

TECHNICAL SPECIFICATIONS

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GENERAL WORK

1. EARTHWORKS

Earthworks are the Contractor's expense.

1.1. SCOPE OF WORK

This section covers excavation and backfilling work and shall include the necessary clearing, grubbing and preparation of the site; removal and disposal of all debris; excavation as required; the handling, storage, transportation and disposal of all excavated material; all necessary sheeting, shoring and protection work; preparation of sub-grades; pumping and dewatering as necessary or required; protection of adjacent property; backfilling; surfacing and grading; and other related works.

No classification of excavated materials will be made. Excavation work shall include the removal and subsequent handling of all materials excavated or otherwise removed in performance of the work, regardless of the type, character, composition or condition thereof.

1.2. SITE INVESTIGATION

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.

1.3. MATERIALS

Construction materials supplied by the Contractor shall include but not be limited to the following:

1.3.1. BACKFILL

Backfill and fill shall be structurally sound material such as sand or native soil free of rocks, lumps, vegetable and other organic materials, obtained from suitable excavated material and/or from approved borrow pits. The backfill shall be appropriate for the existing road or paving construction to be reinstated as required.

1.3.2. WATER

It shall be clean potable water free from injurious amounts of oil, acid or any other deleterious mineral and/or organic matter.

1.3.3. CONCRETE

Used for thrust blocks, chambers, cover slabs or used as fill for making up to correct level and areas of over-excavation, shall have a characteristic strength as stipulated hereinafter.

1.4. SITE PREPARATION

Prior to commencing any excavation work, the Contractor shall establish a horizontal and vertical survey network, record existing ground elevations and stake the location to be excavated.

The Contractor shall prepare the site for construction by cleaning, removing and disposing of all items not indicated on the Drawings to remain or so defined by the Engineer.

The Contractor shall obtain relevant excavation permits as required before commencing work.

1.5. EXISTING UTILITIES

The Contractor shall ascertain the whereabouts of all existing utilities on the site both, above and

below ground.

The Contractor shall be held responsible for all damages entailed on any of the utilities adjacent to the site resulting from the Works.

All proposed or existing utilities, including buried pipes, sewers, ducts, culverts, cesspits, chambers and the like, in the vicinity of the work site, are to be determined by the Contractor and the location of them is to be shown on the as-built drawings.

Prior to commencement of excavation, the Contractor shall establish the number and location of underground utilities and chambers in the immediate proximity of the work.

Where necessary, the Contractor shall use hand tools to excavate test pits prior to excavation to determine the exact locations of existing utilities. It shall be the responsibility of the Contractor to make such explorations sufficiently in advance of construction to enable the engineer to approve modifications, if any, to be made to the pipeline, structure or conflicting utility. The Contractor shall obtain the permission of the Engineer before commencing any test pits and shall fence, mark and protect them, as required by the Engineer. Test pits shall be refilled by hand as soon as practicable after the necessary information has been obtained.

As the excavation approach sewers conduits, cables or other underground facilities, the excavation shall be continued with care by means of hand tools. Where necessary, the Contractor shall provide temporary support for the existing utilities to prevent damage during his operations. Notwithstanding these provisions, if damage to existing utilities results from the Contractor's operations, such damage shall be repaired without delay by the Contractor to the Utility owner's satisfaction.

If damage to existing utilities causes disruption to Contractor's schedule of work by delaying work in the area of such damage, the Contractor shall re-adjust his programme, methods of working and resources so that critical dates in the schedule for the completion of the Contract are not affected. This shall not be deemed to be an instructed acceleration.

1.6. 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 as directed by the Engineer.

1.7. CLEANING AND GRUBBING

The Contractor shall perform the cleaning 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 and sidewalks 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 levelled to approve dumps.

1.8. SETTING-OUT

The Contractor shall stake-out the work as shown on the Drawings and secure the Engineer's approval of his stake-out 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-out for further approval in accordance with the relevant Clause of the Conditions of Contract.

