Wear Resistance: Rate of wear resistance should not be more 2.5mg/mm^2 and 1mg/mm^2 on average for 4 samples of each batch for semi glazed and full glazed ceramic respectively.

6 -METAL WORKS

6.1 Scope

These specifications cover ferrous and non-ferrous works intended to be used in the project; all in accordance with the Drawings and as directed by the Engineer.

The contractor shall ensure of all dimensions on the site and clear them in detailed shop drawings for approval by the Engineer.

The contractor should provide the engineer with detailed shopdrawings for aluminum works that will be installed, in addition to providing samples of profiles, method of statement, accessories and hardware in order to have a written approval prior to starting.

6.2 Materials

6.2.1 Steel

Steel plates, and structural steel shaped sections shall conform to the requirements of B.S. 4 latest edition for structural sections, Part 1 Hot-rolled sections and Part 2 Hot-rolled hollow sections (Metric Series).

6.2.2 Aluminum

The Aluminum used should be approved type by the Palestinian Standards Institute, as indicated in the specifications and Bill of Quantities.

6.2.3 Bolts, Nuts and Washers

Bolts and nuts shall conform to the requirements of B.S. 4190: I.S.O. metric black hexagon bolts, screws and nuts.
Plain washers shall be made of steel. Taper or other specially shaped washers shall be made of steel or malleable cast iron and shall conform to the requirements of B.S. 4320, metal washers for general engineering purposes.

6.2.4 Galvanized Steel Pipes

Galvanized steel pipes shall conform to the requirements of B.S. 1287 - I.S.O. "Medium Series".

6.2.5 Paint

Paint for Metalworker shall comply with the applicable requirements as specified under "PAINTING".

6.3 Description of Steel

Steel to be used for all the works must be new and have never used before and must be free of rust and crusts. The steel bar or plate should not be welded pieces but one unit.
The steel profiles and tubes used should be sound and free of defects like buckling, bending, and cracking or other. The tolerances in sections of steel shall not more than 0.30 mm for thickness and 0.50 mm for other dimensions.

6.4 Description of Aluminum

All of aluminum profiles should be according to the drawings and not be less than the following:

1. The thickness of aluminum profiles used for frames of windows and sliding doors shall not be less than (1.4 mm ± 0.05).
2. The thickness of aluminum profiles used for hinged windows and doors shall not be less than (1.4 mm) and not more 1.8mm.
3. The thickness of aluminum profiles used for leafs of windows and sliding doors shall not be less than (1.3 mm ± 0.05).
4. The thickness of aluminum profiles used for rail of louvers windows and toilet doors shall not be less than (1.3 mm ± 0.05) for Aluminum type 1088.
5. The thickness of aluminum for hollow sections with area of 3200 mm or above shall not be less than 1.4mm meanwhile the thickness for areas of 2200mm shall not less than 1.3mmm.
6. The thickness of aluminum profiles used for balustrade and protection for windows shall not be (2.05mm±0.1).
7. The thickness of decoration and architrave profiles should not less than 1.2 mm.
8. The thickness of anodizing coat at profiles should not less than 15 micron at least.
9. The thickness of powder coating at profile should not less than 60 micron at least.

6.5 Manufacturing and fixing of steel works:

6.5.1 General

The Contractor shall be responsible for the correctness and accuracy of the dimensions of the finished items. He shall therefore carefully check the dimensions indicated on the Drawings, verify any change and ascertain the sizes on the site which will enable him to prepare final working drawings for fabrication and erection purpose. Such drawings shall be submitted to the Engineer for his verification and approval.
Fabrication orders can only take place after the contractor obtains, in writing, the approval of the Engineer for the above drawings.

6.5.2 Flush Steel Door and Frame

Flush steel door shall be fabricated of hot-rolled steel sections for framed skeleton with diagonal bracings and lined both faces with steel sheet of thickness as shown on Drawings or stated in the Bills of Quantities, riveted to framed skeleton as shown on the Drawings. The frame shall be made of hot-rolled steel sections and shall be provided with. 8 No. anchors, one end welded to frame and the other end dove-tailed to the masonry or concrete.

6.5.3 Hollow Metal Door Frames

Hollow metal door's frames shall be made of the profiles and sizes shown on the drawings and obtained from an approved manufacturer. The door frames shall be with minimum 2.0 mm thick, twice laminated steel sections and be delivered to site complete with a factory applied anti-corrosive plastic coating., ties cast to backs of frames for building in and rubber silencers on the locking stile.

The frames shall be stored in a clean, dry place, off the ground and protected from the weather. The frames shall be free of all dents, bumps, splits, and cracks and any defective frames shall be made good or replaced at the Contractor's own expense.

6.6 Workmanship

6.6.1 Aluminum elements

The glass used should be transparent glass with a thickness of 4 mm or if stated otherwise.

The Aluminum used is coated with hot dipped polyester powder (paint thickness should not less than 60 microns).

Aluminum should be colored type and color choice as instructed by supervisor Engineer.

The used flay screen for the aluminum windows is manufactured of fiberglass as specified in drawings and bill of quantities.

Installing of aluminum frames to sills, lintels, and opening sides should be by using wedges manufactured of Polymerized Propylene or using screws made of aluminum or anti rust steel. Those screws should have enough size and length to fix the frames strongly as required and the approval of supervisor Engineer.

The hardware and accessories should be made of aluminum (Allen key corners, rails, locks, handles... etc.) of the same type of profiles required and shall be of solid hardware durable and shaped.
The used wheel rollers should be spherical ball bearing.
The locks should be secured and from approved type by the manufacturer or supervisor engineer.
The closing kit and tapes used to prevent water and air leakage should be manufactured from polymer vinyl chloride (PVC) or neoprene.

The engineer approval should be obtained for the color and appearance of the coating surface of aluminum before industrialization and supplying materials.

Selection of aluminum forms and profiles used to allow the tight closure of the doors and windows by installing tapes anti-air and weather influences, and providing the frames of sliding doors and windows with holes to permit disposing rainwater.

Aluminum works should not be installed before the completion of plastering and painting finishing.

Gap spaces between aluminum and architectural openings for doors and windows should be packed with a silicon paste injected from both sides to ensure full closure. The color of silicon must be fit to the color of aluminum.

Contact between the surfaces of aluminum and any metal surfaces contrast to the stainless steel, zinc-coated nickel or the bronze nickel is prohibited but only after addressing those surfaces using one coat of poly-zinc chromate primer and two coats of oil painting.

The contractor is responsible for all works of aluminum during and after installation until

handing over the project.

Installation of glass must be using strip of rubber between aluminum and glass from inside and outside.
The manufacturer must maintain the corners of aluminum works at right angles and gapless.

6.6.2 Steel elements

All steel works should be done with professional manner and welding must be hidden, not appeared on the face and polished.

All steel parts shall be accurately set out, cut, framed, assembled and executed using proper bolts or welding electrodes. All cut parts shall be sawn cut; no oxygen burning shall be permitted except for pipe supports. All welding shall be electrical welding, clean and of proper workmanship. All cut parts and welded sections shall be ground, even and filed smooth with rounded edges

No allowable showing any signs of knocks or any type of cavity in steel and should be all contact links arbitrator well without leaving any vacuum or clear signals welding redundant on the face.
Forging shall be sharp and true curbs and intersections, members of the same size shall halve together.

All items found in the railway premises in the building by rail to be commensurate with a solid and well.
It must be to work of all holes in block walls, concrete walls, tiles or stairs and where necessary to install steel works strictly by private machineries without causing any damages to the building. Costs of making holes well done and recovered are responsible of contractor with his own costs.

Manufacturing windows and doors as a full specifications and details shown on the drawings, taking into account that fixing 2 hinges for each window's shutter. However, if the height of shutter exceeds 1.5 meters, fix at least 3 Hinges for each shutter. For each door's shutter, fix 3 Hinges, 100 mm length unless otherwise specified in drawings or special specifications.

All steel members in contact with the soil shall paint with two (2) coats of protective asphalt paint. All doors frames staircases, etc... shall be given at least one (1) coat of approved rust inhibiting primer before delivery to Site

Making doors and windows accurately and proficiently duly taking into account that are made all welding by professionals and skilled labors with expertise in this area, and automatically clean all welded links and to get a smooth surface without protrusions
Stored all produced parts prior to installation in a dry place and the process of being transfer without scratches.

The contractor shall provide samples of any section for approval by Engineer before.

Fix door's frames in the wall by steel angles (3mm- thickness, 50 mm- wide, 200 mm- length), and be stationed in the form of right angles by welded one side of angel with steel frame and fix other side of angel with block by cement mortar.
Fix glass to window's frame using metallic clips and rubber or putty.

All work shall be erected plumb and true to lines and rigidly secured to walls, floors or ceilings as shown on Drawings and to the satisfaction of the Engineer
Welding work is along the flat welding (stitching along the line of welding)

6.6.3 Welding

Welding surfaces shall be clean, free cobalt, rust and other materials that will have the opposite effect on the welding by skilled professionals with expertise in this area.
Prohibits a welding operations in the up-normal weather conditions such rain, strong winds, or when temperatures fall to zero (0 ºc), unless action was taken to ensure that the impact of these conditions on welding operations, and the approval of Engineer
The intensity of electricity used in welding operations shall be located within the established range of welding rods, and then welding process is the movement of fluctuations consecutive start of the first welding and so close, and being removed from the slag welding operations abreast so that each layer of the welding layers completely clean before the following class action.
Prohibits any subsequent operations for one welding process unless after the disclosure of welding by engineer and approval, and is not being disclosed mentioned before passing 72 hours after the end of operations
Must provide workers with masks, protective glasses and gloves, and necessary to safe them during welding operations
Welding work is along the flat welding (stitching along the line of welding).

Hollow metal door frames
Hollow metal door frames shall be fixed and shown on the drawings all in accordance with the manufacturer's printed instructions and flushed up solid with plain concrete or cement mortar.

The rates for hollow metal door frames are to include for the supply and assembly of the complete unit including all necessary holes for hinges and lock, cutting of torsion threshold bar if necessary and fixing in walls in accordance with the manufacturer's printed instructions and plain concrete or mortar filling as shown on the drawings.

6.7 Ventilation Louvers

Steel ventilation louvers, shall be made to the sizes, dimensions and designs shown on the drawings and fixed to concrete as indicated on the Drawings. Shop drawings shall be prepared to detail fixing and samples shall submit to the Engineer for approval before ordering the materials.

6.8 Iron Steps

The Contractor shall supply and fix galvanized malleable steel iron steps of general-purpose pattern conforming to B.S. 1247, and having a 117mm tail. They shall build into walls truly level and in vertical lines as shown on the Drawings or directed by the Engineer.

6.9 Ladders

Steel ladders shall consist of galvanized mild steel coated with fiberglass or as specified in the B.O.Q and supplied complete with suitable bottom and top brackets and intermediate support

brackets at centers not exceeding 20cm.

6.10 Steel hand railing & Balustrades

Unless otherwise specified hand railing and balustrades shall consist of handrails and standards of galvanized mild steel. Handrails shall be flush jointed with an internal screwed nipple joint. Removable hand railing shall be half lap jointed.
Handrails shall be not less than 45mm outside diameter and to rails shall be set not less than 1.05m above adjacent floor or platform level, unless shown otherwise on the Drawings.
Standards shall be tubular and not less than 45mm outside diameter and shall be of the double ball type with balls at approximately equal spacing above adjacent floor or platform level.
Base plates wherever possible shall be horizontal and circular. Horizontal and side palm plates shall be secured (I) by not less than 3 bolts of not less than 12mm diameter and 75mm length. Hand railing, base and palm plates shall be (I) painted after erection. Painting shall deem to including in the Contract rates for hand railing.

6.11 Galvanized steel covers

Galvanized steel covers shall be galvanized mild steel with raised threads of Durbar pattern or similar approved by the Engineer. The plate shall be sufficient thickness to support. A distributed load of 5KN/square meter or shall be as detailed on the Drawings.
The covers shall support on galvanized mild steel frames. The frames shall have mitered and welded corners, with welded fishtail anchors at not greater than 1m centers, all galvanized after fabrications.
Galvanized mild steel lifting handles shall be welded onto the covers where shown on the Drawings. Locking devices to manhole covers shall be of galvanized mild steel and as shown on the Drawings. Galvanizing to all covers shall carry out after all welding and fabrication is complete.

6.12 Permanent fencing

Permanent fencing if requested shall be installed over the boundary wall and shall be 0.5m overall height consisting of 4 strands of barbed wire. All steel parts shall be galvanized.
The fencing should supply complete with the fixing supports, which must be galvanized steel pipes, 2" diameter.

6.13 Monorail hoist

Monorail hoist shall be furnished and installed to the dimensions shown on the drawings. "I" beam shall be used, in accordance to BS 449: Part 2 1969 (Specifications for the use of structural street in building. (Part 2: Metric Units).

7 -CARPENTRY WORKS

7.1 General

Carpentry work should be executed as shown on drawings and/or described in the contract documents in a proper manner and in accordance with the specification.
The carpenter is to clean out all shavings, cut ends and other timber waste from work places in the building and remove it from the site, all according to the satisfaction of the engineer.
All timber shall be softwood unless otherwise specified.
The contractor shall verify all sizes on the site by measuring all openings in order to cut wood with exact dimensions.

7.2 Description of Work

The extent of carpentry work is as shown on the drawings. The work includes, but is not necessarily limited to, wood grounds, blocking, nails and the like.

7.3 Quality Assurance

Codes and Standards: Comply with the applicable requirements of following codes and standards:

APA - American Plywood Association.
AWPB – American Wood Preservers Bureau.
U.L – Underwriter's Laboratories.

7.4 Particular

Timber for carpentry work shall be of species and quality suitable for the purpose for which it is to be used.
Samples of every type of timber which the contractor proposes to use in the work shall be sent to the engineer for approval. Each sample shall be labeled and the label shall state the species of the timber and the purpose for which it is to be used.
Timber shall be square, straight, true and shall be free from the following defects:

- Splits, ring checks and soft pitch.
- Hair cracks exceeding 0.25mm wide.
- Checks exceeding 30cm long.
- Checks more than half the thickness of the timber in depth.
- Knots exceeding 1cm mean diameter and/or exceeding 1m distance between their.
- Any size of knots in small timber species.
- Knots exceeding half the width of the surface.
- Decayed dead knots.
- Pitch pockets.
- Loose knots or knot holes.
- Decay and insect attack.
- Moist timber.
- Oil squeezer in timber which is still moist.

The soft wood generally shall have a moisture content limit of 15%. The hardwood shall have a

moisture content limit of 10% and shall have been kiln dried unless otherwise specified. The whole of the timber for joinery work shall be properly stacked and protected from rain and ground moisture.

Where preservation treatment is specified in the contract:
The moisture content of the timber immediately prior to treatment shall not exceed 28% and the timber shall be free from surface moisture and dirt. Treatment is to take place after all cutting and shaping is complete, and care must be taken not to damage surfaces of treated timber. If surface damage or cutting after treatment is unavoidable a liberal coating of preservative is to be made to such areas.
The preservative treatment shall be either:
Creosote applied by vacuum/pressure to BS 144 and 913, or
Copper/ chrome/ arsenic slats applied by vacuum/pressure to BS 4072.

7.5 Submittals

1- Submit shop drawings show full dimensions of each member. Show details of connections, connectors and other accessories. Indicates species and stress grade and other variables in required work.
2- Wood Treatment Data: Submit chemical treatment applied and manufacturer's instructions for proper use of each type of treated material.
3- Pressure Treatment: For each type specified, includE certification by treating plant stating chemicals and process used, net amount of salts retained and conformance with applicable standards.
4- For water-borne preservatives: include statement that moisture content of treated material was reduced to maximum of 15% prior to shipment to the project site.
5- Fire-Retardant Treatment: Include certification by treating plant that treatment material complies with governing regulations and that treatment will not bleed through finished surfaces.

7.6 Product Delivery, Storage and Handling

1- Keep carpentry materials dry during delivery, storage and handling. Store lumber and plywood in stacks with provision for air circulation within stacks. Protect bottom of stacks against contact with damp surfaces. Protect exposed materials against weather.
2- Do not store dressed or treated lumber or plywood out-doors.

7.7 Materials

7.7.1 Timber

1- General: Timber for framing, blocking etc., shall be sound, well conditioned, properly seasoned to suite the particular use and free from defects or combination of defects rendering it unsuitable for the purpose intended. Unless otherwise indicated, timber shall be No.1 yellow pine or No.1 fir.
2- Moisture Content: 15% maximum.

7.7.2 Plywood

1- Concealed Plywood shall be Exterior Type, C-C Grade.

2- Exposed Plywood shall be Exterior Type with medium density overlay on exposed faces.
3- Electrical Panels: If required for backing panels of electrical and communication equipment, provide Interior type plywood with exterior glue, fire-retardant treated.

7.7.3 Anchorage and Fastening Materials

Provide approved type, size, material and finish for each application.

7.7.4 Plywood Covered With Veneer

These sheets are formed of odd layers where each one is perpendicular to the underlying layer and should be ex-factory made with minimum total thickness 4mm unless otherwise specified.
In case of 3-layers for plywood sheet; it is not permitted to exceed the thickness of middle layer than 60% of total thickness of plywood sheet.
But if the plywood sheet consists of more than 3-layers, the total thickness of the two faces and those enclosed layers in which its fibers are in the same direction of faces' fibers; is ranged between 40% and 60% of the total thickness of sheet.
The contractor shall get the approval of the engineer for the source of the plywood sheets.
It is not permitted to combine plywood sheets with thickness less than the specified thickness by any means in order to get the required thickness.
The plywood sheet shall be free from any defects.
The faces of plywood sheet shall be of hard or smooth veneer as per specifications and bills of quantities.

7.7.5 Adhesive material

It is recommended to use highly adhesive material with approval of the engineer.

7.7.6 Plastic Sheets (Formica)

Use fire and moist proof sheets with approved color either shining or mutt. The used sheets shall be approved Britain made or equivalent like (Formica, Arborybe, Upper stop, etc.).

7.7.7 Nails and screws

1- Use nails with appropriate section and length for the work, and do not use weak or bend nails.
2- Use Rawl Plug or Rawl Plastic with nails to fix the wood as recommended by the manufacturer.
3- Soft wood is not permitted for plugs and wedges, only hard wood should be used.
4- Use copper, or chrome nails in case of visible nails, and do not use steel nails in this case.

7.8 Job conditions

1- Time delivery and installation of carpentry work to avoid delaying other activities which is dependent on or affected by the carpentry work and to comply with protection and storage requirements.
2- Framing, furring, nailing, blocking, grounds and similar supports should be performed so that the work will comply with design requirements.

7.9 Wood Preservative Treatments

1- General: treatment of lumber and plywood, where required or indicated as "Treated", is to comply with the applicable requirements of the American Wood Preservers Bureau (AWPB), available form AWPI.
2- Pressure treat the following items with waterborne preservatives for above-ground use, should comply with AWPB LP-2:

- Wood cants, nailing, blocking, stripping and similar members in connection with roofing, flashing, vapor barriers and waterproofing.
- Wood blocking, furring, stripping and similar concealed members in contact with masonry or concrete.
- Kiln-dry wood to a maximum moisture content of 15% after treatment with water-borne preservatives.
- Pressure treat wood members placed in the ground with below-round water-borne preservatives, complying with AWPB LP-22.

7.10 Fire Retardant Treated Wood

- Where fire-retardant treated plywood is specified, comply with AWPB standards for pressure impregnation with fire-retardant chemicals to achieve a flame spread rating of not more than 25 when tested in accordance with UL Test 723, ASTME 84, or National Fire Protection Association (NFPA) Test 355.

  Where transparent or paint finish is shown or scheduled for treated wood, use a fire-retardant treatment which will not bled through or adversely affect bond or finish.
- Complete fabrication prior to treatment, wherever possible, to minimize cutting and jointing after treatment. Coat surfaces cut after treatment with a heavy brush coat of the same fire-retardant chemical.
- Kiln-dry lumber and plywood to a maximum content of 15% after treatment.
- Inspect each piece of plywood after drying; do not use twisted, warped, bowed or otherwise damaged or defective pieces.
- Provide UL label or other equivalent on each piece of fire- retardant treated wood.

7.11 Inspection

The contractor shall examine the substrates and the conditions under which carpentry work shall be carried out and correct any unsatisfactory conditions.
Do not proceed with the work until unsatisfactory conditions have been corrected in a manner acceptable to the Engineer.

7.12 Workmanship

Timber shall be cut and blocked early by enough time to let the wood dries prior to forming.
Sections of timber used in the carpentry work are the net dimensions after cutting, scraping and rubbing the timber.
Make connections with Mortise and Tenon (dove & tail) way and use approved adhesive material to fix them with appropriate wooden nail if necessary.

Through assembling the door components including door frame; use Mortise and Tenon not less than 20mm in length.
Wooden parts should be painted with two coats of primer prior to installation.
Fix wooden frame to the wall using galvanized steel angels (120mm length, 30mm width & 4mm thick) by fixing the angel in the frame using screws and in the wall using cement mortar.
In case of fixing the wooden frame in concrete member; use expandable screws (Philips) with 100mm length and 5mm thick. The screws shall be sunk in the frame and the holes shall be filled with glue mixed with sawdust.
The minimum thickness of frame is 45mm. The frame shall exceed the wall width by not less than 15mm from both sides of wall to fit with plaster work, or 20mm in case of fixing ceramic wall tiling.
Use white cold bitumen coat for maximum 100mm height from bottom of frame legs as well as the back of frame as for moisture protection.
All framing shall be jointed as shown on the drawings, as specified by specification or approval by the engineer.
Hinges shall be designed and fixed so that they will transmit the loads and resist the stresses to which they will be subjected.
Unless otherwise stated; hinges shall be secured with a sufficient number of nails of an approved type.
Use 3-hinges with minimum 100mm length to fix the door with frame. The hinges should be made of brass metal.
All connections exposed to the weather shall be thickly primed except where adhesive materials are used.
No nails, screws, or bolts shall be placed in an end split. If splitting is likely to occur, holes for nails are to be pre-bored at diameters not exceeding 4/5 of the diameter of the nail.
Members of structural units shall be clamped and spiked together before drilling bolt holes. Holes for bolts shall be bored from both sides. A tolerance of 1mm will be allowed in positioning bolt holes.
Timber connectors, where specified, shall be 2 single sides toothed plates for demountable joints and one double sides toothed plate for permanent joint.
Timber shown on the drawings to be plugged shall be properly and securely fixed by means of splayed or expansion bolts.
Timber shall not be built into walls or floors unless this is shown on the drawings. When required, it shall be coated with a wood preservative material suitable for the position in which the member is to be incorporated.

7.13 Installation

1-General: Discard units of material which are unsound, warped, bowed, twisted, improperly treated, not adequately seasoned or too small to fabricate the work with a minimum of joints or the optimum jointing arrangement.
2-Shop Drawings: Comply with details shown on approved shop drawings. Provide lumber and plywood of dimensions not less than those shown.
3- Fit carpentry work to other work. Scribe and cope as required for accurate fit.
4- Set carpentry work accurately to required levels and lines with members plumb and true.
5- Securely attach carpentry work to substrates by anchoring and fastening as shown and as required by recognized standards.

- Provide washers under bolt heads and nuts in contacts with wood.
- Nail plywood to comply with recommendations of the American Plywood Association.
- Countersink nail heads on exposed carpentry work and fill holes.

6- Fasteners:

- Use common wire nails, except as otherwise shown or specified herein. Use finishing nails for exposed work. Do not wax or lubricate fasteners that depend on friction for holding power. Select fasteners of size that will not penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members.
- Install fasteners without splitting of wood, predrilled as required. Do not drive threaded friction type fasteners; turn into place. Tighten bolts and lag screws at installation and retighten as required for tight connections prior to closing or at completion of work.

7.14 Wood Grounds, Nailing, Framing and Blocking:

1- Provide wherever shown and where required for screeding or attachment of other work. Form to shapes as shown and cut as required for true line and level of work to be attached or screeded.
2- Coordinate location with other work; refer to shop drawings of such work, if any.
3- Attach to substrates securely with anchor bolts or other attachment devices as shown and as required to support applied loading. Countersink bolts and nuts flush with surfaces, unless otherwise indicated. Build into masonry as work progresses, cutting to fit masonry unit size involved. Anchor to formwork before concrete placement.
4- Provide grounds of dressed dey-beveled lumber not less than 38mm wide and the thickness required to bring face of ground to exact thickness of finish material involved. Remove temporary grounds when no longer required. Where indicted as permanent grounds, provide treated lumber.

7.15 Wooden door

Make the wooden door according to approved shop drawings.
In case of flush compressed doors, make the internal fillers from white wood with 3cm maximum distance between fillers, and 3cm minimum width for each one. Make the architraves using hard wood unless otherwise specified.
Forming fillers as specified in the drawings and make a tongue through the longitudinal part of the frame with minimum 1cm length.
Doors which their connections include gaps, shall be rejected.

7.15.1 Wooden doorframe

Use class (1) wood to make the frames with appropriate width and 4.5cm thick with appropriate architraves from both sides of the frame.
Fix the frame with 10cm minimum length under the tiling level.
Coat the frame with primer coat then two coats of white cold bitumen for the back and buried part before fixation.

7.15.2 Metal accessories

Use high quality accessories for doors made of brass or chrome, approved by engineer.
Use first class, approved quality locks and handles according to the type specified in the particular specifications.

8 PAINTING WORKS

8.1 SCOPE

The Specifications cover paint work to exposed concrete and plastered surfaces, wood work, ferrous and non-ferrous surfaces in accordance with the schedule of finishes, drawings and bill of quantities and as directed in writing by the Engineer.

The term "Paint" as used herein includes emulsions, enamels, lacquers sealers and other coatings, organic or inorganic, whether used as prime intermediate of finish coats.
All painting works shall be applied by skilled workmen experienced in this work.

8.2 MATERIALS

8.2.1 Materials in General

The materials to be used shall be of the best quality and of approved types, obtained from an approved manufacturers *and these material approved from "**the ministry of Public works and population**"*.
All paints shall comply with the following requirements:

- The product shall be thoroughly mixed.
- The color of the paint shall match the approved sample.
- Paint shall show no evidence of cracking, chipping of flaking.
- Paint in the containers during and after application shall not be abnormally pungent, offensive or disagreeable.
- Paint shall show easy brushing, good flowing and spreading and leveling properties. These properties shall be demonstrated on test specimens at the request of the Engineer. Coats that have any noticeable pull under a large brush and that show poor spreading and flowing properties will not be acceptable.
- Paint shall dry to a uniform, smooth, flat or Semi-gloss finish under ordinary conditions or illumination and wearing. There shall be no laps, skips, high-lighted spot or brush marks. Tinted paints shall dry to a uniform color.
- Recoating of a previous painted surface shall produce no lighting softening or other film irregularities.
- Paint materials should be tested by an authorized and approved laboratory in compliance with the B.S or Palestinian Standard.

8.2.2 Flint-coat Protective Coating:

Flint-coat protective coating on fire escape staircase floors shall be colored, "Decorate". The product of "Flint-coat" or approved equivalent shall be especially compound acrylic resin latex color coating, heavy bodied, flexible and abrasive resistant.

8.2.3 Knotting:

Shall be composed of dissolving shellac or other resin remains unaffected by the resinous materials in the timber leaching into the paint film and causing discoloration or defective drying.

8.2.4 Mordant Solution

Shall be composed of a solution slightly acidic in nature and containing solvents, for applying to new smooth metallic surface to remove grease, organic soaps and provide a physical key and shall be obtained from an approved supplier.

8.2.5 Fillers

Shall be "Polyfilla " or approved equal.

8.2.6 Stopping

Shall be hard stopping composed of white load paste, and other fillers obtained from an approved supplier.

8.2.7 Putty Filler

Shall be composed of white lead and dry filler mixed with pure linseed oil, the content of the white lead shall be not less than ten percent (10%) of the mixture by volume and shall be obtained from an approved supplier.

8.2.8 Thinners

Shall be approved turpentine or white spirit, except where the paints are specified to be water thinered, fresh water shall be used.

8.2.9 Stain

Stain for woodwork shall be of an approved branch of oil stain complying with B.S. 1215.

8.2.10 Color

Shall be pure tiny color that will easily dissolved and mix with the various coatings and shall conform to the requirements of B.S. 1014: 1961 “Pigments for cement, magnesium oxy-chloride and concrete”.

8.2.11 Primers

Primers applied to surfaces of different materials shall be as follows:

- Interior or exterior plastered surfaces: Alkali resistant primer as recommended by the manufacture.
- Ferrous Surfaces: Lead based or zinc Chromate and Calcium Plum bate as recommended by the Manufacturer.
- Non-ferrous surfaces: Mordant solution of an approved brand and rust inhibiting primer.

- Woodwork Surfaces: Leadless grey primer in accordance with B.S. 2524 latest edition.

8.2.12 Undercoating Paints

For exterior or interior shall be as follows:

- One coat of whitewash or color-wash as shown on the Schedule of Finishes and the Drawings.
- White lead bases undercoating in accordance with B.S. 2525, Colors shall be similar to the finishing paint.
- Other undercoating paints to be applied as recommended by the manufacturers of the finishing paint.

8.2.13 Finishing Paints

Shall be as follows unless otherwise indicated on the Drawings:

- Interior plastered surfaces and exposed concrete surfaces as shown on the Schedule of finishes and the drawings:
  Float enamel paint or approved emulsion paint for interior use of an approved color and supplier.
- Exterior exposed and plastered surfaces as shown on the Drawings:
  Approved emulsion paint for exterior use of the color indicated on the Drawings.
- Interior woodwork surfaces other than hardwood:
  Oil paint semi-gloss finish of an approved manufacturer.
- Hardwood surfaces:
  Approve oil stain and ducco spray, or flat enamel paint.

8.3 WORKMANSHIP STATIONARY

8.3.1 General

The Contractor shall submit to the Engineer for approval; the brand and quality of the paints he proposes to use.
If approval is given to a brand of paint the contractor shall use the primers, undercoats etc… manufactured or recommended by the manufacturers of that brand.

All paints to be used under this contract shall be delivered and stored on the Site in sealed, labeled containers, a minimum of 30 days prior to application by the contractor. As the materials are in the Site, samples of each material shall be obtained at random from sealed container by the Engineer in the presence of an authorized representative of the contractor.

Samples shall be clearly identified by commercial name, type of paint and intended use. If judgment is necessary by the Engineer the paint samples may be tested in a laboratory designated by the Engineer at the contractor's expense, complete color charts for the paints to be used shall be submitted to the Engineer for approval.
Pigmented paints shall be furnished in containers not larger than 25 kgs. All paints shall be produced that have a minimum of 2 years satisfactory field services.

Mixing and application of paint shall be in accordance with the Specifications of the manufacturers concerned, and to the approval of the Engineer.
The mixing of paints of different brands before or during application will not be permitted. No dilution of painting materials shall be allowed except strictly as detailed by the manufacturers and as approved by the Engineer.

Hardware, hardware accessories, machine surfaces, plates, lighting fixtures and similar items in place prior to cleaning and painting, which are not intended to be painted, shall be removed or protected prior to painting operations and repositioned upon completion of painting work as directed by the Engineer.
Equipment adjacent or against walls shall be disconnected by workmen skilled in these trades and moved to permit the wall surfaces to be painted, and following completion of painting shall be replaced and reconnected.
Cleaning solvents shall be of low toxicity. Cleaning and painting shall be so programmed that dust and other contaminants from the cleaning process will not fall on wet or newly painted surfaces.

Brushes, pails, kettles, etc… used in carrying out the work shall be clean and free from foreign matter. They shall be thoroughly cleaned before being used for different types or classes of material.
No exterior or exposed painting shall be carried out under adverse weather conditions such as rain, extreme humidity, dust storms, etc.
Painting shall preferably be shaded from direct sun light to avoid blistering and wrinkling. Wherever possible, painting of exterior surfaces shall "follow" the sun such that it is carried out in shadow.

Edges, corners, crevices, welds and rivets shall receive special station to insure that they receive an adequate thickness of paint.
All cracks and holes shall be cut out properly square and made good with suitable hard plaster or cement sand mix as appropriate such repaired portions being allowed to dry out and sandpapered smooth.

8.3.2 Plastered Surfaces with Emulsion or Enamel Paint

Such works shall be allowed to dry out completely before carrying out the painting operation. Plaster applied in the winter season shall be at least five weeks old and that applied in the summer shall be at least two weeks old before commencing painting operations.

Preparation of surfaces shall consist of vigorous brushing and rubbing down to remove loose surface material and dust.
Surfaces shall then be left for a week to determine whether efflorescence re-appear in which case it shall be brushed of dry and a further waiting period of one week allowed.
Alternatively, the surfaces may be neutralized by brushing on a solution of 3 percent phosphoric acid and 2 percent zinc chloride and removing all loose particles after drying. No painting shall be carried out until the Engineer is satisfied that no efflorescence is occurring.

Where required by the Engineer one or two coats of "Alkali resistant" primer shall be applied, sufficiently thinned to penetrate the surface.
The first coat of stopping shall be applied after the primer coat dried out completely and the second coat after the first undercoat application. Each coat of stopping shall be allowed to dry and harden thoroughly and shall then be rubbed by sandpaper until smooth surface is

achieved.
A minimum of two approved undercoats recommended by the manufacturers of finishing coat shall be applied by brushing well into the surface. Each coat shall be allowed to dry and harden thoroughly before the next coat is applied.
The finishing coat of paint shall be applied after the completion and testing of the mechanical and electrical works.

8.3.3 Ferrous Surfaces:

Surfaces shall be thoroughly cleaned to remove and dirt, wire brushed and scraped to remove scale and rust. One coat of approval putty shall be applied on the surfaces and left to dry for at least twenty four (24) hours; surfaces shall then be rubbed by sandpaper or other approved means before primer is applied.

One coat of rust inhibiting "Galvanized" primer or other approved equal shall be approved equal shall be applied by brushing well into the surface and shall be allowed to dry and harden thoroughly before the application of subsequent coats.
If ferrous works delivered primed, the surfaces shall be examined to ascertain that the primer coat is hard. If not satisfactory the primer coat shall be removed and the surfaces cleaned to remove grease and dirt and reprimand as described above for ferrous. Abraded spots on shop-coated surfaces shall be wire-coated surfaces, shall be wire-brushed and touched up with same materials as the shop-coat.

The undercoat and finishing coat shall be chlorinated rubber paint interior or exterior grades and used all in accordance with the directions of the approved manufacturer.
Chlorinated rubber paint, interior or exterior grades, shall not be applied in damp, foggy or freezing weather or to any surface which is not perfectly dry. Ferrous surfaces shall be thoroughly cleaned free of all rust, scale, dirt, oil and grease, etc….

Brush application is recommended although this material may be sprayed if desired, only special thinners produced by the approved manufacturer may be added to achieve the spraying consistency required.
Special approved thinners may be used for cleaning brushes after use.
Ferrous works such as frames, covers to expansion joints, etc… which are to be built into walls shall be primed before installation.

8.3.4 Non-Ferrous Surfaces

Galvanized steel surfaces to be painted shall be solvent-cleaned or painted with mordant solution and shall be primed with Poly-zinc before the application of paints as described above for ferrous surfaces.

8.3.5 Wood Surfaces

Wood surfaces except surfaces to be given natural finish or other finish specified shall be primed, undercoated twice with undercoating paint as recommended by the manufacturer of finishing coat and final coat with semi-gloss enamel paint of approved manufacturer.
Wood surfaces shall be scrubbed with abrasive paper to obtain a smooth surface. Surface mould where exist shall be removed by washing, rubbing down and burning off as necessary. Oil wood shall be swabbed with white spirit. Resinous exudation and large knots shall be removed and replaced by approved filler or knot sealer and the surface shall be primed.

Parts of wood to be enclosed in walls shall be primed unless already impregnated with creosote or other preservative. Priming shall be brushed on and a minimum of two coats applied to end grain. After the primer coat is hard, all cracks, holes, open joints, etc… shall be made good with hard stopping and rubbed with fine abrasive paper. If the first process of stopping found to be unsatisfactory it shall be repeated after the first undercoating is applied and well it shall be repeated after the first undercoating is applied and well dried.
Priming of joinery shall be applied only on the site after the Engineer has approved such joinery and before it is fixed. The two undercoat paints shall be applied on wood doors, panels, etc. before they are fixed, to ensure that the bottom and top edge and sides are thoroughly painted. The finishing coat of paint to such wood doors, panels etc… shall be applied after fixing in position and as directed by the Engineer.
Wood surfaces specified as stained shall only be rubbed down with fine abrasive paper and two coats of oil stain deco sprayed to the satisfaction of the Engineer.
Wood surfaces specified as varnished shall be thoroughly cleaned down of all dirt, oil, grease, etc… and rubbed to a smooth finish, knots shall be treated with knotting and 2 coats of approved oil varnish applied.

8.3.6 Flint coat Protective Coating

Two coats of flint coat Decorate colored coatings should be applied at normal dilution i.e.: two (2) volumes Decorate and one (1) volume water, using no primer. The first coat should be allowed to dry before applying the second one.

8.3.7 Oil Stain Finish to Woodwork

The stain finish to woodwork shall be an approved manufacturer’s oil stain system applied strictly in accordance with the manufacturer’s instructions.
All surfaces are to be thoroughly dry and cleaned and sanded down and all nail holes or similar defects shall be filled and leveled up with approved hard stopping
The finish shall be applied in two coats. The first coat shall be pigmented stain wax brush applied. The surface shall be allowed to dry for 2-10 minutes and then rubbed with a cloth in rotary motion to remove excess stain and produce an even surface.
The first coat shall be allowed to dry completely before application of the second coat.
The second coat shall be natural (clear) stain wax and buffed.
The Engineer shall select the stain color and the contractor shall allow for preparing sample panels for the Engineer’s approval and these sample panels will provide the standard for the work.

9 -ROOFING, WATERPROOFING AND THERMAL INSULATION

9.1 SCOPE

These specifications cover, waterproofing, roofing and thermal insulation to be used for underground structures, floors and roof decks required for the Works in accordance with the Drawings, Bills of Quantities and as directed in writing by the Engineer.

9.2 Preparation

All surfaces must be clean sound, and free from oil, grease and all loosely adherent materials. Wire brush, sand blast or grit blasting may be used to remove any surplus adhered to concrete and steel. The contractor must submit a request for all materials for Engineer approval.

9.3 MATERIALS

9.3.1 Damp proofing

All substructures, floors of ground floor of kitchens, toilet and bathrooms have to be painted with a waterproofing liquid.
Before application of primer and bituminous layers, angle fillets of concrete should be constructed at the wall boundary of the bathroom, toilet and kitchen with dimension of 7 cm* 7 cm and working mix cement & sand by 1:3. Thresholds of the same mix must be implemented at the bathroom, toilet and kitchen doors.

9.3.2 Waterproofing of exterior walls

This will be added to the exterior plastering of walls. It's an integral concrete waterproofing compound that will reduce moisture absorption in the plastering mixture.

In case of buried masonry, the joints between courses should be ranked out to 0.5cm, and then the walls to be plastered with rich cement mortar 0.5cm thick by 1:1 cement –sand ratio.
The bitumen primer should be applied after the plastering is totally dried and left enough time as per instructions of the manufacturer. Two coats of hot bitumen 75/25 should be applied perpendicular to each other, unless otherwise indicated, so that any holes, cracks or any defects are not been noticed.
In case of concrete walls; any loose particles and steel ties should be removed and accordingly patched with special cementeous material prior to application of the primer and bituminous coats as previously described.