1.9. EXCAVATION

The Contractor shall perform all excavation true to line, width and depths shown on the Drawings or to such further lines, depths or dimensions or to reach suitable bearing strata as may be directed by the Engineer.

1.10.KEEPING EXCAVATIONS FREE FROM WATER

All excavations shall be kept clear of water by pumping or bailing or by well-point de-watering, 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 with regulations of the Municipalities.

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.

1.11.STORING OF SUITABLE EXCAVATED MATERIAL

During excavation, materials suitable for backfill shall be stockpiled on the site at adequate distance from the sides of the excavation to avoid over-loading and prevent collapse of the trench walls.

1.12.DISPOSAL OF UNSUITABLE AND SURPLUS EXCAVATED MATERIAL

Upon the order of the Engineer, all unsuitable and surplus 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.

1.13.SHEETING, SHORING AND BRACING

Except where banks are cut back on a stable slope, excavation shall be sheeted, braced and shored as necessary to prevent collapse of the excavations. The Contractor shall furnish, put in place, and maintain such sheeting, bracing, etc, as may be necessary to support the sides of the excavation and to prevent any movement of earth which could in any way diminish the width of the excavation to less than that necessary for proper construction, or could otherwise injure or delay the work, or endanger adjacent structures. If the Engineer's Representative is of the opinion that at any point sufficient proper supports have not been provided, he may order additional supports.

The Engineer may direct that sheeting and bracing be cut off at any specified elevation.

All sheeting and bracing not to be left in place shall be carefully removed in such manner as not to endanger the construction or other structures. All voids left or caused by the withdrawal of sheeting shall be backfilled immediately with approved material and compacted by ramming with tools especially adapted to that purpose, by watering or by other means as may be directed.

1.14.EXCAVATION FOR STRUCTURES AND MANHOLES

Excavation for the structures and manholes shall be carried out to the dimensions, lines and grades shown on the Drawings or required by the Engineer.

Should it appear that the bottom of the excavation does not provide a solid base for the chamber, the

Contractor shall be required to consolidate the bottom using hand tampers and increasing the moisture content, if required, all as directed by the Engineer.

Any over-excavation at the bottom of the structure and manholes shall be restored to the proper grade by filling the over-excavation with suitable material or shall be filled with concrete. In the case of over-excavation in the walls, whether caused by careless work or by the necessity to prevent slides by excavating to a slope or for any other reason, the Contractor shall remove all loose material from the excavation, construct the walls of the structure to the dimensions shown on the Drawings and fill the spaces between the structures and the sides of the excavation with compacted backfill in layers of 15cm thickness. The material of the backfill shall be moistened if necessary and compacted to the level of the adjacent natural soil.

1.15.UNAUTHORIZED EXCAVATION

If the bottom of any excavation is taken out beyond the limits indicated or prescribed, the resulting void shall be backfilled at the Contractor's expense with thoroughly compacted, selected screened gravel or sand fill as directed by the engineer if the excavation was for a pipeline or with concrete if the excavation was for a structure or a manhole.

1.16.ELIMINATION OF UNSUITABLE MATERIAL

Suitable material shall comprise all material that is acceptable in accordance with the Contract for use in the Works. Suitable material for earthworks shall be approved soil with a plasticity index not exceeding 6% obtained from excavations within the Works approved by the Engineer. It shall not contain an excess of fines.

Unsuitable material shall be deemed to be:

- ◆ Rock particles exceeding 75mm in size.
- ◆ Organic material, stumps and other perishable material.
- ◆ Material susceptible to spontaneous combustion.
- ◆ Soils of liquid limit exceeding 40% and/or plasticity index exceeding 6%.
- ◆ Any other material which the Engineer may deem to be unsuitable for earthwork.

If material unsuitable for foundation (in the opinion of the Engineer's Representative) is found at or below the grade to which excavation would normally be carried in accordance with the Drawings and/or structure, the Contractor shall remove such material to the required width and depth and replace it with compacted, selected screened gravel, sand fill or concrete as directed by the Engineer or his Representative.