9.3.3 Waterproofing of the roof

9.3.3.1 Lightweight Concrete

A sloping screed consisting of lightweight concrete screed shall conform to B.S.3797:

lightweight aggregate for concrete. The lightweight aggregate shall be such a Vermiculite, Alveolite, etc…. aggregate of an exfoliated micaceous mineral aggregate incombustible and chemically inert, obtained from an approved manufacturer, graded and mixed in accordance with the manufacturer's instructions.
The lightweight aggregate shall be delivered to the Site in the manufacturer's sealed and branded containers which shall be clearly marked to show the grade of lightweight aggregate contained therein. They shall be stored in a covered shed with floor raised off the ground and bags stacked not more than 3.00 meters high.
Process of damp-proofing layers should not be started at least four days after curing of concrete screed finished and dried.
Cement angle fillets 10cm * 10 cm must to be executed at the boundary of roof parapet with cement & sand mix by 1:3

9.3.3.1.1 Mixing Proportions

The lightweight concrete screeds shall be measured, mixed applied and cured in accordance with the manufacturer's instructions and to the satisfaction of the Engineer.
Gauges boxes shall be used for the measurement of light- weight aggregate and the following mixing table 9-1 shall be strictly observed.

Table 9-1: Mixing of light- weight aggregate

Nominal Mix	Lightweight Aggregate	Cement Contents	Water
8:1	1:00 Cubic Meter	150 kgs.	200 Liters

As overall, the maximum bulk dried density of the lightweight concrete should not exceed in anyhow 1200kg/m2.

9.3.3.1.2Mixing Methods

Mixing may be carried out by hand or by approved machine in accordance with the following procedures:

By Hand

The measured quantity of lightweight aggregate shall be poured out onto a clean dry level surface and sufficient water added only to give workability. Mixing shall be carried out until the water has been distributed amongst the lightweight aggregate. The cement shall be added and further mixing shall take place until all materials are uniformly distributed.

By Machine

The machine used for mixing shall be an approved countercurrent rotating paddle type mixer operating at the speed recommended by the manufacturer. The water shall be placed in the mixer followed by the lightweight aggregate and mixing shall continue until the water has been distributed amongst the lightweight aggregate.

The cement shall then be added and further mixing shall take place until all the materials are uniformly distributed.

It is extremely important to ensure that the mixing period is kept as short as possible in order to prevent compression of the lightweight aggregate. For this reason ordinary concrete mixer of the revolving drum type are unsuitable and shall not be used.

If an approved mixing machine is not available then the mixing shall be carried out by hand.

It is also important that the water content be kept to the minimum possible to allow for the proper hydration of the cement. Sloppy mixes shall not be used. An even consistency free from lumps and excess water is required. As a Site test for consistency, a handful of the mix when firmly gripped should just release water.

Placing of the lightweight concrete mix shall take place immediately after mixing. The lightweight concrete screed shall be laid to falls in alternate bays not exceeding 16.00 square meters in area to a minimum depth of 50mm. The lightweight concrete mix shall be carefully spread by means of a rake to a depth 12.5% greater than the finished thickness required and shall then be lightly troweled down to its finished thickness. The mix shall not be tamped, vibrated or compressed with heavy implements.

The lightweight concrete screed shall be cured by covering with damp Hessian for a period of seven days and during this time the screed shall not be subjected to traffic to any kind.

After curing the light weight concrete screed shall be protected by a layer of cement and sand (1:4) mix. This topping shall be well troweled in to ensure proper adhesion with the lightweight concrete screed and shall have a minimum finished thickness above the lightweight concrete screed of 30mm and shall be finished flat and true with a steel trowel.

The screed and topping shall be water cured with damp hessian for a period of 7 days then left for 4 days drying before receiving waterproofing system.
Alternatively the cement and sand topping may, with the approval of the Engineer be applied immediately after troweling the lightweight concrete screed. Lightweight concrete screed, cement and sand topping shall not be laid during rain.

9.3.4 Waterproofing

An application of Plastomeric Bitumen-Polymer waterproofing sheets (APP) with splayed chips must be carried out after application of corresponding primer as instructed by the manufacturer. Membranes should not be less than 4mm in thickness or 4.5kg/m2.
Application process of the membranes must be done by torching them to the specified temperature prior to adhering to the roof deck. The pricing will include overlapping 10cm between sheets, upstands up to 15cm, dressing into storm water traps, etc.
Measurement of the membrane and underlay screeds will be for the horizontal projection of the deck unless otherwise described

9.3.4.1 Workmanship

Prior to the beginning of the roofing works, the Engineer and the roofing superintendent shall proceed to the inspection and approval of the receiving surfaces, the upstands at roof edges, the drains, vent pipes and other venting devices, the construction joints etc.

The contractor will be notified in writing of all defects of the flat surfaces or details and work shall not be preceded until such defects have been corrected.

One coat of primer is painted over the entire surface. Installation of the bituminous layers shall be carried out in conformity with the manufacturer's specifications and using propane torch welding only.
Asphalt coatings shall be softened but not melted as to avoid superheating using a single-

nozzle torch of adequate size. Rolls shall overlap 75mm on sides and 150mm at ends. All inadequately welded seams will be refused. All superheated areas or parts will be refused and will require adequate repair in accordance with the degree of deterioration of the membrane.

Air blisters, wrinkles impact and tearing marks and protective granules pounding marks are not admissible. Should these defects occur, roofing works shall be carried out again.

9.3.4.2 Bituminous Flashings

A plain underlay bonded to the support with previously applied primer coating or welded to it with propane torch. This underlay shall be unrolled parallel to the upstanding element in one meter width extending 150mm onto the current surface underlay.

Apply the current surface-finishing layer onto the flashing underlay and then recover with the flashing-finishing layer extending 200mm onto the current finished surface.
This layer shall be welded with propane torch in full adherence that no air is entrapped between layers. Side and end laps shall be staggered over underlay seams and 75mm wide.

9.4 WATERSTOPS

9.4.1 General

Rubber water stops or PVC water stops shall be provided in the joints in concrete where shown on the Drawings. If not shown on the drawings the minimum width of the water stop shall be 200mm.

The Contractor shall submit with his Tender a detailed description of the water stop he intends to use, accompanied by a drawing showing the shape and size of the water stop, the name of the manufacture, and the methods to be installing and splicing the water stop, which shall be in accordance with the requirements detailed below.

The Contractor shall also furnish all labor and materials for making field splices in all water-stops. The Contractor shall take suitable precaution to support and protect the water-stops during the progress of the work and shall repair or replace any damaged water-stop.

All water-stops shall be stored in as cool a place as practicable, preferably at 21 C^0 or less. Water-stops shall not be stored in the open or where they will be exposed to the direct rays of the sun. All water-stops shall be protected form oil or grease.

9.4.2 Rubber Water-stops

The rubber water-stop shall be fabricated from a high-grade, tread-type compound. The basic polymer shall be natural rubber or a synthetic rubber. The material shall be compounded and cured to have the following physical characteristics: yield strength 10.2 N/mm2, elasticity of 400% at braking strain.

9.4.3 Installation

The water-stop shall be installed with approximately one-half of the width of the material embedded in the concrete on each side of the joint. Care shall be exercised in placing and

vibrating the concrete about the water-stop to insure complete filling of the concrete forms under and about the water-stop, and to obtain a continuous bond between the concrete and the water-stop at all points around the periphery of the water-stop. In the event the water-stop is installed in the concrete on one side of a joint more than one month prior to the scheduled in date of placing the concrete on the other side of the joint, the exposed water-stop shall be covered or shaded to protect it from the direct rays of the sun during the exposure. Before placing the concrete on the other side of the joint the projecting half of the water-stop shall be carefully cleaned.

The contractor shall take suitable precaution to support and protect the water-stops during of the work and shall replace at this own cost all damaged or deteriorated water-stops.

9.5 THERMAL INSULATION

Criteria, design aspects, implementation methodology and relevant materials of the thermal insulation must be according to the Palestinian Code for Energy Efficient Building and using the supplementary Guidelines.

10 -STONE WORKS

10.1 Introduction

The masonry stone is one of the oldest building materials known in the history of construction that had strongly influenced the architectural style and construction system in the Middle East.
By given the unique quality of the masonry stone, it is considered as one of the most prevailing and essential items in the building construction until the twentieth century as introduced other materials.
Natural masonry stone has several sources in the world especially in the Middle East including Jordan, Palestine, Saudi Arabia, Morocco and other.
The masonry stone specifications cover all the stone works intended to be used for external walls including the decorations at elevations, architectural openings, arches, and copings covering the parapet of the roof.
All these required works should be in accordance with the drawings, bills of Quantities and as directed in writing by the supervisor Engineer.

10.2 Categories of stone in Palestine

10.2.1 According to the classification of compounds, which contains:

- Stones contain wire mainly stone such as quartz
- Stones containing silicate minerals and other silicate minerals that contain Feldspar which is aluminum silicate with lime and potassium with color red or pink, or containing aluminum silicate with iron then the color becomes brown black.
- Calcareous stones contain minerals which are either calcite (calcium carbonate) or dolomite with a calcium magnesium carbonate.

10.2.2 Classification by region of stone:

- Al Shoyokh stone, this type of stone is extracted from Hebron, which is more common in Gaza Strip.
- Kabatia stone, this type of stone is extracted from Jenien.
- Anjasa stone, this type of stone is extracted from Hebron, which is most common in the Gaza Strip.
- Jamma'in stone, this type of stone is extracted from Nablus, which is a high price stone, and hard formation with a high quality).
- Yatta stone, this type of stone is extracted from Hebron.

10.2.3 Classification by engraving formats:

The masonry stone is craved in multiple formats including:

10.2.3.1 Stippled stone (Milattash) format

This type of stone format is achieved by engraving all over the stone surface using a pointed carving chisel distributed regularly as possible.
The depth of Stippling groove should not be more than 3 mm in stone class A, and 5 mm in stone class B and C.

10.2.3.2 (Misamsam) stone format

This type of stone format is achieved by engraving the stone surface using a fork head chisel equal and parallel lines horizontally or vertically or at angle of 45 degrees.
The depth of groove should not be more than 3 mm in stone class A, and 5 mm in stone class B and C.

10.2.3.3 Rough stone (Tobzeh) format

This type of stone format is achieved by keeping the stone in its original rough surface, but refining works should be done around the edges of the stone.
The depth of refining works should be more than 90 mm from the edges and not less than 50 in stone class A, and 40 in stone class B and 30 in stone class C.

10.2.3.4 (Tabbih) stone Format

This type of stone formats is achieved by engraving intensively as required on the stone surface using a spiky-head hammer grade 10, 12, or 14 to keep it free of cavities, or other stone defects.

10.3 Advantages of natural stone

1. Color consistency and not influenced by natural erosion agents
2. Thermal insulation and firmness and durability
3. Maintain the natural form and flair.
4. Lack of need for maintenance.
5. Relevance for all weather conditions.

10.4 Defects in stone

1. Holes: in the form of pockets within the stone make it a weak over time.
2. Impurities: in the form of pockets within the stone filled with shells.
3. Seams: a shakes within the stone filled with materials mainly crystallized calcium carbonate.
4. Races: the pockets filled with lime which distorts the stone and makes it weak as well.
5. Irregularities of colors: the regular color of stone is very important advantage in terms of architectural appearance and durability of stone, that determining the acceptance of stone or not.

10.5 Stone Industry

The stone industry process is going through several stages.

1. Extracting of natural stone from stone quarries in the form of blocks that go through cutting process to the required sizes and volumes.
2. Stone carving using different kinds of chisels. The stone surface should be chipped manually to be fitted with the required formats.
3. If a saw is used in the Stone cutting process, the inner edges of stone should bi-chipped to increase the contact between the stone and the backfilling concrete.

10.6 Materials

10.6.1 Technical Specifications for masonry stone

1. The masonry stone in its different shapes and formats that intended to be used in walls construction should be of high quality and free of defects such as holes, impurities, seams and shakes, races, irregularities of colors, structural weaknesses and other defects that would tend to increase unduly the deteriorations from natural causes.
2. Should be regular in color, and remains constant through the time.
3. Samples of stone materials and dressing shall be submitted for the Engineer's approval 30 days before delivery of any such material to the Site.
4. All stones shall be selected well in advance of the time required and passing through the physical and laboratory test as the following table:

Table 10.1 : Illustrates the Test Parameters and Values for the Masonry Stones

TEST	STANDARD	TEST TIME (DAY)	CLASS A	CLASS B	CLASS C
Dry density g/cm2	ASTM C97	3	2.56	2.45	2.16
Compression Resistance kg/m2	ASTM C170	2	800	700	600
Flexural Resistance kg/cm2	ASTM C99	3	55	47	28
Sear Resistance kg/cm2	ASTM C97	3	6.9	5.2	3.4
Erosion & abrasion	ASTM C241	3	≤1%	≤1%	≤1%
Water absorption	ASTM C97	3	3%	4.3%	7.5%

5. Stone Dimensions
   - The height of mason stone is 25 cm or 12.5 cm and other sizes can be selected depending on the nature of the project.
   - The masonry stone length should be between 35 – 70cm, while the length of small pieces that used to complete the facade should not be less than 1.5 stone height.
6. Stone thickness: The thickness of masonry stone according to the Jordanian specifications should be between 5 - 7 cm of the stone used in the facades building and 3 cm of the stone used in the facades cladding or tiling.

10.6.2 Backfilling Concrete:

The backfilling concrete used for the Stone construction should be concrete (B-150) where the design compressive strength of the concrete should not be less than (185 kg / cm 2) and the quantity of cement at a minimum of (260 kg / m 3).

10.6.3 Wire meshes reinforcement

Wire mesh reinforcement of spacing 20cm*20cm and ø8 mm should be fixed to the façade concrete block by anchors with distance does not exceed 60 cm in two directions.

10.7 Workmanship

The contractor should provide stone samples for the engineer approval and the approved stones

to be kept with the engineer during of the implementation of the work until completion, and should set up mockup of the stone facade for the Engineer's approval before executing any pointing.

The total thickness of stone building and concrete backing shall be as shown on the approved shop drawings.

All stones shall be cleaned and thoroughly wetted before setting up.

The back surface of the stone should be chipped well in terms of increasing the contact between stone and concrete.

All stone courses should be hand placed, carried up in a uniform manner. Not more than 2 courses are allowed to rise above one another at the same time .The joints must be solidly bedded with full mortar and fully squeezed out.

The mortar for bedding will consist of mixture of cement, fine aggregate size (1.18mm), and clean sand with ratio 1:2:1 respectively.

The period of time allowable for using the mortar in masonry stone works should not be more half an hour

The vertical overlapping between stone courses should not be less than 25cm unless otherwise mentioned.

The horizontal and vertical joints between stone courses should be 5mm in width, and to ensure even and regular width of beds and joints when setting up stones. The Contractor shall use hardwood wedges to ensure close and regular gaps between beds and joints.

The horizontal and vertical joints should be straight and perpendicular to each other and should be cleaned and grooved in depth of not less than 1.5 cm.

All stone courses, stone arches, and any architectural decorations should be well supported by convenient shuttering works according to the engineer's instructions and under the contractor's responsibility for any damage occurred of any kind.

A holes of 2.5cm depth (2 holes at least) on the upper surface of each stone , then a galvanized wire of ø 4mm, Z-shape should be fixed in the holes with adhesive paste and tied to the wire mesh reinforcement.

Care should be exercised when casting the backfilling concrete behind the stone courses, that should gradually with layers' doesn't exceed 20cm thickness for each layer and in a period of time between layers of 1 hour at least.

Backfilling concrete for masonry stone should be from 5 - 8 cm thickness, unless otherwise mentioned.

Detailed shop drawings for all stone works and installations should be submitted and approved by the supervisor engineer, clarifying the method of installations, dimensions and sizes, types, formats, width of joints, etc.

10.8 Stone cleaning and Joints grouting (TAKHEEL)

After completion of the installation of stone, hardwood wedges should be removed, then the stones are cleaned from the suspended dirt by one of two ways either by sand blasting or by grinder machine with wire brush.

The mortar used for grouting works should be consists of mixture of white cement, fine aggregate size (1.18mm), and clean sand with ratio 1:1:1 respectively, while the coloring of the mortar should according to engineer's instruction.

Types of grouting (TAKHEEL).

1. flush: the grouting should be flat with the face of the stone and polished well.
2. Grooved: the grouting concavity should be half circular with diameter (5 mm) and depth (3 mm) of the surface of the stone.
3. Recessed: the grouting depth and width should be according to instructions and

specifications, where the recessed grouting width should not be less than (4mm) of the depth of the joints.

10.9 Quantity measurements for mason stone works

All stone works quantities should be measured by square meter for all kinds, types, stone arches, architectural openings, and façade decorations unless otherwise mentioned, taking in consideration that the price includes the installation of scaffolding duration of the implementation, wire mesh reinforcements works, backfilling concrete works, Stone cleaning and Joints grouting and all needed works according to engineer's instructions .

11 -PLUMPING AND SANITARY INSTALLATIONS

11.1 Scope of work

The Contractor shall furnish all labors, materials, equipment tools, appurtenances, services and temporary work to provide and complete the several plumbing and drainage systems all in perfect working order. This work shall include but not be limited to the following:

- Excavating, backfilling, breaking in wall, concrete encasement and reinstatement works.
- Plumping fixtures.
- Water supply systems including cold and hot water services.
- Waste disposal system.
- Rainwater services.
- External gravity sewer network.
- Fire fighting system.
- Gas system.
- Water tanks and water pump.
- Testing of all piping systems and equipment and other devices to demonstrate that the entire installations are in perfect working order.
-

All fixtures and materials shall be brand new bearing stamped ratings as required and must be approved by the Engineer prior to their use.

The foregoing sub-paragraphs are not intended to itemize all works required by this section of the Specifications and are only for the purpose of outlining the extent of work for the guidance of Tendering.

11.2 General Description of the work

The sanitary works in the building shall consist of all water supply to and water discharge from all the sanitary fixtures.
Water distribution to all floors is effected from a roof tank fed from the main city network.
Hot water is generated by means of water heater or solar system and stored in hot water storage tank.
Drainage of the ground floor is discharged by gravity from individual points to a system of manholes which will be later discharged to any close outlet.
All riser branches must be provided by elbows, Tees or nipples with gate at the point of connecting with branches.
Clean out opening must be provided where shown on drawings and where required.
Slope of drain pipes to be 1cm/mr unless otherwise indicated.
Vent for sewage pipes to be 1 meter above finished roof and including galvanized wire dome grating.
Where vent pipe penetrates the roof slab; roof finishes and waterproofing material must be carried up around the pipe and must be closed with vent cap to prevent water penetration, all to the approval of the Engineer.
Fire fighting in the building is achieved by a wet riser system and in certain locations by portable fire extinguishers as shown in approved shop drawing.
Rain water is collected from roof and discharged to any nearby outlet as shown on approved shop drawing.

11.2.1 Drainage and Drain system

The external pipes shall be made of un-plasticized polyvinyl chloride (U.P.V.C.) from approved made unless otherwise noted according to the approved shop drawings.
The internal pipes shall be made of polyvinyl chloride (P.V.C.) or propylene (P.P) from approved made unless otherwise noted according to the approved shop drawings. Pipes shall be laid in position by means of leveling instrument.

11.2.2 Water Distribution Networks

All the materials used in the main water distribution lines are galvanized steel pipes, grade B and approved made unless otherwise specified. All the internal cold and hot water pipes will be galvanized steel grade B or Polyethylene pipes (Golani system) as indicated in the drawings and bill of quantities, all per specifications and engineer's approval.
All the under ground pipes shall be galvanized steel coated with bitumen and wrapped with insulation tape as directed by the engineer unless otherwise specified.
Where pipes emerge through walls, floors or ceilings; they should be passing through sleeves and insulated with tape over bitumen coats.
Wherever galvanized steel pipes are used for hot water, approved heat insulator should cover the pipes in addition to bitumen coats.
Fire fighting pipes will be galvanized steel pipes and as in the approved shop drawings.

11.3 Pipe Installation

All piping shall be properly supported or suspended on stands, clamps, hangers, etc. of approved made. Supports shall be designated to permit free expansion and contraction while minimizing vibration. Pipes shall be anchored as directed by means of steel clamps securely fastened to the pipe and rigidly attached to the building structure. Screw threads shall be cut clean and true and joints made tight without caulking. Reducing fittings shall be used to change pipe size, and reductions to be made with eccentric reducers. Short radius fittings shall not be used.
Pipe work shall confirm fully of the following requirements:

- Piping shall be properly graded to secure easy circulations and prevent noise and water hammer. As much pitch as space conditions allow must be given. Capped dirt pockets to be installed at all riser heels, low points, and other places where dirt may accumulate. Allowance must be made for proper provision for expansion and contraction in all portions of pipe work to prevent undue strain in piping. Expansion joints to be installed as directed by the Engineer.
- All fittings such as elbows, tees, bushes, etc. shall be of best quality, foreign made or approved made [Class A] according to local standard with smooth interior surfaces. Approved screw unions or spherical joints shall be installed at trapped instruments, etc. and where else directed to permit easy connection and disconnection. Final connection to all equipment and fixtures shall be made in a manner that will permit the complete removal of any fixture or any piece of equipment without cutting of pipeline. If after the plant is in operation any system do not circulate quickly and noiselessly [due to trapped or air bound connections]. The Contractor shall make proper alternations in these defective connections. If connections are concealed in furring floors or ceilings, the contractor shall bear all expenses of tearing up and rebuilding construction and finish.
- All mains shall have a slope of not less than 5mm in 3 meters in direction of flow. All

branches shall have a slope of not less than 1mm in 3 meters towards the main. All branches from mains shall be connected at the angle of 45 if possible. Each piece of pipe and each fitting shall be carefully inspected on the inside to see that there is not defective workmanship on the pipe or obstructions in the pipes or fittings. Joints in all threaded piping shall be jointed using red oxide lead and boiled in.

- Straight elbows, bushing, long screws or bull head tees shall not be installed, and all offsets shall be made with fittings. Pipes shall not be bended at any time.
- Pipe work shall be installed in manner to allow for ease of air escape and system draining. It shall be endeavored to obtain this naturally by gravity. However, where conditions don't permit it an automatic air vent shall be installed at all air pocket locations and drain gate valves shall be supplied and installed at all low points and risers legs or as shown on drawings.

Before turning the project over to owner, system shall be thoroughly flushed of all dirt and foreign matter and the contractor shall thoroughly disinfect the entire water system including underground mains.

Pipes material is galvanized steel "blue sign" local made "class A".
All pipe fittings such as elbow, tee, reducer, union, etc. shall be galvanized forged steel of the same quality of the pipe. Pipes and fittings shall be suitable for threaded connections

The Contractor shall provide suitable and substantial hangers and supports for all piping works. Piping shall be carried by pipe hangers supported by concrete insets. In general supports for pipes shall be not more than 2.5m apart for 2" and smaller pipes according to the conditions of the job and directions of the engineer. Copper piping shall have hanger every 1.5 meter.

All vertical piping will be supported by heavy pipe clamps resting on the building structure. No piping shall be hung with other piping and all hangers shall be of heavy construction suitable for the size of supported pipes. All horizontal pipes shall be supported by split ring hangers of malleable iron provided with solid rod and nuts to maintain adjustable height.
All vertical pipe line passing up through the building shall be hung from each floor of the building. Malleable iron clamps of suitable size and bolted around the pipes shall be used for these supports.
These pipes shall be secured midway between the floor and the ceiling of each story by means of malleable iron, solid hangers around the pipe and fastened to adjacent walls by means of inverted bolts cast in concrete walls. Anchors shall be separated and independent from all hangers and supports.

11.4 Valves

Hand valves, float valves and check valves shall be of an approved made and shall be furnished and installed as shown on the drawings or as directed during construction.
The Contractor shall include for the finishing; the required valve tag and a schedule of valves with a schematic drawing showing position of each. The drawing shall be glazed, framed and hung in the machine room.

11.5 Floor Drain

Floor drain shall be obtained from an approved made P.V.C. 4"/2" minimum water seal, complete with chrome plated duty strainer tightly sealed to drain body. All 2" P.V.C. drain pipes are connected to floor trap by rubber sealed record fittings.

11.6 Roof Drain

Each roof drain shall be of P.V.C. constructed with built in trap, having and integral flange and wire dome type strainer, fixed by screwing into the drain body. Rain drain shall be installed as shown on drawings.

11.7 Storage Tanks

Water tank used is P.E approved made class A with lockable cover. The tank capacities will be as mentioned in the bills of quantities and as shown in the drawings.
The installation of the water tank must be carried out according to the drawings, manufacturer's instructions i.e. (tank foundation, mechanical float valve, valves, fittings, vent pipe, overflow, drain, connections and the required accessories) and as supervisor engineer instructions.

11.8 Manholes and Chambers

11.8.1 General

All chambers and manholes will be supplied by the Contractor according to drawings, specifications, bills of quantities and Engineer's instructions.
Work shall include excavation, backfilling, concrete base, hard-core installation, reinforced concrete cover slab, benching, internal rendering, external bituminous insulation, internal epoxy protection paining if notified in the bills of quantities, etc.

11.8.2 Construction of Manholes and valve Chambers

All manholes and chambers shall have reinforced-concrete bases. The Contractor shall construct all manholes, chambers, and special structures including transition chambers and outfall structures as indicated on the Drawings and herein specified.

Manholes, chambers, and special structures shall conform in shape, size, dimensions, materials, and other respects to the details indicated on the Drawings or as ordered by the Engineer.

Manhole and chamber cover slabs shall be either pre-cast or cast in place reinforced-concrete as marked on the Drawings. The cast iron frames and covers for manholes and chambers shall be brought with grade so that to sustain the indicated load.

Manhole walls (rings) and cover slabs shall be either pre-cast or cast in place reinforced-concrete. In pre-cast construction; rubber o-rings are to be placed in all joints except for the joint between the cast in place roof slab and the top wall ring. In general, the top level of manhole cover slab shall not be in any how lower than the level of cast iron cover by 30cm.

Benching of manholes must be smoothly curved and semi circular of diameter equivalent to inlet and outlet pipes. Benching should be rendered and plastered perfectly smooth, inclined in the manhole to 2cm minimum.

Manholes over 1m deep shall be supplied with Cast Iron steps well anchored to the concrete walls at a spacing of 30cm.

Drop manholes must be constructed if the difference in depth between the inlet and outlet pipes exceeds 60cm.

11.8.3 Formwork of Valve Chambers

The Contractor shall be responsible for the design and stability of the formwork of the chambers. The Contractor shall submit a full program of work and safety indicating the various phases for the erection and removal of forms and the manner in which he intends to execute.
The contractor shall take the safety measures in order to avoid any corresponding incident and he shall hold the responsibility of pit protection during the construction of the chamber.

11.8.4 Cleaning

All manholes and valve chambers specified under this section shall be cleaned of any accumulation of silt, mortar, debris or any other foreign matter of any kind and shall be free of any such accumulations at the time of final inspection.

11.9 TESTING

11.9.1 General

The Contractor shall submit to the Engineer prior to the date of commencement of the tests his proposed test procedure. The procedure method and points of measurement and the method of calculation, shall be approved by the Engineer before any test is carried out.
The Contractor shall supply skilled staff and all necessary instruments and carry out any test of any kind on a piece of equipment, apparatus, part of a system or on a complete system if the Engineer requests such a test for determining specified or guaranteed data, as given in the Specifications.
Any damage resulting from the tests shall be repaired and/ or damage material replaced, all to the satisfaction of the Engineer.

In the event of any repair or any adjustment having to be made other than normal running adjustment, the tests shall be voided and shall be recommenced after the adjustment or repairs have been completed.
The test shall not be made void due to circumstances beyond the contractor's control.
All testing, balancing and final adjustment shall be in accordance with the provision of the applicable BS Code of technical practice.

11.9.2 Water Supply Systems

All water supply piping shall be tested under hydrostatic pressure of not less than working pressure for 24 or hydrostatic pressure of not less than 1.5 working pressure for one hour as directed by the supervisor engineer. This test should be applied to separate lengths of pipe work before final connection of equipment and appliances but after all piping is completed. Systems shall also be flushed.
Test shall be completed and approved before pipes, valves and fittings have been concealed.

11.9.3 Gas Network

A - Copper Pipes Used for Gas:
1 - The pipes should be round and smooth, completely clean, free of defects and surface

oxidation and to be trimmed off vertically so that the roundness of the cross section does not be affected.
2 – The supplied pipes should be of brand name and clearly showing the manufacturer brand, Standard No. in addition to the type and size of such pipes.
3 - The contractor has to provide a certificate issued by recognized laboratory proving that the pipes comply with the specifications, otherwise the engineer is entitled to take samples from the supplied pipes for testing at the expense of the contractor.

B - Pressure to Cut Copper Pipes:
1 – Fittings should be suitable for connections of copper pipes and comply with the British Standard (BS 864 PART2).
2 - Fittings should be made of copper or copper alloys which resist chemical corrosion.
3 - Fittings must pass the hydraulic pressure test equal to 2.1 N/mm2 with no leakage.
4 - Fittings must pass must pass the porosity test according to British Standard (BS 864 PART2).

C – Connection of Copper Pipes by Welding:
1 – Both ends of the two pipes should be cleaned properly with steel wool or glass paper, wiped from any particles and painted with welding agent (FLUX) before the welding process.
2 - The process of welding should be performed either by silver ring or welding tin according to the special specifications. If is not explicitly specified which method to be followed, the contractor has the right to choose the appropriate one of those methods.

* **Silver Ring Method:**

This method is used to joint a pipe with a fitting so that the pipe end as well the fitting are heated till the silver ring inside the fitting melts and flow to fill the gap between the pipe and the fitting.
*** Welding Tin Method:**

This method is used to joint a pipe with a fitting or a pipe to pipe so that the ends of the two pipes are heated, then make the welding rod touches the area of welding till it fills the gap between the pipes.

11.9.4 Drainage and Waste Systems

These systems shall be subject to a water test prior to being covered and also tested for water tightness after backfilling.
On any section of the pipe under test the head of water applied shall not be less than 3.00 meters and not greater than 6.00 meters. Tests shall be maintained for 20 minutes, and any defects shall be rectified and the test reapplied to the complete satisfaction of the Engineer.

11.9.5 Final Testing

In addition to the above, final tests shall be carried out as directed by the Engineer just before final completion of the Works and during the maintenance period.

11.10 PLUMBING FIXTURES

The following fixtures shall be supplied with cold and hot water by pipes not less than 1/2".

1. Supply and installation of wash basin, porcelain approved made class "A", with chrome plated cold and hot water mixer or faucet, size ½" of approved manufacturer such as including PVC trap connected with over flow and with the floor trap by plastic P.V.C. pipe 2". The work shall include supply and install soap holder, chain and rubber plug, angle valves, hoses and all needed accessories . Height of basin is 80 cm from the finish floor level.

2. Supply and installation of porcelain W.C. including internal S or P Siphon approved made class "A". The price includes plastic flushing cistern tank, plastic W.C. seat cover of heavy duty, porcelain toilet paper holder, chrome plated angle valve ½", chrome plated flexible hoses ½", flushing spray hose, and all needed accessories. The W.C. should be connected with the 4 inch P.V.C. main sewage pipes and the flushing tank to be connected to the main water line by ½" galvanized pipe or otherwise specified. European W.C. bowels shall be fixed to floor by cadmium screws and tightly grouted.

3. Supply and installation of stainless steel kitchen or fire clay porcelain including the supply and fixation of chrome plated mixer of approved quality connected to cold and hot water mainline by ½" galvanized steel pipes or otherwise specified including PVC trap connected with over flow and with the floor trap by plastic P.V.C. pipe 2". The work shall include supply and install chain and rubber plug, angle valves, hoses and all needed accessories.

11.11 Working Drawings and Ordering

Immediately after the Contract has been awarded; the Contractor shall prepare detailed drawings showing exact position of all plumping fixtures, position, type and size of all water pipe work, drainage, and piping clearly indicating the proposed fittings. These drawings, when approved by the Engineer, shall be used for ordering purposes.

12 -ELECTRICAL WORKS

12.1 GENERAL REQUIREMENT

12.1.1 Prerequisite Conditions

All applicable sections of the general Specifications are included by reference to the work required by this division of the specifications.

12.1.2 Extend of Work

The work shall include all necessary labour, materials, plant services machinery and appliances and alike at the Contractor's own risk and expense to deliver, construct, install and complete the electrical installation in good working condition in accordance with the drawings, specifications and bills of quantities. All materials and workmanship shall, except where otherwise directed, comply with the requirements and regulations of the appropriate local Electrical Authority, and I.E.E. and shall be subject to the approval of the Engineer.

Work shall also include:

- The procurement of and payment for all permits and licenses required for the performance of the work.
- All hoists, scaffolds, staging, runways and equipment required for the performance of the work.
- All job measurements and shop layouts required for the proper installation of material and equipment included in the work.
- All lights, guards and signs as required by safety regulations applicable to the work.
- The removal of all dirt and refused materials resulting from the performance of the work from the premises, as it accumulates,.
- All equipment under this heading shall be installed under complete supervisory service finished by the Contractor and where necessary, this shall include the services of special erection and operation engineers.

12.1.3 Miscellaneous Conditions

1. All installed material and equipment shall be new, with best quality and design, and free from defects and imperfections.
2. All the installation and adjustment of material and equipment shall be done by experienced electricians, has proper trade and all workmanship shall be first class.
3. Installed material and equipment included in the work shall be protected from dirt and damage and maintained in a clean condition during the performance of the work.
4. Apparatus, equipment and material required for the performance of the work shall be stored under requirements of applicable regulations and of direction from the Architect.
5. The Contractor shall cooperate with all other Contractors on the project, be responsible for prompt delivery of all materials and equipments and for the installation of all works under this division at a time and in a manner so that there will be no delay in the construction schedule.

6. Acceptance of the work shall be subject to the condition that all installed systems, equipment, apparatus and appliances included in the work shall operate and perform as designed and as selected with respect to efficiency capacity and quietness and shall operate and perform without producing objectionable noise within occupied area of the building.
7. Acceptance of the work shall be subject to the conditions that any time within one year after date of final approval, any defective part of the work resulting from the supply of faulty workmanship or material shall be immediately amended, repaired or replaced as a part of the contract work without any cost to the owner.

12.1.4 Power Supply

The system of distribution will be fed from a 230/400 volts 3-phase, 4 wire 50 Hz.

12.1.5 System of Distribution

The system of distribution to be used for lighting and power is to be the radial type, including branch circuits and ring circuits system where shown in drawings.

12.1.6 Drawings and Specifications

All electrical drawings are intended to cover the layout and design of the work, but are not to be scaled for exact measurements. Where special detail and dimensions are not shown on the drawings, the Contractor shall take measurements and make electrical layouts as required for the proper installation of electrical work so that interference with all other work will be avoided.

All drawings and specifications on the project are complementary, each set to all other sets, and they shall be used in combination for the execution of the work. Electrical work shown on any set drawings, including all architectural drawings for general work and equipment, and electrical work called for under any section of the project specifications, shall be considered as included in the work unless specifically excluded by inclusion in some other part of the work. The work shall include roughing in for fixtures and equipment as called for or inferred. The Contractor shall check all drawings and specifications for the project and shall be responsible for the installation of all electrical work.

12.1.7 Inspection of the Site

Contractor shall inspect the Site, study existing conditions, check with the drawings and specification and be fully informed as to the work required by the Contract.

12.1.8 Operation and Maintenance Instructions

The Contractor shall furnish all services and personnel to the Owner’s operating and maintenance as required for adequate verbal and written instructions. Two complete copies of a service manual in hard back binders shall be furnished at the end of the project and shall include printed operating and maintenance instructions for systems specified under this heading, all approved shop drawings and all manufacturers’ printed instructions for operation and maintenance of the equipment.
When the work is completed and at a time designed by the Owner, the Contractor shall furnish

the services of a qualified instructor to train the Owner's personnel in the operation and maintenance of the systems & equipment.

12.1.9 Record Drawings

Contractor shall be required to keep a day to day record of changes in location of all equipment, conduit, and devices on one or more sets of contract drawings, underground utilities or other readily identifiable feature.

The Contractor shall record such changes in red ink on black line prints. The record prints shall be submitted to the Engineer for approval prior to final payment.

12.1.10 Cutting and Patching

Any cutting of new construction which is required for the installation of electrical work after the construction of walls and floor slabs shall be done by the Contractor.
Cutting shall be done with extreme care so that the strength of the structure will not be endangered.
Adequate protection shall be provided to prevent damage to adjacent areas. Patching and finishing of opening shall be the responsibility of the Contractor.

12.1.11 Existing Equipment

All existing equipment that indicated to be removed shall remain the property of the Owner if he so desires. Such equipment shall be removed by the Contractor and delivered to a point on the project site as designated by the Owner. Any equipment that the Owner does not desire to retain shall be promptly removed from the Site by the Contractor.

Any existing equipment or material that is to remain in service and is damaged by the Contractor during the course of the Contract shall be repaired and refinished or replaced to the satisfaction of the Owner, at his discretion.

12.1.12 Conduct of Work

All work under this Contract which may interfere with the operation of the Owner's utilities, shall be done in such a manner and at such time as may be satisfactory to the Owner. Make temporary alternations and connections as required to execute work so that all services in the building are maintained with the minimum possible interruption. Temporary shutdowns shall be segregated and shall be of the shortest possible duration. All services shall be kept on continuous operation unless permissions are otherwise granted by the Owner. All temporary wiring shall be the responsibility of the Contractor at no additional cost of the Owner.

12.1.13 Omissions

If anything necessary to the proper installation or operation of the electric system is omitted from the drawings or specifications, or bill of quantities, or indicated incorrectly, the Contractor shall call the attention of the Engineer to these omissions or inaccuracy immediately before work proceeds. Should the Contractor fall to do so, he shall be herder responsible and shall make good such errors or any damage caused at his own expense.

12.1.14 Samples

Samples of the following shall be submitted to Engineer by the Contractor before the work commences:

Section of conduit, section of wires and cables, junction boxes, switches and plates, outlet box isolating switches, lamp holders, ceiling roses ,distribution boxes, circuits breakers, earth leakage relays, any fixtures to be supplied by the Contractor and other materials to be incorporated in the installation. The work done by the Contractor shall not vary in any manner from the samples submitted and approved without written permission from the Engineer.

12.1.15 Layout

Before the Contractor commences the installation he shall discuss the exact timing and the whole layout in detail with the Engineer, in order to determinate the exact position of distribution boards, fittings and accessories, the runs of cable and conduits, etc.

12.1.16 Drawings

The design of the accompanied drawings and the quantities in the attached schedules are not definite and are subject to any variations made by the Engineer during constructions. No variations or amendments in the drawings and the specifications shall be instructed to the Contractor except as directed in writing by the Engineer who has the right to refuse all the materials and works which don't match with the drawings and specifications.

12.1.17 Testing

The Contractor shall make tests for perfect operation of installations, insulation and earth resistance and continuity at his own expense and in the presence of the Engineer

12.1.18 Tenderers

Tenderers for the electrical work shall have previous experience in this field of work and an official license of three-phase installations from the local Electrical Authority.

12.1.19 Risks insurance policy

The Contractor should provide on his own expense and all risks insurance policy for his workers during all the period of his work.

12.1.20 Director of works

The Contractor or his representatives should be on the Site daily for taking any instructions from the director of works (Engineer).