1.17.DISPOSAL OF SURPLUS EXCAVATION MATERIALS

All surplus excavated materials shall be disposed of by the Contractor, except as otherwise directed or approved by the Engineer.

1.18.BACKFILL

1.18.1. BACKFILL AROUND STRUCTURES

The materials to be used for backfill around structures, shall be approved granular backfill material obtained either from excavation for the structure and appurtenant Works, if it is approved by the Engineer or his representative, or from borrow pits cleaned and free of clay and stones as directed and specified hereinafter. The material used for backfill, the amount thereof, and the manner of placing shall be subject to direction of the Engineer or his representative. The backfill shall be

carried out to the lines and grades shown on the Drawings. The backfill material shall completely and firmly fill the spaces between the excavation lines and the structure without leaving any voids and shall be compacted to the density of the adjacent natural or compacted earth or to 97% density using modified Proctor, whichever is greater. The backfill material shall be placed in horizontal layers not exceeding 25 cm in thickness after compaction.

The sides and bottom of the excavation shall be wetted before backfilling and so shall the backfill material, in order to obtain the moisture content necessary for the required compaction. Every layer shall be compacted by hand-operated and/or pneumatic tampers approved by the Engineer or his representative for every specific case as suitable.

Backfill against foundation walls shall not be placed until obtaining the approval of the Engineer or his representative. The backfill shall be performed in a manner that will not create unbalanced pressure that could damage completed Work.

Backfill material may be placed in either a dry or a wet condition. Any material, which is in the "bulking" range of the moisture content of the material, shall be saturated before compaction. No backfill material shall be placed when free water is standing on the surface of the area where the backfill is to be placed. No compaction of backfill will be permitted with free water on any portion of the backfill to be compacted. Any backfill containing organic materials or other unacceptable material previously described shall be removed and replaced with approved backfill material prior to compaction.

Compaction of backfill shall be performed as specified, with equipment suitable for the type of backfill material being placed. The Contractor shall select equipment capable of providing the minimum density required by these Specifications or in cases where the compaction equipment is specified, this specified equipment shall be used, and he shall submit information pertaining to the equipment to the Engineer or his representative for approval. Equipment shall be capable of compacting in restricted areas next to structures and around piping without damaging same.

Each lift of backfill material shall be compacted by at least two coverage of all portions of the surface of each lift by approved compaction equipment. One coverage is defined as the condition obtained when all portions of the surface of the backfill material have been subjected to the direct contact of the compacting surface of the compactor. The minimum density to be obtained in compacting select backfill shall be 97 percent of maximum density obtained in the laboratory in accordance with ASTM D 1557. This percentage is of standard Proctor density. Compaction tests, soil analyses and any other laboratory tests necessary in the opinion of the Engineer or his representative for proper completion of the work shall be performed by the Contractor.

The water content of the fill shall be controlled during placement within the range necessary to obtain the compaction specified. In general, the moisture content of backfill soils shall be within 3 percent of the optimum moisture content for compaction as determined by laboratory tests. All laboratory tests necessary to establish that the water content of the backfill is suitable for placement shall be performed by the Engineer or his representative. The Contractor shall perform all necessary work to adjust the water content of the backfill material to be within the range necessary to permit the compaction specified. This shall include, but not be limited to, spreading, scarifying and mixing to permit drying to reduce natural water contents to an acceptable range or adding water to increase the water content to an acceptable level.

The Contractor shall perform whatever tests he deems necessary to provide data for his selection of backfill material and control of water content. Copies of a test results shall be furnished to the Engineer or his representative for his review.

If the field and laboratory tests indicate unsatisfactory compaction, the Contractor shall provide the additional compaction necessary to obtain the specified degree of compaction. All additional

compaction work shall be performed and paid for by the Contractor until the specified compactions is obtained.