12.1.21 Owner reserves

The Owner reserves the right to accept any tender, either as regards the whole of the work indicated therein, or any one or, more parts so included. The Owner does not bind himself to accept the lowest of any tender.

12.2 MISCELLANEOUS WORK

12.2.1 Equipment Identification and Labels

All electrical equipments, such as disconnect switches, motor starters, controls, push buttons, panel boards, and other similar items shall be adequately identified with labels. Labels shall clearly designate name and use of equipment and be made of embossed plastic tape except where engraved plates are called for elsewhere in the specification or on the drawings.

12.2.2 Grounding

1. Grounding shall be in accordance with the local Electrical Authority requirements and regulations, and with the I.E.E. regulations.

2. All branch circuit conduit wiring shall include an insulated copper wire for grounding of all non-current carrying conductive surfaces of electrical equipment subject to person contact, and for every electrical outlet.

3. Earthing conductivity test should be conducted so that the resistance not exceeding 2 Ohm.

4. Earth electrode must be provided which consists of 3 driven copper rods 1,5 meter long of standard type, and must be installed as near as possible to the main board. The earth wire has to be copper conductor as specified making loop connection between the rods and the earth (ground) bus bar, the distance between each rod and the other have to be at least 7 meters with a checking manhole at least 60cm depth.

5. Other similar P.V.C. copper conductor has to be bonded to the main water supply pipe from the earth bus bar.

12.2.3 Adjusting, Aligning and Testing

1. All-electrical equipment furnished under this heading and all electrical equipment furnished by others shall be adjusted and tested by the Contractor.

2. Mechanism of all electrical equipment shall be checked for alignment with drive and adjusted as required. Protective devices and parts shall be checked and tested for specified and required application and adjusted as required. Adjustable parts of all lighting fixtures and electrical equipment shall be checked, tested and adjusted as required to produce the intended performance.

3. Complete wiring system shall be free from short circuits and after completion, the Contractor shall perform tests for insulation resistance in accordance with the requirements of the I.E.E.

4. The Contractor shall hold responsibility of the operation, service and maintenance of all new electrical equipment furnished by him during construction and prior to acceptance by the Owner. All electrical equipments shall be maintained in the best operating condition including proper lubrication. Operational failure caused by defective material and/or

labour will be recovered by the contractor.

12.2.4 Motor and other Control Equipment

The Contractor shall install and mount miscellaneous disconnection switches and motor controls in accordance with the instructions, wiring diagrams and approved shop drawings, also he shall be responsible for the operation of such devices only to the extend of proper mounting and wiring. Work shall include mountings and supporting as required for all equipments including angle frames, steel plates, bars, bolts, etc. The Contractor shall furnish and install all conduit, wire, etc., as required to connect all equipment furnished by him including motors, disconnect switches, starters, controls, push buttons, etc.

The Contractor shall perform all work required to rough in and connect to all equipment required electrical connections, except equipment that is furnished by the Owner which shall be roughed in only. This work shall be as indicated on drawings, approved equipment shop drawings and by direction on the job.

The Contractor shall connect feeders to control and motors as shown on drawings, make connections and install wire to all mechanical components. The Contractor shall coordinate with other traders involved in the proper coil voltages for control of magnetic starters and contactors.

12.2.5 Opening and Setting of Conduit

Work shall include all required cutting and afterward patching for the installation of material and equipment included in the work.

Any cutting and/or patching of new construction which is required for the installation of Electrical work after new walls and floors have been constructed, shall be the responsibility of the Contractor if the cutting and patching is due to errors or omissions on the part of the Contractors.

12.2.6 Excavation and Backfilling

The Contractor shall excavate as required for the installation of all underground work under this heading. Surplus material not needed for backfilling shall be deposited or distributed in the premises as directed. Trenches shall be of sufficient width and shall be cribbed or braced to prevent cave-in or settlement. Trenches close to walls and columns shall not be excavated without prior consultation with the Engineer, otherwise it will be his representative. Pumping equipment shall be furnished to keep trenches free of water. Dry earth shall be rammed into place at the sides of conduits and leaving joints and top of conduits exposed until approved.

After approval, all trenches for work installed by the Contractor shall be backfilled by him in 15cm layers of well-tamped dry sand in a manner to prevent future settlement. Rocks debris, bricks, and like material shall not be used for backfilling. Where direct burial cable is installed, the trenches shall have 5cm of dry sand on the bottom of trench.

Any trenches improperly backfilled or where settlement occurs, they shall be reopened to a depth required for the proper compaction, then refilled and compacted with the surface restored to the required grade.

As a part of this Contract, all roads, streets, and sidewalks damaged by the installation of building services or other work under this heading shall be furnished to the satisfaction of the authorities and regulations having jurisdiction.

12.3 GENERAL CONDITION OF THE DIFFERENT PARTS OF INSTALLATIONS

12.3.1 CONDUITS

1. Conduit shall be installed for all wires and cables except where otherwise stated or directed. The conduits shall be P.V.C. pipe of the thinner type or similar under plaster.
2. Fireproof plastic type should be used whenever exposed installations are used. In addition, conduits shall be securely fastened in place with approved straps.
3. Steel conduit should be used in the boiler, and where else directed by the Engineer.
4. No conduits should have an internal diameter less that 13mm. The Conductors area within the conduit should not exceed 50% of the area of the conduit.
5. The conduit has to be away from heat and mechanical pressure.
6. The contractor shall be responsible for ensuring that the conduits are laid so that water cannot infiltrate or accumulate at any point.
7. The Contractor shall be responsible to ensure that placing of the conduit is done prior to pouring of concrete without delaying the concrete work.
8. The Contractor should make all his effort to run all the conduit pipes in horizontal or vertical lines and not to be inclined and to be at the same level from the floor in all rooms.
9. The conduits should have cover at least of 2cm of plaster or concrete.
10. Separate conduits have to be used for separate systems of different voltage.
11. Conduits between any two connection boxes have to be of one piece with no connection in the pipes.
12. Where finish wall surfaces are to be plastered, the Electrical Contractor shall cooperate with the General Contractor during construction of these walls and use care in the installation of all conduits and boxes so that wall surfaces will have a finished appearance
13. Conduit shall be installed to requirements of structure and to requirements of all other work on the project. Conduits shall be installed so that to divert from all openings, depressions, pipes, ducts, reinforcing steel, etc., and conduits set in the forms of concrete structure shall be installed in a manner that installation will not affect the strength of the structure.
14. All electrical work shall be protected against damages during construction and any work damaged or moved out of line after roughing-in shall be repaired and re-set to the approval of the Engineer, without additional cost to the owner.
15. All conduits have to match the local standard.

12.3.2 PULL BOXES AND CONNECTION BOXES

1. The contractor has to make his best to use the minimum number of these boxes.
2. All boxes should be of the same material as that of the conduits.
3. Boxes should be wide enough to contain all connections of cables easily.
4. Pull boxes and connection boxes should be installed all at the same level from ceiling.
5. All boxes should be covered.
6. All the connections for installed connectors should be done inside the boxes.
7. Cables of different voltage should not be drawn or connected in the same connection box.

12.3.3 OUTLET BOXES

1. Suitable outlet boxes shall be installed for all electrical service outlets, including plug receptacles, lighting fixtures, switches, etc.
2. Location of outlets on drawings is approximate and except where dimensions are shown, exact location of outlets shall be taken from plans and details on general drawings or as directed by the Engineer.
3. Outlets shall be located generally from column centers and finished wall lines or to center of acoustical and decorative ceiling panels and to centers or joints of wall panels.
4. Outlets shall be installed in an accessible location.

12.3.4 SWITCHES

1. Outlet boxes for switches are to be fixed 140cm above finished floor level and 12cm horizontally from the outside edge of the nearest door.
2. Switches should be of 10 amp with different signs for emergency switches if used.
3. Switches should be of waterproof type for the bathrooms and where else shown.
4. All switches should be installed flush.
5. Switches shall be wired in the phase lines only.
6. The neutral conductors shall not be broken.
7. Switches panels shall have a similar assembly to switches and should be group-mounted in a common box if possible, and if it is without pilot lamp, otherwise it has to be group-mounted in aluminum or stainless steel cover to the approval of the Engineer.

12.3.5 SOCKETS

1. Boxes for sockets outlets are to be installed 60cm or, as shown in the drawings above finished floor level.
2. Socket should be of 13 amp or 16 amp for the power socket with different color for socket and non-emergency.
3. Sockets should be of all-installed rockers flush.
4. Sockets in the boiler room should be industrial heavy duty.
5. Sockets in the bathrooms and where else shown shall be waterproof.
6. All sockets shall be wired in the same manner with the phase always connected to the same pole [right pole].

12.3.6 WIRES, WIRING

1. All wires and cables, except where otherwise stated are to have a soft copper core, refined and tinned, with an electric conductivity of not less than 98%. The core shall be insulated with rubber with braid for 600 volley service.
2. Samples of cabling and wiring proposed by the contractor, are to be submitted prior to commencement of the work. These must comply with the requirements of the I.E.E., and local standard to ensure a constant voltage in every part of the building.
3. All wires are to be standard. [for lighting and power, the neutral wire shall be different in color from the phase wires].
4. All wires shall be run through conduits and shall be continuous between outlets and boxes. At least 20cm of wire to be left outside the outlet for fixture connection.
5. Where wire size is shown on drawings or specified, it shall be the same size throughout the circuit.
6. Wiring inside panel boards shall be neat and well arranged, using appropriate lugs for

termination and connection of conductors.

7. Joints in the cables or wires are not allowed to be made inside conduits.
8. Wires are to be fixed to boards with an appliance ensuring perfect electrical contact, to the approval of the Engineer.
9. When drawing wires through conduits, no lubricant is permitted.
10. Cable shoes have to be used for wires of 6 sq. mm. or above.
11. All boxes and distribution boards have to be carefully cleaned from plaster and other foreign material before drawing any electrical wires or cables.
12. Colours of the cables should be as follows:

- Single phase circuits:

Brown	for the phase
Black	for the neutral
Green & Yellow or White	for the earth
Blue	for direct [switch Wires].

- 3 Phase circuits:

Brown, Yellow & Blue	for the three phase.
Black	for the neutral
Green & Yellow or white	for the earth

12.3.7 Cables

1. All the cables should be of the following type NYY, 5 or 4 cores, 11000 volt, plain annealed high conductivity copper wire conductors P.V.C. sheathed. Under Ground cables should be of type NYBY or XLPE.
2. Colours of cores in the cable should be red, yellow, blue & black. Colours of sheathes shall be black.
3. Cables terminations should be through brass cable glands. Glands should be complete with brass earth tags and steel locknuts.
4. Cable connection at both ends should be through cable shoes.
5. Cables should be covered with soft sand, concrete slabs and special warning tape in 3 languages.

12.3.8 Wire Size

1. Sizes of wires should be 1.5mm2 for lighting and 2.5mm2 for socket outlets and local ring main circuit unless otherwise indicated in the contract documents or instructed by the engineer.
2. The size of the earth cable for any circuit should be the same size as that of the phase or as shown on the drawings.
3. The size of the wire for the bells, loud speakers and sound outlets should not be less than 0.6sq.mm

12.3.9 Electrical Boards

1. All boards should be manufactured by a qualified factory who has a wide experience in this field.
2. The Contractor should supply detailed drawings for each board which show the electrical and mechanical design of the board with dimensions. Therefore, the contractor shall get the approval of the Engineer before he commences with the manufacturing of these boards.
3. Electrical boards should be erected complete with all conduits terminated to it before

installation of any cable in the conduit.

Body of Electrical Boards

1. Electrical boards and panels shall be ready made otherwise it should be manufactured from 2mm galvanized steel sheet with all angles and channels needed for supporting and mounting the equipments and it should be full finished steel with electrostatic painting with beige colour.
2. All screws, nuts and washers should be galvanized.
3. Boards to be designed with removable front plates for easy access to the interior for cabling up and maintenance.
4. A special compartment with separate cover shall be made for terminals, neutral and earth bars.
5. All panel boards shall be with doors.
6. All doors which have equipments mounted on them shall be shielded from inside with isolation sheets.
7. Distribution Boards in wet areas should be of waterproof type.
8. All electrical boards shall have spare space of at least 25% of their space.

12.3.10 Bus - Bars

1. All bus-bars shall be of hard drawn electrolytic copper.
2. Bus bars shall be supported by suitable bus-bar insulator to protect the bars from any electrical, mechanical and dynamic stresses.
3. Bus-bars shall be rated at a max. of 2 amps/sq. mm.

12.3.11 Neutral and Earth Bars

Suitable bars for neutral and earth shall be mounted on the top compartment of each board, for terminating the outgoing circuits on them. A bolt with suitable size shall be welded on the body of each board for earthing.

12.3.12 Labels

All circuits shall be labeled in English language and to be of the black sandwich type and engraved.

12.3.13 Main C.B.S

These C.Bs shall be air insulated, adjustable, with magnetic and thermal protection, and have a main rupturing capacity of 25 K.A.
These C.Bs shall be of the best quality and preferably of the Siemens or NZM-type K.L.M made. in Germany or equivalent.

12.3.14 Miniature C.BS, Automatic Change Over Switch, [Mechanical Interlock] and E.L.Rs.

These M.C.Bs shall be of the air insulated type with magnetic and thermal protection and fixed adjustment, the main rupturing capacity of these M.C.Bs shall not be less than 15 K.A. The M.C.Bs type N and E.L.R. shall be of the best quality and preferably Siemens or NZM-type

K.L.M made. in Germany or equivalent. All E.L.R. shall be 4-pole with 0,03 amp sensitivity.

12.3.15 On - OFF Swtches

All these switches shall be hand operated, air insulated and able to withstand any load and fault conditions.
These switches shall be Gewiss type or K.L.M. made or equivalent.

12.3.16 Instruments

All the measuring instruments shall be very accurate which have dimensions of 120x100 mm. and mounted on the boards.
All ampere and volt meters shall be with selector switches to measure the voltage between phases and between phases and the neutral.

12.3.17 Connectors

All outgoing connectors shall be terminated and mounted on the upper compartment of the boards or otherwise shown in the drawings.
Connectors must have a copper strip between the wire and the screws. All connectors shall have special paper fixed on them for writing the names of the circuits. Connectors shall be of or best quality.

12.3.18 Telephones

1. 1” conduit should be installed from each telephone box to the main telephone box in the floor where shown in drawings with galvanized rope to be installed within for the telephone company.
2. The telephone box should be 1 meter high from floor level unless otherwise indicated.
3. Main conduits from the floor boxes and the operator have to be shown in drawings with a galvanized rope.
4. Telephone cables for the main boxes and the telephone outlet should be drawn with the presence of the telephone department.

12.3.19 Fire Alarm Installations

1. MICC/PVC sheathed cable only shall be used for the wiring of the fire alarm, smoke detectors, etc., associated with the installation.
2. Where interconnections are to be made between buildings for control panel displays, PVC/SWA/PVC cables may be used.
3. Size of wire for Fire Alarm should be at least 1.5 sq. mm.
4. Fire alarm system shall include the following:
   - Smoke detectors
   - Heat detectors
   - Addressable break glass call point
   - Short circuit isolators
   - End of line resistors
   - 6” diameter ,24V internal fire bells (sounder)
   - Addressable repeater FACP (X-zone)
   - Voice evacuation and emergency telephone system (auto dialer)

5. The FACP shall indicate :
   - Zone leds main fire
   - Fault and pre-alarm leds
   - Power tests, system fault, alarm fault, remote signal and activated sound and silence alarm leds
   - The duration of the FACP will be 24 hours standby

12.3.20 Lightening System

1- Lightening system should be implemented in compliance to drawings and American Standard NFPA78.
2- The Contractor has to submit samples of the lightening system components to the Engineer for approval.
3- Electrodes and strips should be made of copper type 11000C according to ASTM-B187 or equivalent.
4- After installation of the lightening system to be completed, the contractor has to make earth leakage and resistance tests for the system according to the American Standard and under supervision of the Engineer.

12.3.21 Lighting Fixtures Schedule

Type of lamp	Description	Manufacturer
A	Single Fluorescent Fixture on ceiling or wall	GAASH or equivalent Fl. 1x36 W
B	Double Fluorescent Fixture on ceiling or wall	GAASH or equivalent Fl. 2x36 W
C	Globe on ceiling or wall with Incandescent lamp	GAASH or equivalent Fl. 1x75 W
D	Recessed spotlight (Recessed spotlight with reflector lamp and white colour).	GAASH or equivalent Fl. 1x60 W

13 -SUB BASE AND BASE COURSES

13.1 General

Locating sources and manufacturers of materials are the responsibility of the contractor.

Prior to starting quarry or borrow pit operations, the contractor shall obtain written permission from the Authorities or Owner concerned.

The contractor shall submit to the Engineer, 10 days prior to the scheduled beginning of crushing and screening, a statement of origin of all stone and/or gravel aggregates and granular materials.

The contractor shall submit for testing and approval, representative samples of all materials needed. Samples shall be taken by the contractor in the presence of the Engineer. Approval of specific sources of materials shall not be considered as final approval.

The contractor may conduct necessary tests in the Field Laboratory in the presence of the Engineer and the contractor's Materials Engineer.

Samples shall satisfy all specified test requirements. The contractor shall furnish all necessary labor, transport, tools and equipment required by the Engineer.

13.2 Granular Material for Sub-Base

Granular material for use in sub-base courses shall be naturally occurring gravel, blended as necessary with fine or coarse material and screened to produce the specified gradation. Crushing of natural granular material shall not normally be required, unless for the purpose of meeting the gradation requirements, or when shown on the Drawings (to produce a higher quality sub-base with improved mechanical stability).

Gravel shall consist of hard, durable and sound stones, free from deleterious substances not mentioned below.

Other requirements are:

Crystalline gypsum (expressed as SO3)	5% max.
Clay lumps and friable particles	10% max.

Flakey and elongated particles

Crushed rock	40% max. Each
Crushed gravel	45% max. Each
Natural gravel	50% max. Each

Determined in accordance with BS812 Section 105.1: 1985 and BS812 Part 1 1975)

Maximum dry density

Minimum dry density is **2.05gm/cm^3**.

Chart content (determined by percentage by weight insoluble in hydrochloric acid) should be specified in

special technical specification.

Granular materials delivered to the road site shall meet the requirement of class A or B as shown in Table 3.1, when tested in accordance with AASHTO T-27 after dry mixing and just before spreading and compacting. The Class of granular material to be used shall be as shown on the Drawings or otherwise as selected by the Engineer. The actual gradation shall, in all cases, be continuous ad smooth within the specified limits for each Class. If gradation is tested after compaction, a tolerance of 3% is allowed in the upper limit for the percentage of material passing sieve no. 200.

Gradation of Granular Material by Class, shown table 13-1

Table 13-1: Gradation of Granular Material by class

Sieve Designation (Square openings)	**Percent by weight passing**	
	Class A	**Class B**
63 mm (2-1/2 in.)	100	
50 mm (2 in.)	80-100	100
37.5 mm (1-1/2 in.)	70-95	80-100
25 mm (1 in.)	55-90	60-95
12.5 mm (1/2 in.)	45-75	47-80
4.75 mm (No.4)	30-60	30-60
2.00 mm (No. 10)	22-48	22-45
0.425 mm (No.40)	10-30	10-30
0.075 mm (No. 200)	5-12	5-12

Sand equivalent

The material shall contain a minimum of **25%** sand equivalent at any stage of construction.
Shrinkage limit less than 3%

Loss weight of granular material

The loss weight of granular material shall not exceed **45%** after 500 revolution, when tested in accordance with AASHTO T 96 (Los Angelos Abrasion Test).

$$\text{The ratio of wear loss} = \frac{Abrasion\,after\,100\,\text{Re}\,v.}{Abrasion\,after\,500\,\text{Re}\,v.}$$

Should not be more than twenty percent of the maximum allowed abrasion after 500 revelations.

Soaked CBR

The granular material shall have a 4-day soaked CBR of not **less than 30 when** compacted at 100% of modified proctor AASHTO (T 180-D) and tested in accordance with AASHTO T 193.

Soundness

When tested for soundness in accordance with AASHTO T 104, the material shall not show signs of disintegration and the percentage loss in weight after 5 cycles shall not exceed 12% in the case of the sodium sulphate test and 18% in the case of the magnesium sulphate test.

Portion of granular material

The portion of granular material, including any blended material, passing the 0.425 mm (No. 40) mesh sieve shall have a liquid limit **(L.L) of not more than 27** and a plasticity index **(P.I.) not grater than 6** when tested in accordance with AASHTO T 89 and T 90.
Non-Plastic condition might be accepted if crushed limestone is used provided that angularity test (R) value shall not be less than 8.

Additional fine material

If additional fine material is required to correct the gradation of the granular material, or for adjusting the L.L. or P.I. of the fraction passing 0.425 mm (No. 40) sieve, it shall be uniformly blended and mixed with the granular material. Additional fine material for these purposes shall be obtained from the crushing of stone, gravel, or slag, if naturally occurring fine materials not available.

13.3 Aggregate for Base Courses:

Aggregate for use in base course construction shall be crushed stone, and may be washed, if directed, to remove excessive quantities of clay, silty clay or salts.

It shall consist of hard durable and sound particles or fragments of stone, free from other substance. Other requirements are gypsum, or flaky particles.

Other requirements

Gypsum content (expressed as SO_3) 2 % max.
Clay lumps and friable particles 8 % max.
Elongated and flakey particles for crushed rock (Determined in accordance with BS 812 Part 1: 1975)
Granit and Basalt 40 % max each.
Lime stone 35 % max
Minimum dry density (g/cm3) 2.15 % min
Linear shrinkage not exceed 3%
Gradation of Base course Aggregate by class, shown in table 13-2.

Table 13-2: Gradation of Base course Aggregate by class

Sieve Designation	Percent by weight passing	
	Class A	Class B
50 mm (2 in)		100
37.5 mm (1.5 in)	100	70-100
25 mm (1 in)	75-100	55-85
19 mm (3/4 in)	60-90	50-80
12.5 mm (1/2 in)	45-80	
9.5 mm (3/8 in)	40-70	40-70
4.75 mm (No 4)	30-65	30-60
2 mm (No 10)	20-40	20-50
0.425 mm (No 40)	8-20	10-30
0.075 mm (No 200)	5-10	5-15

The material shall contain a minimum of 40% sand equivalent at any stage of construction.

The loss weight shall not exceed 40 % after 500 revolutions, when tested in accordance with AASHTO T96 (Los Angeles Abrasion Test).

The ratio of wear loss should not be more than twenty percent of maximum allowed abrasion after 500 revolutions.

The crushed aggregate base course material shall have a 4-day soaked CBR of not less than 80 when compacted at 100 % of modified proctor AASHTO (T 180-D) and tested in accordance with AASHTO T 193.

When tested for soundness is accordance with AASHTO -104, the material shall not show signs of disintegration and the loss by weight shall not exceed 12 % in case of the sodium sulphate test, and 18 % in the case of the magnesium sulphate test.

The portion of aggregate, including any blended material passing the 0.425 mm (No. 40) sieve shall have a liquid limit (L.L.) of not more than 25 and plasticity index (P.I) of not more than 6, and not less than 3 when tested in accordance with AASHTO T 89 and T 90.

If additional fine material is required to correct the aggregate gradation or for adjusting the L.L or P.I. of fraction passing the 0.425 mm (No 40) sieve, it shall be uniformly blended and mixed with the aggregate material.

Elongated and flakiness not to exceed 35% for each.

13.4 GRANULAR SUB-BASE COURSES

13.4.1 Scope

These Works shall consist of furnishing granular sub-base material of the required Class, mixing, spreading on prepared sub-grade, compacting and finishing, all as and where shown on the Drawings.

13.4.2 Materials

All materials shall conform to the relevant requirements of Section "Materials", in respect of granular material Class A or Class B for sub-base construction.

13.4.3 Sub-grade Surface Preparation

The sub-grade shall have previously been constructed in accordance with the requirements of Section "Sub-grade Construction and Topping" and properly maintained and kept well drained thereafter.
At all special grade control points, such as at bridge structures, existing pavements, etc. The sub-grade shall be lowered to a depth sufficient to permit construction of the sub-base course to the specified elevations and thickness.

Transitions shall be of sufficient length to avoid abrupt change of grade and shall be within plus or minus 3% of the final design grade unless otherwise directed. Surplus material shall be removed and disposed of.

The sub grade shall be inspected and approved immediately prior to commencement of sub-

base construction. Any soft, yielding material shall be removed and replaced by approved topping material. Holes, depression and other irregularities shall be made good as directed and the sub-grade re-compacted as necessary and finished ready to receive the sub-base course.

13.4.4 Equipment

Equipment used to handle, place, spread, water, compact and finish sub-base shall conform to the requirements of Section “Contractor's Plant and Equipment" and with the Contractor's approved Work Program.

13.4.5 Construction

13.4.5.1 Stockpiling of Granular Material

Stockpiling procedures shall conform to the relevant requirements of Section "Materials".

Methods used for stockpiling granular material and removing it from stockpiles shall not result in significant degradation or segregation nor the introduction of significant amounts of foreign materials or extraneous matter.

Granular material adversely affected, in the opinion of the Engineer, by stockpiling or handling procedures shall be incorporated in the Works regardless of previous approval of such material, until the deficiencies have been rectified in an acceptable manner.

13.4.5.2 Mixing and Spreading

All components of sub-base course material shall be mixed thoroughly and uniformly with water in situ. The amount of water added, as approved by the Engineer, shall be such that the material will be uniform and within the specified moisture content range at the time of compaction. Wetting of granular material in stockpiles or in trucks before or during delivery to the Site will not be permitted. However, water shall be added to the material, if necessary, during placing and compaction of sub-base material.

The sub-base material shall be placed on the subgrade in a uniform two layers each 150 mm thickness (after compaction).

If approved, heavy duty vibratory compaction equipment is used, the sub base may be in one 300 mm layer (after compaction) provided compaction tests with appropriate testing equipment indicate that the specified compaction standard will be attained and uniform throughout the thickness.

The sub-base material shall be placed to the required width using a self-propelled spreader or motor grade equipped with blade extensions. Water shall be applied by approved spraying equipment and thoroughly mixed with the sub-base material.
The material shall not be bundled in such a way as to cause segregation. If the spreading equipment causes segregation in the material, or leaves ridges, or other objectionable marks on the surface which cannot be readily eliminated or prevented by adjustment of the equipment, the use of such equipment shall forthwith be discontinued and it shall be replaced by a spreader or grader capable or spreading the material in proper manner.

All segregated material shall be removed and replaced with well-graded material. "Skin"

patching will not be permitted. Only minor surface manipulation and watering to achieve the required surface tolerances will be permitted during the compaction process.

Neither hauling nor placement of material will be permitted when, in the judgment of the Engineer, the weather or surface conditions are such that hauling operations will cause cutting of the subgrade or cause contamination of the sub-base material.

13.4.5.3 Compaction

The Contractor shall plan the sequence of operations so that the least amount of water will be lost by evaporation from uncompleted surfaces, If the Contractor delays placing of succeeding layers of material to the extent that additional water is required to prevent raveling or excessive drying, the application of such water shall be carried out as directed and at the Contractor's expense.

The sub-base material shall be compacted by means of approved compaction equipment, progressing gradually from the outside towards the center, with each succeeding pass uniformly overlapping the previous pass.

Rolling shall continue until the entire thickness of each sub-base layer so thoroughly and uniformly to 100% AASHTO T 180 (Method D) maximum density. Final rolling of the completed course shall be by means of an approved self-propelled roller. Rolling shall be accompanied by sufficient blading, to insure a smooth surface, free from ruts or ridges and having the proper shape. When additional water is required, it shall be applied in an approved manner.

Any areas inaccessible to normal compaction shall be compacted by use of portable mechanical tampers until the required standard of compaction is achieved.

Each layer shall be completely compacted and approved prior to delivery of materials for the subsequent layer.

Prior to placing a subsequent layer, the existing surface shall be made sufficiently moist as directed, to ensure proper bond between the layers.

The edges and slopes of the sub-base course shall be bladed or otherwise dressed to conform to the lines and dimensions shown on the Drawings and to present straight, neat lines and slopes as free of loose material as practicable.

Material which has dried out prior to final compaction, or which has dried and compacted subsequent to final compaction, shall be watered and recompacted using approved equipment and procedure. If the Contractor is unable to return the material to its original or specified condition with respect to compaction, thickness and surface tolerances, the Contractor shall remove the material and reconstruct the sub-base course on a re-approved sub grade.

13.4.5.4 Tolerances

The fully compacted and completed sub-base course shall conform to the lines, grades and cross sections as shown on the Drawings.

The elevations of the finished sub-base course shall be checked by the Contractor in the

presence of the Engineer at maximum intervals of 10 m and at intermediate points as directed.

The tolerance on elevations of finished surface shall be plus 10 mm to minus 20 mm, minus tolerance shall be compensating by the proceeding layer.

When the finished surface is tested with a 3 m long straightedge, placed parallel to, or at right angles to the centerline, the maximum deviation of the surface from the testing edge between any 2 contact points shall not exceed 10 mm.

All areas which exceed the specified tolerances shall be corrected by removing the defective sections of sub-base and reconstructing them or, if approved, by adding new material mixing and re-compacting and finishing to the specified standard.

13.4.5.5 Maintenance of Completed Sub-base

Following completion and acceptance of the sub-base course, it shall be maintained by the Contractor at his own expense. The sub-base shall be bladed, broomed and otherwise maintained, keeping it free from raveling and other defects until such time as the base course is placed. Water shall be applied at such times and in such directed by the Engineer.

13.4.6 Testing

Every 500 linear meter of sub-base material or whenever there is a change in the material source shall be subject to a full set (3 points and one point extra will take around manholes if exist 1 sample / 20 manholes))of tests after mixing in situ and, if found satisfactory, shall be approved for compaction. This approval shall not deem to constitute acceptance of the sub-base course.

Sampling and testing shall conform to the relevant requirements of Section 1.05- "Control of Materials and Standards for Sampling and Testing".

Compaction shall be tested in accordance with AASHTO T 191 or AASHTO T 205. If there is a delay between the construction of any layer and the following layer, if necessary and required by the Engineer the compaction of the lower layer may be recertified to ensure that it has not loosened due to traffic, passage of construction equipment, adverse weather conditions or otherwise.

13.4.3 Measurement

1. The net area executed must be measured (without the area under the curb stone).
2. The area of manholes and gullies is to be deducted from measurement.

13.5 AGGREGATE BASE COURSES

13.5.1 Scope

These works shall consist of furnishing crushed aggregate base course material of class a, mixing, spreading, compacting and finishing, all as and where shown in the Drawings.

13.5.2 Surface Preparation

The sub-grade surface shall be inspected and approved prior to commencement of base construction, Holes, depressions and other irregularities shall be made good as directed an the

sub-grade re-compacted as necessary and finished ready to receive the base course layer.

13.5.3 Equipment

Equipment used to handle, place, spread, water, compact and finish base course in accordance with contractor's Work program approved by the Engineer.

13.5.4 Construction

13.5.4.1 Stockpiling of Base Course Material

Stockpiling method of aggregates and moving them from stockpiles shall not result in significant degradation or the introduction of significant amounts of foreign materials. Aggregate materials adversely affected, in the opinion of the Engineer, by stockpiling or handling procedures shall not be incorporated in the works regardless of previous approval of such material until the deficiencies have been rectified in an acceptable manner.

13.5.4.2 Mixing and Spreading

Base course material shall be mixed with water to reach the specified moisture content range at the time of compaction. The mixed material shall be handled and placed on subgrade in a uniform layer as to not cause segregation. All segregating material shall be removed and replaced with well-graded material, "Skin" patching will not be permitted and spread to the required width and shall be delivered such that it is ready for compaction without farther shaping.

13.5.4.3 Compaction

The contractor shall plan the sequence of operations so that the least amount of water will be lost by evaporation from uncompleted surfaces.
The base course material shall be compacted by means of approved compaction equipment, progressing gradually from the outside towards the center, with each succeeding pass uniformly overlapping the previous pass. Rolling shall continue until the entire thickness of each base layer is thoroughly and uniformly compacted to 100% AASHTO T 180 (Method D) maximum density:

The edges and edge slops of the base course shall be bladed or otherwise dressed to conform to the lines and dimension shown on the Drawings.

Materials which have dried out prior to final compaction, or which has dried and decompacted subsequent to final compaction, shall be watered and recompacted. If the contractor failed to return the material to its original or specified condition with respect to compaction, thickness and surface tolerance the contractor shall scarify the material and reconstruct the base course on a re-approved subgrade surface or to the satisfaction of the Engineer.

13.5.4.4 Tolerances

The dully-compacted base course shall conform to the lines, grades and cross sections as shown in the drawings.

The elevations of base course shall be checked at intervals of 10 m on straight and 5 m on curves, the tolerance on elevations of surface shall not exceed +10 mm or -05 mm, and not exceed 12 mm between any two contact points tested with a 4 m long straight edge placed parallel to, or at right angles to center line.

All areas which exceed the specified tolerances shall be scarified and corrected to specified standard.

13.5.4.5 Maintenance of Completed Base Course

Following completion and acceptance of base course, it shall be maintained by contractor at his own expense. The surface shall be broomed and rolled keeping it free from defects until such time as the following course is placed. Water shall be applied at such times and in such quantities as directed.

13.5.5 Testing

Sub base and base Course material shall be tested in accordance with the table shown below at stock pile and at the mixing plant for control on site tests, and if satisfactory shall be approved for use. This approval shall not be deemed to constitute acceptance of base course for full payment purposes.

Required Tests and Minimum Repetition for Base course material, shown in table 13-3.

Table 13-3: Required Tests and Minimum Repetition for Base course

Source of Materials		**Control on Site (The Road)**	
Required Test	**Repetition Required for all Test**	**Required Tests**	**Repetition Required for all Test**
1-Gradation of materials	* Test for each source	1. Proctor	* test for every 500 Lm for each layer * when materials changed
2- Plasticity Index	* for every 1000 m^3	2. Gradation of materials	
3- Abrasion	* When materials changed or every 1000 m^3	3. Plasticity Index	
4- C.B.R.		4. C.B.R.	
5- Sand equivalent		5. Abrasion	
6-Percentage of Fractured Grains		6. Sand equivalent 7. Clay Lumps & Friable particles 8. Field Density 9. Thickness	

Compaction test: for every layer at least 3 samples taken for one street or 1000 m^2 from layer area, or 200 linear meter of road which is smaller.

13.5.6 Measurement

3. The net area executed must be measured (without the area under the curb stone).
4. The area of manholes and gullies is to be deducted from measurement.

14 -BITUMINOUS CONSTRUCTION

14.1 Material

14.1.1 Scope

All material sources and the quality of materials proposed for use in the works shall be approved prior to procurement or processing material from such sources. Inspection, sampling, testing and re-testing as necessary, shall be at the contractors expense.

14.1.2 Sampling and Testing of Aggregate

In order to ascertain the properties of aggregate materials, the contractor shall submit for testing and approval, representative samples of all materials intended for corporation in the works, prior to starting quarry operations, the samples shall be taken by contractor in the presence of the Engineer.

Tests performed by the contractor shall utilize in assessing the locations, extent of deposits and quantities of materials which will conform to the specifications when properly processed. All testing as carried out by the contractor shall in no way obviate the need for further testing by Engineer.
Approval of specific sources of materials shall not be considered as final approval and acceptance of materials from such sources.

Unsatisfactory materials whether in place or not, shall be removed promptly from the site. The contractor shall furnish all necessary material, labor, tools, and equipment and transport required by the engineer for such inspections.

14.1.3 Aggregates for Bituminous Paving Mixes

1. Aggregate for use in bituminous, binder and wearing courses, shall consist of crushed stone.

2. Course aggregate shall be the fraction of crushed aggregate material retained on 4.75 mm (No. 4) sieve. Fine aggregate shall be the fraction of crushed aggregate material passing 4.75 mm (N0. 4) sieve. Mineral filler shall be added when the combined grading of course and fine aggregates is deficient in material passing 0.075 mm (No. 200) sieve.

3. The material from hot bins passing the number 40 sieve (0.425 mm) when tested in accordance with AASHTO T90 shall be non plastic.

4. Aggregate shall not contain gypsum more than 1% and the course fraction of the aggregate shall not contain more than:
   - 5% chert and flint for aggregate to be used in the Wearing course.
   - 5% chert and flint for aggregate to be used in the Binder course.

5. Aggregates shall be of uniform quality, free from decomposed stone, organic matter, shale.

6. The percentage by weight of friable particles, clay lumps, and other deleterious matter shall not exceed 1% as determined by AASHTO T112.

7. Aggregate particles shall be clean, hard, durable and sound. Crushing shall result in a product such that, for particles retained on 4.75 mm (No. 4) sieve, at least 90% by weight shall have 2 or more fractured faces.

8. The flakiness index and the elongation index test should be conducted in accordance with BS 812, the flakiness and elongation index must be less than 30.

9. Aggregates shall be washed if directed, to remove any clay lumps, organic matter, adherent dust or clay films or other extraneous or deleterious matter that may prevent or detract from proper adhesion of bitumen to the aggregate particles.

10. Material filler shall consist of finely divided mineral matter such as limestone dust if added separately; hydrated lime; other non-plastic mineral filler, free from clay and organic impurities; or Portland cement, conforming to AASHTO M17.

11. Combined course and fine aggregates for bituminous mixes, including mineral filler, when tested in accordance with AASHTO T27 and T11, shall conform to gradations shown in Table shown below (Table 14-1):-

Table 14-1: Gradation of Aggregates for Bituminous Mixes

Sieve Designation	Binder Course Percent Passing	Wearing Course Percent Passing
1″ (25.0mm)	-	-
3/4″ (19.0mm)	100	100
1/2 ″ (12.5mm)	82±9	89±9
3/8″ (9.5 mm)	72±9	82±9
No. 4 (4.75mm)	54±9	66±9
No. 8 (2.36mm)	41±9	53±9
No. 16 (1.18mm)	32±9	41±9
No. 30 (0.600mm)	24±9	31±9
No. 50 (0.300mm)	17±7	21±8
No. 80 (0.150mm)	12±5	13±6
No. 200 (0.75mm)	5±2	4.5±2.5

12. The loss in weight of aggregate after 500 revolutions, when tested in accordance with AASHTO T96, shall not exceed 35%.

    Ratio of wear loss = [ ] is less than or equal 25.

13. When tested for soundness in accordance with AASHTO T104 the course aggregate (retained on No. 4 sieve) shall not shown sings of disintegration and the loss by weight after 5 cycles shall not exceed 9% in the case of the sodium sulphate test and 12% in the case of the magnesium sulphate test.

14. When tested for resistance to stripping in accordance with the AASHTO T-182 at least 95% coated particles should be achieved. Scandinavian test shall be carried out and at last 60% of the coarse aggregate surfaces area shall remain coated with a bitumen film especially for exposed surfaces other wise anti stripping agent must be added to achieve the required coating.
15. The material shall contain minimum 50% sand equivalent. Test sample shall be taken from hot bins.

16. Minimum Dry Specific Gravity (g/cm3) 2.55 min

17. Water absorption not exceed 2%

14.1.4 Heating of Bitumen

1. Heating equipment shall be of an approved type. Any method of heating that introduces free steam or moisture into the bitumen will not be approved.

2. Bitumen shall not be heated more than 170degrees C. materials heated in excess of this temperature will be rejected and shall not be used in the works.