If the specified densities are not being obtained because of the Contractor's improper control of placement or compaction procedures or because of improperly functioning compaction equipment, the Contractor shall perform whatever work is required to provide the specified densities. This work shall include complete removal of unacceptable backfill areas and replacement and re-compaction until acceptable backfill is provided. All additional work to provide acceptable backfill shall be performed and paid for by the Contractor. In-place density determinations shall be made by an approved laboratory using a sand density cone or equivalent method as specified by ASTM D1556.

1.18.2. FILL AND BACKFILL UNDER STRUCTURES

Unless otherwise indicated or specified, all fill and backfill under structures shall be compacted.

The percentage of compacting for backfill shall be 97% of maximum density at optimum moisture content.

1.18.3. TAMPING

Suitable material shall be deposited and spread in uniform, parallel layers not exceeding 15 cm thick before compacting. Before the next layer is placed, each layer shall be tamped as required so as to obtain a thoroughly compacted mass. The Contractor shall furnish and use an adequate number of power-driven tampers, each weighing at least 10kg for this purpose. Care shall be taken that the material close to the bank, as well as in all other portions of the trench, is thoroughly compacted.

To ensure proper compacting by tamping, the material shall first be wet by sprinkling. However no compacting by tamping shall be done when the material is too wet either from rain or too great an application of water to be compacted properly; at such times the work shall be suspended until the previously placed and new materials have dried out sufficiently to permit proper compacting or such other precautions shall be taken as may be necessary to obtain proper compacting.

No superficial load shall be placed on the exposed surface of the trench unless the backfill, if of non-cohesive sand is vibrated or tamped in layers not exceeding 15 cm in depth until the Engineer's Representative is satisfied that sufficient settlement has occurred to alleviate live or impact loads.

1.18.4. BACKFILLING FOR PIPELINES

Backfilling of pipe trenches if any shall be done as practicable after the pipes have been satisfactorily laid in position and jointed. The first stage of the backfill, from the bedding surface and up to 30 cm above the top of the pipe, shall consist of granular material as specified in the subsection of Granular Backfill obtained from trench excavation or from borrow areas, free from, stones, clods, and organic matter. This backfill shall be hand-tamped under and around the pipe in layers not exceeding 15 cm in thickness after compaction, to a density not less than that required for the subsequent backfill (at least 97% of modified Proctor).

The remainder of the pipe trench (second stage backfill from 30 cm above the pipe to the top of the trench) shall be backfilled with selected excavated material or imported material as specified in the subsection of Select Backfill, and shall be placed in layers not exceeding 25 cm thickness after compaction, wetted as necessary and compacted to a density not less than that of the adjacent material or compacted soil (at least 97% of modified Proctor).

1.18.5. GRANULAR BACKFILL

The material shall consist of natural silica sand subject to approval of the Engineer or his representative, other inert materials with similar characteristics having durable particles.

Materials from different sources of supply shall not be mixed or stored in the same pile nor used alternately in the same class of construction without permission from the Engineer or his representative.

The granular material shall be uniformly graded and shall meet the following gradation requirements.

Table (1-1): Gradation for Granular Material

Sieve designation	Passing square-Mesh Sieves Percentages by Weight (AASHOT T 27)
3/8"	100
No. 4	95-100
No. 16	45-80
No. 50	10-30
No. 100	2-10

The material shall not contain deleterious substances in excess of the following percentages:

Table (1-2): Gradation for Granular Material

	AASHTO Test Method	Percentage by Weight
Clay Lumps	T 112	1
Coal and Lignite	T 113	1
Material passing sieve No. 200	T 11	3

Total deleterious substances including the above and shale, alkali, mica, coated grains, and soft and flaky particles shall not exceed 5 percent by weight.

The placing, compacting and testing of granular backfill shall conform to applicable requirements for select backfill as specified herein except as noted above.

The Contractor shall submit to the Engineer or his representative samples of proposed Granular Backfill. The proposed material must receive the approval of the Engineer or his representative prior to using it on the Project. The Contractor will be permitted to use excess materials from the trench provided that they conform to the above requirements.