3. Heating of bitumen shall be uniform and under control at all times, to the specified temperature. The circulation system shall be of adequate size to insure proper and continuous circulation of bitumen during the entire operating period.

4. Thermometers of adequate range (calibrated in 2 degrees c increments) for accurately measuring the temperature of the bitumen, shall be located so as to be readily visible and shall be kept clean and working order at all times.

14.2 BITUMINOUS PRIME AND TACK COATS

14.2.1 Scope

This work shall consist of furnishing and applying and MC cutback bitumen prime coat to a previously constructed aggregate base course and applying tack coat on Asphalt or concrete surfaces all as and where shown on the Drawings.

14.2.2 Medium Curing Cutback Bitumen

1. MC cutback bitumen for prime coat shall be used as recommended by ASTM D2399-83 for open and tight surface, and RC should be used as tack coat.

2. All surfaces to receive either prime or tack coats shall conform to the specified tolerances and compaction requirements and shall be properly cleaned and finally approved before applying any bitumen material.

3. Application of prime and tack coats shall be performed only when the surface to be treated is sufficiently moist and atmospheric temperature is above 15 C. There should be no fog, rain, strong winds, dusty conditions, or dust storms.

4. The surface of all structures shall be protected in an approved manner during the

equipment operation. The contractor shall be responsible for making good any staining or damage of the structures to the satisfaction of the Engineer.

5. Traffic shall not be permitted to surfaces after they have been cleaned and prepared for prime coat application.

6. The contractor shall maintain prime or tack coats until it is covered by the subsequent pavement course.
7. Any area where the coats have been damaged shall be cleaned of all loose material and re-applied at the contractor's expense.

8. Applying temperature of MC- 70 shall be 45-80C.

9. Areas to be primed shall be including 200 mm widths outside the edge of the permanent line.

10. Application rate for prime coat shall be 1 lit/sq.m and tack coat application shall be 0.7 lit/sq.m.

11. Asphalt pavement shall not be placed on prime coat before 24 hours, and no traffic is allowed to pass on prime coat.

12. The minimum solid residue by evaporation by weight must exceed 50 % when tested according to ASTM D 1461-85.

13. The Ash content of residue by weight must not exceed 7 % when tested according to AASHTO T-83(2000).

14. The drying time for prime coat must not exceed 24 hour.

15. The density range from 990 to 1010 gm/l when tested according to ASTM D 70

14.3 BITUMINOUS COURSES

14.3.1 Scope

This work shall consist of the general requirements of furnishing materials, mixing at a central mixing plant, spreading and compacting bituminous courses.

14.3.2 Job Mix and Project Mixes

1. The contractor shall submit certificate of origin of all material used in the mix for approval of the engineer, the material must be of best kinds.

2. The contractor shall submit his proposed Job Mix Formula for approval, at least 30 days prior to beginning production so that the life of the submitted Job Mix should not exceed 6 months from the date of submittion for small size projects but to be furnished particularly for large size projects . Therefore, samples from materials use in the preparing mix design (aggregates and bitumen) shall be sent to specialized laboratories to be tested for final approval of mix design.

3. The Job Mix Formula is established by the contractor, under the supervision of the engineer, in the field laboratory mix design procedures shall conform to the Marshall method of mix design. All trial mixes shall be prepared and tested by the contractor in the presence of the Engineer.

4. The Job Mix Formula shall specify a combination of mineral aggregates including filler and bitumen in such proportions as to produce a Job Mix which is within the limits of the specified gradation and bitumen content ranges and which meets the Marshall Test requirements. It shall also stipulate the mixing temperature at discharge from the mixer which, unless otherwise directed, shall be 170 degrees C.

5. The Marshall Test procedure shall be used to determine the percentage of bitumen to be incorporated in the mix. The Job Mix Formula shall take into consideration the absorption of bitumen into the aggregates. Air voids shall be calculated in accordance with the procedure given in the Asphalt Institute Manual, MS-2.

6. When compacting specimens on accordance with the Marshall Test procedure, the number of blows applied with the compaction hammer shall be 75 on each side.

7. In order to meet the requirements, an approved additive such as Portland cement, hydrated lime or liquid antistrip agent, may be required in the Job Mix. Portland cement shall meet the requirements of ASTM M 85. Hydrated lime shall meet the requirements of ASTM C207, Type N. Cement or hydrated lime will normally be required in the approximate range of 2-3% by weight of the aggregates and shall be added at the cold feed in dry or slurry form as directed. Liquid antistriping agent, if needed will normally be required in the approximate range of 0.6-1.0% by weight of the bitumen, or according to the manufacturers specifications.

8. Upon receipt of approval of the Job Mix Formula, the Contractor shall adjust his mixing plant to proportion the individual aggregates, mineral filler and bitumen to produce a final project mix within the limits given in Table shown (14-2) with respect to the Job Mix gradation

Table 14-2: Maximum Variations of Project Mix from Approved Job Mix

Sieve Designation (square openings)	Specified Tolerances
9.5 mm (3/8 in.) and above	± 5.0%
4.75 mm (No. 4)	± 4.0%
2.36 mm (No. 8)	± 4.0%
1.18 mm (No. 16)	± 4.0%
0.600 mm (No. 30)	± 4.0%
0.300 mm (No. 50)	± 4.0%
0.150 mm (No. 100)	± 4.0%
0.75 mm (No. 200)	± 1.5%
Bitumen Content	± 0.3%
Temperature of Mix on discharge temperature	± 5 C of the specified mixing

9. Conformance to gradation requirements will be determined on the extracted aggregate in accordance with AASHTO T 30. The bitumen content shall be determined in accordance

with AASHTO T 164.

10. The participation of the Engineer in the preparation of the Job Mix Formula shall in no way relieve the Contractor of responsibility for producing project mixes meeting the specified requirements.

14.3.3 Spreading and Finishing Equipment

1. Bituminous course shall be spread and finished using approved type, self contained, power-propelled pavers of sufficient capacity. Pavers shall be provided with electronically controlled vibratory screed or strike-off assembly and shall be capable of spreading and finishing the course of bituminous mix to the proper thickness and in lane widths applicable to the typical cross sections shown on the Drawings.

2. The pavers shall employ mechanical devices such as equalizing runners, straightedge runners, evener arms or other compensating devices, to maintain trueness of grade and confine the edges of the mix to true lines without the use of stationary side forms. Joint leveling devices shall be provided for smoothing adjusting longitudinal joints between lanes.

3. The paver shall be equipped with receiving hopper having sufficient capacity for a uniform spreading operation. The hopper is equipped with a distribution system to place the mix uniformly in front of the full length of the screed.

4. The screed or strike-off assembly and extensions shall effectively produce a finished surface of the required evenness and texture without tearing, shoving, or gouging the mix.

5. The paver shall be capable of being operated at forward speeds consistent with satisfactory laying of the mix. Speed shall be fully adjustable

6. The Contractor shall make available, for reference by the engineer, the manufacturer's instruction and operating manuals for each paver intended for use.

14.3.4 Surface Preparation

1. When the bituminous mix is to be placed on a base course, the surface shall be prepared to meet the appropriate specified compaction and surface tolerance requirements. The surface shall hen be primed as specified “Bituminous Prime Coat”. No bituminous mix shall be laid on a prime coat until it has been inspected and approved.

2. Broken, soft, or unstable areas of aggregate base course shall be removed and replaced. The areas shall be excavated to a depth as directed and refilled with the specified bituminous mix.

14.3.5 Delivery, Spreading and Finishing

14.3.5.1 Delivery of Mix to Site

1. A sufficient number of haul vehicles shall be provided so that adequate supplies of mix are delivered to ensure that continuous paving will be achieved.

2. Hauling equipment for aggregates and bituminous mixes shall consist of vehicles having dump bodies suitable for dumping materials in a windrow or in spreader boxes. The bodied shall be so constructed that their volume measurement can be accurately determined. They shall be constructed and maintained such that loss of materials during hauling operations will not occur.
3. Dump controls shall be capable of operation from the driver's seat.

4. Hauling equipment for hot bituminous mixes shall have tight, clean, smooth metal beds which are periodically thinly coated with a lime solution or other approved material to prevent adherence of the mix. All hauling units shall be equipped with a canvas or other approved type cover which shall be used to cover the hot material upon loading at the mixing plant and shall not be removed until the mix is discharged into the paver.

5. The dispatching of the hauling vehicles to the site shall be so scheduled that all material delivered is placed at least 90 minutes before sunset to allow sufficient time for compaction.
6. Delivery of material shall be at a uniform rate and in an amount well within the capacity of the paving and compacting equipment.

7. The mix delivered to site must have a temperature range from 139^{o} to 163^{o} .

8. Each haul vehicle shall be weighed after each loading at the mixing plant and accurate records shall be kept of the gross weight and net weight of each load, for each vehicle dates and time of loading.

14.3.5.2 Setting out Reference Line

1. The Contractor shall survey the centerline profile and crown of the existing surface or base and determine a reference grade line which will be submitted for approval. A reference line of wire or suitable cord shall be installed at a uniform grade parallel to the approved reference grade line such that conformance with the required geometrics, surface tolerance and minimum thickness requirements shall be ensured.

2. The reference line shall be maintained taut and free from sags at all times during spreading and initial compacting operations.

3. A wire or cord reference line shall be installed on both sides of the paver for the initial bituminous course being laid. Thereafter only one reference line will normally be required, if the paver is equipped with adequate automatic super elevation control.

14.3.5.3 Spreading and Finishing

1. Bituminous mixes shall be laid only when the air temperature is at least 5 degrees C or above when the existing surface is free from moisture, and when the weather is not foggy, rainy, dusty or excessively windy (particularly at low temperatures).

2. After completion of surface preparation, the bituminous mix shall be spread and finished true to crown and grade by approved automatically controlled bituminous pavers. The mix may be spread and finished by approved hand methods only where the engineer determines that machine methods are impracticable. Hand methods include heated hand tampers of at least 10 kg weight and approved type mechanical (vibratory) tampers.

3. The paver shall spread the bituminous mix without tearing the surface and shall strike a finish that is smooth, true to cross section, uniform in density and texture and free from hollows, transverse corrugations and other irregularities.

4. The paver shall be operated at a speed which gives the best results for the type of pavers being used and which coordinates satisfactorily with the rate of delivery of the mix to the paver. A uniform rate of placement shall be achieved without repeated intermittent operation of the paver.

5. The mix shall be delivered to the paver in time to permit completion of spreading, finishing and compaction of the mix during daylight hours.

6. If during laying, the paver is repeatedly delayed because of lack of mix or if the paver stands at one location for an extended period, resulting in the (unrolled) mat under and adjacent to the rear of the spreader falling below the minimum temperature for breakdown rolling, the affected portion of mat shall be cut out and discarded and a transverse joint shall be constructed. Paving shall not recommence until the engineer is satisfied that paving will proceed without interruptions.

7. Contact surfaces of curbing, gutters, manholes, and similar structures shall be painted with a thin, uniform coating of tack coat material. The bituminous mixture shall be placed uniformly high near the contact surfaces so that after compaction it will be 10 mm above the edge of such structure.

8. If during the paving operations, it is found that the spreading and finishing equipment in operation leaves in the pavement surface tracks or indented areas or other objectionable irregularities that are not satisfactorily corrected by the scheduled operations, the use of the equipment shall be discontinued, until faults are corrected to the approval of the engineer. If this is not possible, other satisfactory spreading and finishing equipment shall be provided by the contractor.

9. Transverse joints in succeeding layers shall be offset by at least 2 m. Longitudinal joints shall be offset at least 150 mm.

10. Bituminous mix shall be spread in one or more layers so that, after rolling, the nominal thickness of each layer of the compacted bituminous material does not exceed 2 to 3 times maximum size of aggregate. This maximum thickness may be increased slightly when such increase is more appropriate to total pavement thickness and provided the engineer determines that such increased thickness will not be detrimental to the quality of the finished bituminous course, and the contractor can show that the required density is attained throughout the layer thickness.

11. Transitions and structure approaches shall meet the design criteria for geometrics, the surface tolerance specifications, and shall not be visually discontinuous or abrupt in appearance.

14.3.5.4 Joints and Edges

1. All joints between old and new pavements or between successive days' work shall be as to ensure thorough and continuous bond between the old and new material.

2. Before placing fresh mix against previously laid, the contact surface shall be cut back to a near vertical face, and shall be sprayed or painted with a thin uniform coat of tack coat material. Longitudinal joints shall be made by overlapping the paver screed on the previously laid material (cut back as necessary) and depositing a sufficient amount of fresh mix so that the joint formed will be smooth and tight.

3. Unsupported edges of bituminous layers shall be rolled immediately following the rolling of the longitudinal joint. The material along the unsupported edge may, if approved, be raised slightly by hand methods, to ensure that the full weight of the roller will bear fully on the edge material

4. On completion, the longitudinal edges of bituminous pavement shall be true to the width and alignment as shown on the drawings. The edges shall be cut back if necessary prior to rolling, additional mix placed manually in a longitudinal strip adjoining each pavement edge, and the edge rolled down to a neat 3:1 (H:V) slope.

5. Transverse joints shall be carefully constructed and thoroughly compacted to provide a smooth riding surface. Joints shall be straight-edged and string-lined to assure smoothness and true alignment

14.3.5.5 Compaction

1. After spreading and strike-off, and as soon as the mix conditions permit the rolling to be performed without excessive shoving or tearing, the mixture shall be thoroughly and uniformly compacted, using approved types, sizes and number of rollers. Rolling shall not be prolonged to the point where cracks appear or shoving or displacement occurs.

2. All rollers shall be self-propelled vibratory steel wheel, 2-axle tandem steel-tired and pneumatic-tired types, in proper operating condition, capable of reversing without backlash or tearing of the surface, and shall be operated at numbers of rollers required is 3, of which one must be pneumatic type. The Contractor shall select a suitable method and pattern of rolling that will achieve the required compaction, to engineers approval.

3. Prior to use on site of pneumatic-tired rollers, the contractor shall furnish, for reference and retention by the engineer, manufacturers' charts or tabulations showing the contact areas and contact pressures for the full range of tire inflation pressures and for the full range of tire loadings for each type and size of compactor tire to be used. The contractor shall ensure that tire pressures are maintained at all times in conformity with such charts or tabulations. The maximum allowable tolerances shall be plus or minus 35 KN/sq.m (5 psi).

4. Rollers should move at a slow but uniform speed, generally with the drive roll or wheels nearest the paver.

5. Breakdown rolling shall be consist of 3 complete coverage unless otherwise directed. Rolling shall be longitudinal, and overlapping on successive trips by at least one half the width of the rear wheels.

6. To prevent adhesion of the mix to the rollers, the wheels shall be kept lightly moistened with water. Excessive use of water will not be permitted.

7. The initial or breakdown rolling shall be followed by intermediate rolling involving 3 coverage with pneumatic-tired rollers unless otherwise specified.

8. Finishing rolling shall then be carried out by means of tandem power steel rollers unless otherwise designated. If specified density is not achieved, changes shall be made in size and number of rollers being used to ensure the compaction requirements are met.

9. The compacted density shall be equal to or more than 97% and 98% for binder course and wearing course, respectively, of average Marshall bulk specific gravity for each day production unless otherwise directed by the engineer.

10. If after re-testing the density achieved is 0.5% or less below the specified density, the asphaltic layer will be accepted in the works subject to a 10% reduction to the billed rates. If on the other hand the density achieved is greater than 0.5% below the specified density the asphaltic material shall be removed and new materials laid to the specification at the contractor's cost.

14.3.5.6 Test for Bituminous Pavements

1. Minimum Tests Required as shown in table 14-3 below:

Table 14-3: Minimum Test Required for Bituminous

Work item	Tests at Source of material	Frequency of tests	Tests at road site	Frequency of tests
1- Materials used in Asphalt mix (at Batching plant)	1- Specific gravity and water absorption 2- Abrasion test 3- Chert content 4- Clay lumps and friable materials 5- Flaky and elongated particles 6- Soundness	- Test for each source - When materials quality changes - As requested		
2- Materials used in Asphalt mix (from hot bins)	1- Gradation 2- Specific gravity and water absorption 3- Plasticity index 4-Sand equivalent 5- Stripping with asphalt	- Test for each source - when materials quality changes - As requested		
3- Asphalt mix	1. Complete mix	-For each		

Work item	Tests at Source of material	Frequency of tests	Tests at road site	Frequency of tests
design (At batching plant)	design in accordance with American Asphalt Institute (MS2) 2. Loss of stability	project -When materials quality changes -When results are not consistent with the mix design results - As requested		
4- Asphalt	At Batching plant 1- Stability 2- Flow 3- Extraction (binder content and gradation) 4- Air voids 5- Voids in mineral aggregates 6- Daily Marshall density	- Test each 3 working days - Test for each batching plant - As requested	Behind spreader 1- Stability 2- Flow 3-Extraction (binder content and gradation 4-Air voids 5- Voids in mineral aggregates 6-Marshall density	-Test each working day - Test for each batch - As requested
	7-Loss of Stability	- Once a week - As requested	7- Road density and thickness (after final compaction	- Test each 200 lin.m. per lane - As requested
			8-Loss off stability	- Once a week - As requested

2. The Marshall Bulk specific gravity shall be determined in accordance with AASHTO T 166 or AASHTO T 275. The Marshall specimens shall be prepared from the same material used in construction, taken from samples of fresh bituminous mix at the mixing plant or from trucks delivering mix to the site. Oven heating for up to 30 minutes to maintain the heat of the sample is permissible.

3. The bulk specific gravity of the mix as placed and compacted in situ shall be determined from 100 mm nominal diameter core samples, or slab samples cut from compacted layer on the road at locations designated by the engineer who may require additional tests to determine limits of areas deficient in density, or for recheck.

4. Samples for in situ bulk specific gravity determinations shall be taken in sets of 2 from each pavement location. Minimum frequency of sampling for each bituminous layer shall be one set/lane/500 m, with a minimum of one set per day of placing bituminous layers.

5. The contractor shall, cut the samples with an approved core drill in the presence of the

engineer. The equipment shall be capable of cutting the mixture without shattering the edges or otherwise disturbing the density of the specimen. The contractor shall fill and compact all test holes at his own expense.

14.3.6 Surface Tolerances

1. The fully compacted and completed bituminous course shall conform to the lines, grades and cross sections as shown on the drawings.

2. The elevations of the finished course shall be checked by the contractor in the presence of the engineer at maximum intervals of 25 m and at intermediate points as directed.

3. When the finished surface is tested with a 4 m long straightedge, placed parallel to, or at right angles to the centerline, the maximum deviation of the surface from the test edge between any 2 contacts points shall not exceed the tolerances specified 6.0 mm.

4. All areas which exceed the specified tolerances shall be corrected by removing the defective sections of bituminous course and reconstructing them or, if approved, by adding new material and recompacting and finishing to the specified standard or increasing the thickness of the succeeding course.

5. The tolerances specified for evenness of finished surfaces for all types of bituminous course, shall not invalidate the tolerances specified for construction thickness and elevations of such courses.

14.3.7 Determination of Thickness of Course

1. Cylinder core samples shall be taken next day of pavement layer as specified gravity core samples.

2. Thickness of bituminous course shall be determined by average caliper measurement of cores, rounded upwards to the nearest mm.

3. Paved sections to be measured separately shall consist of each 200 lin.m section in each traffic lane. The last section in each traffic lane shall be 200 m plus the fractional part of 200 m remaining. Other areas such as intersections, entrances, etc. shall be measured as one section and the thickness of each shall be determined separately. Small irregular unit areas may be included as part of another section.

4. One core shall be taken from each section by the contractor at approved location and in the presence of the engineer. When the measurement of the core from any paved section is not deficient by more than 3 mm from the specified thickness, the core will be deemed to be off the specified thickness as shown on the drawings.

5. When the measurement of the core from any paved section is deficient by more than 3 mm but not more than 15% from specified thickness layer, 2 additional cores spaced at not less than 100 m shall be taken and used together with the first core to determine the average thickness of such section, if it failed again, 15% will reduction from unit price.

6. When the measurement of the core from any paved section is less than the specified

thickness by more than 15% from specified thickness layer, the average thickness of such section shall be determined by taking additional cores at not less than 5 m intervals parallel to the centerline in each direction from the affected location until, in each direction, a core is taken which is not deficient by more than 15% from specified thickness layer, Exploratory cores for deficient thickness will not be used in average thickness determinations, if it failed again, Asphalt layer will remove or replacement.

7. Any retest should be taken directly within a week from pavement layer.

8. Any deficiencies in the total thickness of bituminous courses shall be subject to a proportional reduction in the area of layer measured for payment. Alternatively, the contractor shall construct all at his own expense, a wearing course overlay, if practicable in the judgment of the engineer. Any such overlay shall be a minimum of 30 mm compacted thicknesses and to the specified standard of the course it is overlaying.

9. If the deficiency in total asphalt layers thickness is from 0 -3 mm, full payment will be made, on condition that deficiencies are not found in more than 10% of the total project.
   If deficiencies from 0 -3 mm more than 10% from total layer then Engineer shall be left to the substantial handing -over procedure.

10. Deficiencies exceeding 3 mm shall be rejected, removed and re-paved on his own expenses as per specification for the defected areas.

14.3.8 Measurement

1. Bituminous course shall be measured by sq.m for furnished, paved compacted, tested and approved areas placed according to drawing.
2. Any correction, tests, samples, etc. shall not be measured for direct payment.

14.4 BITUMINOUS BINDER AND WEARING COURSES

14.4.1 Scope

These works shall consist of furnishing materials, mixing at mixing plant, spreading and compacting bituminous binder and wearing course on an approved aggregate base course as and where shown in the drawings.

14.4.2 Materials

1. Materials shall conform to relevant requirements of section" Materials" mentioned before.

2. Unless otherwise shown on drawings, bitumen for binder and wearing course construction shall be 60/70 penetration graded bitumen.

14.4.3 Job Mix and Project Mix

1. The Job Mix formula shall be established by the contractor in accordance with the procedure and requirements of section "Bituminous Course" mentioned before.

2. The Job Mix for bituminous binder and wearing courses shall conform to the following

composition limits, as shown in Table 14-4: with Marshal density is more than 2.3 g/cm3

3.

Table 14-4: Job Mix Requirements to Bituminous Courses

Property Medium-Light		
	Binder	***Wearing***
Marshall Stability at 60c (kg)	900	900
Flow (mms)	2-4	2-4
Voids in Mineral aggregate %	13.5	14.5
Voids in total mix (%)	3-7	3-5
Stiffness (kg/mm)	500 (Min)	400 (Min)
* Loss of stability (%)	25(Max)	25(Max)
Asphalt Content (% in weight)	4.5-6	5-7

* This test to be carried out in accordance with AASHTO T 165-82.
* After the Job Mix Formula has been established and approved, all subsequent mixes shall conform to it within the allowable tolerances.

14.4.4 Equipment

Plant and equipment for mixing, hauling, placing and compacting bituminous binder course and wearing course materials, shall conform to the relevant requirements of section “Bituminous Course”.

14.4.5 Surface Preparation:

Preparation of surface upon which bituminous binder course and the bituminous wearing course mixes are to be laid, and the use of prime coat, shall be appropriate to type and condition of such surface and shall conform with the relevant requirements of section "Bituminous Courses".

14.4.6 Delivery, Spreading and Finishing

14.4.6.1 General

The delivery, spreading and finishing of bituminous mixes for binder and wearing courses shall conform with the relevant requirements of Section “Bituminous Course” and to the following particular requirements.

14.4.6.2 Rollers

1. Initial breakdown rolling shall be carried out by use of 2 dual-drum steel-wheeled rollers each of minimum weight 7,000 kg. These rollers shall be purpose made for compaction of hot bituminous courses.

2. Intermediate rolling shall be carried out by of at least 2 self-propelled, tandem pneumatic smooth-tired rollers each capable of exerting contact pressures of up to 690 kN/sq.m (100

psi) and ballast- adjustable to ensure uniform wheel loadings.

3. Final rolling shall be carried out by use 2, 2-axle tandem, steel-tired rollers each of minimum weight 10.000 kg, capable of exerting contract pressures of up to 65 kg/cm (350 Ib/in.)

14.4.6.3 Standard of Compaction

The compacted density of the bituminous wearing course shall be not less than 98% of the average Marshall Bulk density for each day's production.

14.4.7 Sampling and Testing

Sampling and testing shall conform to the relevant requirements of Section "Bituminous Course ".

14.4.8 Surface Tolerances

1. Surface tolerances shall conform with the relevant requirements of Section "Bituminous Course ", and to the following particular requirements.

2. The tolerances on elevations of the final bituminous wearing course surface shall not be greater than 10 mms.

3. When the finished wearing course surface is tested with a 3 m long straightedge, placed parallel to, or at right angles to the centerline, the maximum deviation of the surface from the testing edge between any 2 contact points shall not exceed 5.0 mm.

14.4.9 Determination of Thickness

1. Procedures for determining the average compacted thickness of bituminous binder and wearing course shall conform with the relevant requirements of Section " Bituminous Courses" and the following particular requirements.

2. Cores for thickness measurements of binder course shall be used to determine if changes are necessary in the constructed thickness of the wearing course to rectify and thickness deficiencies in the binder course.

14.4.10 Measurement

1. Bituminous binder course and bituminous wearing course shall be measured by sq.m. of mix finished, spread, compacted, completed and accepted; measurements shall be of the areas and thickness as shown on the drawings.

2. Deficiencies in thickness of wearing course shall, unless an overlay is constructed at contractor's expense, result in proportion only of the wearing course area being measured for payment. Proportions shall be determined in accordance with the thickness deficiencies and area proportions mentioned in section "Bituminous Course".

3. All other items shall not be measured for direct payment and their cost shall be included in bituminous binder course and bituminous wearing course price.

14.5 PAVEMENT MARKINGS FOR TRAFFIC

14.5.1 Scope

1. These Works shall consist of the furnishing and application, of the traffic markings and to highway pavements for the guidance, control and safety of vehicular and pedestrian traffic.

2. White (Class A) and yellow (Class B) painted markings shall include centerlines, lane lines, border (edge) lines, pedestrian crossing lines, stop lines, directional arrows, lettering and symbols using the following materials as appropriate and as on the Drawings.

14.5.2 PAINT AND THERMOPLASTIC MATERIALS

Reflective Paint (RP)

1. RP shall consist of a mixture of binder, white or yellow pigment and filler specifically compounded for cold application and adhesion to finished paved areas. Paint shall be reflective by adding reflective spheres before adhesion the film dries or sets.

2. White and yellow RP shall conform to AASHTO M248 Type III. The surface application glass spheres shall conform to AASHTO M247, Type I.

14.5.3 APPLICATION

14.5.3.1 Equipment for Pavement Marking

1. The equipment used for pavement marking shall consist of approved types of truck-mounted units, or motorized equipment, or manually operated equipment, depending on the type of marking required. The truck-mounted or motorized unit for centerlines, lines, and edge lines shall consist of a mobile, self-contained unit carrying its own material and capable of operating at a maximum speed of 10 km/h while applying paint. The hand applicator equipment shall be sufficiently maneuverable to install centerlines, lane lines; edge lines gore striping, run lines, crosswalks, stop lines, arrows, and legends

2. Spraying equipment shall be capable of satisfactorily applying the paint under pressure with a uniformity of feed through nozzles spraying directly on the pavement. Each paint tank shall be equipped with cut-off valves which will enable broken (skip) lines to be sprayed automatically. Each nozzle shall have a mechanical bed dispenser that will operate simultaneously with the spray muzzle and distribute the beads in a uniform pattern at the rate specified. Each nozzle shall also be equipped with suitable line guides and shall provide a method for cleaning the surface of dust just prior to paint application.

3. The spray machine for application of reflective paint lines and other markings shall have an attachment to accurately regulate the rate of application and a tachometer or other approved device to ensure uniform paint application at the designated rate. It shall be adjustable to enable the painting of 1 or 2 adjacent lines simultaneously along the centerline. The paint shall be properly agitated while in operation.

4. An automatic glass sphere dispenser with synchronized automatic cut-off shall be attached to

the applicator machine. The dispenser shall utilize pressure type spray guns which will embed the spheres into the surface to at least 0.5 times the sphere diameter. The dispenser shall also be equipped with an automatic cut-off synchronized with the cut-off of the thermoplastic material.

5. Hand equipment shall be used only for painted markings, including arrows, crosswalks, stop lines, symbols and legends, and it shall hold a minimum of 25kg and not more than 100kg of molten material unless otherwise agreed between the Engineer and the supplier.

14.5.3.2 Setting Out and Pavement Preparation

1. The Contractor shall set out all control points necessary for locating paint lines and markings. On irregular widths of roads, the locations of boarder (edge) lines shall be adjusted so as to fall continuously on the pavement.
   The locations of all painted markings shall be accurately established and shall be subject to approval before application commences. Markers shall not be located over longitudinal or transverse pavement joints.

2 The area of road surface on which marking is to take place shall be free of dirt, grease, oil, moisture, lose or unsound layers, and any other material which could adversely affect the bond. The areas shall be thoroughly cleaned to the satisfaction of the Engineer before proceeding with painting.

3. Pavement marking shall not proceed when there is moisture on the pavement surface or the air is misty; or the surface temperature of the pavement is below 10 degrees C; or when wind or other conditions may cause a film of dust to be deposited on the surface, or in other conditions that, in the opinion of the Engineer, could displace, damage, or adversely affect the bonding of the material to the pavement surface. Any markings damaged due to water or rain within 20 minutes after application, shall be removed and replaced at the Contractor's expense.

14.5.3.3 Painting and Adhesive Film Application

1. The use of Class A (white) paint or Class B (yellow) paint and the type of paint material shall be in accordance with the design standards and as shown on the drawings.

2. Application of the various categories of point to the pavement surface shall be carried out in accordance with the equipment manufacturer's recommendations and as shown on the drawings and directed by the engineer.

3. Painting applications may include centerlines, border (edge) lines, 'no passing' lines, intersection markings chevron striping (in gross areas), pedestrian crossings, letters, arrow, symbols and other special purpose pavement markings.

4. Preformed reflective thermoplastic film shall be utilized only where specified for markings such as intersection markings, lettering, arrows, symbols and other special purpose markings. Application shall be in accordance with the manufacturer's recommendations and shall be carried out in the presence of the Engineer.

14.5.3.4 Reflective Paint (RP) Application

1. Traffic paint shall be thoroughly mixed in the shipping container before placing in the machine tank. The paint machine tanks, connections, and spray nozzles shall be thoroughly cleaned each day with thinner before starting any spraying.

2. The minimum wet film thickness for all painted areas shall be 0.4 mm.
   The minimum rate of application for 100 mm width paint lines shall be as follows:
   a- Continuous (solid) paint lines: 40 ltr/km for smooth surfaces and 50 ltr/km for rough surfaces.
   b- Broken (skip) paint lines: 14 ltr/km for smooth surfaces and 17.5ltr/km for rough surfaces (assuming gap length is double the length of paint line).
   Rates shall be modified proportionately for other widths of traffic lines.

3. The measured application rate shall not vary from the approved rate by more than 5% in any 1/km. At any point where a check indicates a variation in exceeds of 5% painting shall be stopped and the equipment adjusted or replaced. Identifiable areas of deficiency shall be corrected as directed.

4. Immediately following the application of paint, a uniform application of glass beads shall be applied at the rate of 0.6-0.7 kg/ltr of paint.

14.5.3.5 Protection of Markings

1. Immediately following the application of paint lines and other markings on pavement open to traffic, traffic cones and other devices shall be placed alongside or over the paint at intervals not exceeding 10 m and shall remain on place until the paint has dried.

2. Traffic shall be prevented from crossing wet paint lines and the Contractor shall use sufficient numbers of flagmen, barricades, or other protection, particularly at crossings to prevent traffic from crossing wet paint. Section of paint which have been damaged by traffic before the paint has cured, shall be repaired and pavement outside the painted area cleaned at the contractor's expense.

14.5.4 Sampling and Testing

1. All material shall be shipped to the job site in undamaged, sealed, original packaging clearly identifying each material as to name, color, manufacturer, batch number, and date of manufacture. All material shall be accompanied by certified test results verifying compliance with all specified physical and chemical requirements.

2. All paint products and other materials designated by the engineer shall be sampled for testing. Sampling shall be performed by the contractor in the presence of the engineer. Materials shall be sampled in their original containers. All samples shall be packaged for shipment as approved by the engineer. Samples shall be transported to the mobile field laboratory or to an approved independent laboratory, as directed by the engineer. Paint materials shall not be used until approved by the employer.

14.5.5 Measurement

Painted pavement lines and painted pavement markings shall be deemed to be included in the price of the painted surfaces.

14.6 CONCRETE CURBS

14.6.1 Scope

This work shall consist of furnishing and constructing concrete curbs and concrete paving to sidewalks as and where shown in the Drawings.

14.6.2 Materials and Precast Manufacture

14.6.2.1 Concrete

Portland cement concrete shall be class B 300 for all in situ and precast concrete unless otherwise indicated.

14.6.2.2 Mortar

Mortar shall consist of cement and fine aggregate having the same proportions used in the concrete construction.

14.6.2.3 Precast Concrete Units

1. All precast units shall be manufactured to the dimension shown on the drawings. Manufacturing tolerances shall be 3mm in any one dimension. End and edge faces shall be perpendicular to the base.

2. For horizontal curves of radius less than 10m, curb units shall be manufactured to the radius shown and in such circumstances where straight elements or portions of straight elements shall not be used.

4. Precast units shall be cast upside down in approved steel molds under conditions of controlled temperature and humidity. The engineer's approval of the samples will not be considered final and the engineer may reject any precast units delivered to the site which do not meet the required standards.

14.6.3 Precast Concrete Curbs

1. The sub-grade shall be excavated to the dimensions as shown in the drawings, and the surface of sub-grade shall be leveled and compacted to at least 95% AASHTO T180 maximum density.

2. The Base Coarse under the curb is to be placed to the required level and compacted and tested according to the base course specifications.

3. Forms for the concrete base shall be approved wood or steel. All forms shall be sufficiently strong and rigid and securely staked and braced to obtain a finished product correct to the dimensions, lines and grade required. Forms shall be cleaned and oiled before each use.

4. Concrete shall be placed, compacted and shaped to the sections shown on the drawings taking in account expansion joints. Concrete shall be compacted with an approved internal

type vibrator or if approved, by hand spudding and tamping.
Edges shall be rounded if necessary by the use of wood molding or by the use of an edger as applicable. The concrete base shall be finished to a true and even surface with a wood float. Concrete shall be membrane or water cured for at least 7 days before precast units are placed thereon.

5. Precast units from approved factory shall be set accurately in position in mortar on the concrete base. Joints pattern precast units shall not be mortared unless otherwise shown on the drawings. Units shall be closely spaced and every 10 m run shall be provided with an expansion joint.

6. Where curbs or gutters are installed on existing concrete pavement and using epoxy resin adhesive, the installation procedures shall conform to those specified for raised pavement markers in Section "Pavement Markings for Traffic".

7. After curbs have been installed, forms shall be erected and concrete backing, shall be placed as shown on the drawings.
Pavement courses shall not be laid against curbs until the concrete backing has membrane or water cured for at least 14 days.

8. The tolerances on alignment of completed precast shall be as specified for in situ concrete construction.

3. The area adjacent to completed and accepted curbs shall be backfilled with approved material to the top edges of the curbs to 95 % AASHTO T180 maximum density.

10. The curb to be painted by white, red, and black colours according to traffic requirement, the paint must be after cleaning the curb, with one prime coat and two faces coloured approved road paints.

11. Test: 5 curbs must be tested for every 1000 curbs as British Standard Bs-Pn 1340/2003 Average flexural strength of the curb must not less than 5 N/mm2 but not less than 4 N/mm2 for any specimen of the sample.

14.7 INTERLOCKING TILES

The work includes supply, install and maintain of all forms, dimensions and colors of interlock tiles in accordance with the specifications and technical requirements of the contract and in accordance with the instructions of the Engineer. The Contractor shall comply with the following:

14.7.1 - Not to use broken or distorted tiles in any way, and the layers of tiles consist of: Upper layer: cement, basalt and coloring pigment mix (not less than 10 mm). Bottom layer: cement and aggregate mix.

14.7.2 - Not to fill the gaps between and around the tiles with concrete or cement mortar but in case of no way to install complete tile, mechanical or electrical cutter should be used. At the boundary of tiled area, ready made end pieces must be installed.

14.7.3 - Interlock tiles should be transported in palettes and using a crane mechanism or fork lift to upload and download tile packages.

14.7.4 - Installation of interlocking tiles might be carried out manually or automatically.

14.7.5 - Soiled or non homogenous tiles must be replaced by clean and unharmed ones.

14.7.6 - Manufacturer, type, dimensions, color must be approved prior to supply of the tiles to the site.

14.7.7 - Average compression strength of the interlocking tiles must not less than 49N/mm2 but not less than 40N/mm2 for any specimen of the sample.

14.7.8- Average abrasion resistance of interlocking tiles should not be more than 3mm but not more than 4mm for any specimen at 440 revolutions of carborundum stone.

14.7.9 - Water absorption of the interlocking tiles should not be not more than 2% after 10 minutes and not more than 5% after 24 hours.

14.7.10 Sample of interlocking tiles must be tested by an approved lab according to the international standards. Each sample contains at least 2 specimens per 1000 tiles. Each set consist of 12 tiles distributed as follows:
For Compressive & Dimensions: 6 tiles
For Abrasion: 3 tiles.
For Absorption: 3 tiles.

14.7.11 - Tolerance in dimensions should not exceed 2 mm in all directions.

14.7.12 - The price of the interlocking tiles work should include the following according to the technical specification and instructed by the Engineer :

I. Supply and spread of dry, clean and coarse sand layer with thickness 5 cm below the tiles. Sand must be graded by mechanical or manual long straight stick taking into consideration the required slopes.

II. Supply and install of tiles according to the required size and color. Finish level of tiles must be even and straightness must be maintained along the area boundary. Tiles should be compacted mechanically using a plate compactor with area 0.35 - 0.50 m 2 , power 16-24 kN and frequency 75-100 Hz taking necessary precautions to avoid any damage to the tiles during the process of compaction. In case of unconstrained edges, compaction should be carried out at a distance not less than one 1 m from edge.

III. The gaps between the interlocking tiles should not exceed 3 mm.

IV. When testing the surface using a straight stick length of 3 m should not excess ± 5 mm.

V. Evenness of two adjoining tiles should not exceed 2 mm.

VI. The implementation of the edge beams is set first and then closing the spaces with interlocking tiles.

VII. Finish level should not exceed the design level by ± 5 mm.
VIII. Prior to tiling work, the concrete backing level of curbstone should be adjusted so that not to obstruct with the tiles level.

14.7.13 - Concrete edge beam B250 (Size 20 × 40 cm) should be constructed at the beginnings and ends of the interlocking tiles (unless otherwise noted in drawings and bill of quantities), including the necessary excavation and cutting the existing asphalt using a special cutter, as well as the shuttering and reinforcement works.

14.7.14 - The Contractor shall submit a statement of work as well as performing mockup of implementation before the start of work. The contractor must obtain the Engineer's approval of this plan before starting work.

14.7.15 - The Contractor shall take into account using the readymade starters ½ or ¾ of the tile, depending on the proposed pattern.

14.7.16 - Measurement will be engineering quantities so that calculating the net area of tiles laid on the ground. Area of manholes, storm water gullies, etc are to be deducted from the gross area.