1.18.6. SELECT BACKFILL

Select backfill shall be placed as shown and specified or where directed by the Engineer or his representative. All materials used as select backfill shall consist of well-graded clean sand or sand and gravel meeting the following gradation requirements:

Table (1-3): Gradation for Gravel Material

Sieve Size	Percent Passing by Weight
1"	100
No.4	0-40
No.200	0-10

No material containing pieces of wood or other organic matters or having lumps, pockets or concentrations of silt or clay will be accepted. Samples of proposed backfill material should be submitted to the Engineer or his representative for testing and approval prior to using the backfill. The contractor shall certify that for samples submitted, sufficient similar material is available to complete the Works. No backfill shall be placed at the site without approval by the Engineer or his representative. The Engineer or his representative shall be permitted to access borrow pits at all times for purposes of inspection.

Prior to placement of select backfill, the surface of the sub-grade shall be leveled and shall be compacted with two complete coverage using equipment approved for backfill placement. The Engineer or his representative shall approve the sub-grade prior to backfill placement. All backfill shall be placed in horizontal loose lifts not exceeding the thickness specified in previous section and shall be mixed and spread in a manner assuring uniform lift thickness after placing. Each layer of backfill shall be properly compacted as specified herein before placement of the following lift.

1.19.MISCELLANEOUS REQUIREMENTS

Whatever method of compacting backfill is used, care shall be taken that stones and lumps shall not become nested and that all voids between stones shall be completely filled with fine material. The Contractor shall, as part of the work done under the items involving earth excavation and rock excavation as appropriate, furnish and place all other necessary backfill material.

All voids left by the removal of sheeting shall be completely backfilled with suitable materials thoroughly compacted.

When required, the excavated material which is acceptable to the Engineer for surfacing or pavement sub-base shall be placed at the top of the backfill to such depths as may be specified elsewhere or as directed. The surface shall be brought to the required grade and stones raked out and removed.

2. CONCRETE WORKS

2.1. GENERAL

Concrete work shall consist of furnishing all materials and constructing structures of the forms, shapes and dimensions shown on the Drawings or as directed, using Portland Cement Concrete, in accordance with the details shown on the Drawings and these Specifications.

Portland cement concrete shall consist of a mixture of Portland Cement, fine aggregate, coarse aggregate, water and additives when required. The mixture shall be proportioned, mixed, placed and cured in accordance with the requirements of B.S. 8110 Part 1:1985 Sections 6 and 7 specification. Where an additional clause conflicts or is inconsistent with the requirements of B.S. 8110, the additional clause shall always prevail. The concrete mixes shall be designed mixes for special or ordinary concrete as defined in B.S. 8110 Clause 6.3, the design requirements of which are laid down in this Specification.

2.2. MATERIALS

2.2.1. GENERAL REQUIREMENTS

The classes of concrete and their respective minimum cement content, consistencies and the minimum required compressive strengths shall be as shown:

Table (2-1): Specification for Concrete Classes

Class	Compression strength at 28 days for cylinder	Compression strength at 28 days for 15*15*15 cm cube	Slump (mm)	Minimum cement content (kg/m)	Maximum free w/c ration
B300	300 kg/ cm ²	345 kg/ cm ²	25 - 75	350	0.55
B250	250 kg/ cm ²	290 kg/ cm ²	25 - 75	325	0.60
B200	200 kg/ cm ²	230 kg/ cm ²	25 - 100	300	0.70

2.2.2. FINE AGGREGATE FOR CONCRETE AND MORTAR

Fine aggregate for concrete shall consist a natural screened and washed sand or crushed sand which having hard and durable particles, or of other inert materials with similar characteristics. It shall not contain harmful material such as clay lumps, tree roots, shale, iron pyrites, coal, mica, organic matter or any deleterious matter which may attack the reinforcement, in such a form or in sufficient quantity to affect adversely the strength and durability of the concrete. If necessary the aggregate shall be washed and sieved to remove the deleterious substances.

The fine aggregate shall comply in all respects with the requirements of B.S. 882.

Fine aggregate of fine grading (BS 882) shall not be used. In addition to the above, fine concrete aggregate shall meet the following requirements:

Table (2-2): Requirements for Fine Aggregate

Fineness Modulus	Max. +/- 0.2 variance from test sample
Sodium Sulphate Soundness	Max. 10 %
Clay and Friable Particles	Max. 1% by weight
Test for Organic Impurities	Lighter than standard
Material Passing 0.075 mm sieve	Max. 3%
Chlorides (Cl), BS 812, part 117	Max. 0.06% by weight of fine (acid soluble) aggregate
Sulphate (SO ₃), BS 812, part 118	Max. 0.3% by weight of fine(acid soluble) aggregate
Sand Equivalent	Min. 75

Fine concrete aggregate shall conform to one of the following grading (reproduced from BS882):

Table (2-3): Requirements for Fine Concrete Aggregate

BS 410 Test Sieve (mm)	Percentage by Weight Passing BS Sieve	
	Coarse	Medium
10	100	100
5	100	100
2.36	60- 100	65- 100
1.18	30- 90	45- 100
0.60	15- 54	25- 80
0.30	5- 40	5- 48
0.15	0- 15	0- 15

2.2.3. COARSE AGGREGATE FOR CONCRETE

Coarse aggregate for concrete shall consist of natural gravel, crushed gravel, or crushed stone, free from coating of clay or other deleterious substances. It shall not contain harmful materials such as pyrites, coal, mica, laminated materials, tree roots, shale, or any materials which may attack the reinforcement, in such a form or in sufficient quantity to affect adversely the strength and durability of the concrete. If necessary, coarse aggregate shall be washed to remove deleterious substances. The aggregate shall comply in all respects with the requirements of B.S. 882. The aggregate shall also fulfil the following requirements:

Table (2-4): Requirements for Coarse Concrete Aggregate

Flakiness Index (37.5 mm) B.S. 812	0 - 40%
Flakiness Index (20 mm) B.S. 812	0 - 20%
Elongation Index (20 mm) B.S. 812	0 - 35%
Sodium Sulphate Soundness	Max. 10% loss
Abrasion	Max. 40% loss
Clay lumps and Friable Particles	Max. 0.25 % by weight
Soft Fragments and Shale	Max. 3% by weight B.S. 812
Passing 0.075 mm	Max. 1%
Chlorides (Cl) BS 812, Part 117	Max. 0.02% by weight of (acid soluble) Coarse Aggregate
Sulphates (SO ₃) BS 812, Part 118	Max. 0.3% by weight of (acid soluble) Coarse Aggregate
Water Absorption	Max. 2%

The coarse aggregate shall conform to the following grading in accordance with the nominal size of aggregate specified (reproduced from BS 882).

Table (2-5): Gradation of Coarse Concrete Aggregate

BS 410 Sieve mm	Nominal Size of Single-Size Aggregate Percentage by weight passing BS Sieve			
	40 mm	20 mm	14 mm	10 mm
50.00	100	--	--	--
37.50	85- 100	100	--	--

BS 410 Sieve mm	Nominal Size of Single-Size Aggregate Percentage by weight passing BS Sieve			
	40 mm	20 mm	14 mm	10 mm
20.00	0- 25	85- 100	100	--
14.00	--	--	85- 100	100
10.00	0- 5	0- 25	0- 50	85- 100
5.00	--	0- 5	0- 10	0- 25
--	--	--	--	0- 5

Combined Aggregate - Approved coarse aggregate and fine concrete aggregate in each batch of concrete shall be combined in proportions as specified in BS.882 and as approved by the Engineer. However, in no case shall materials passing the 0.075 mm sieve exceed three (3) percent by weight of the combined aggregate.

For the overall concrete mix the following controls of salts contents of aggregates shall be adopted:

Chlorides (Cl) Max. 0.3% by weight of cement

Sulphates (SO₃) Max. 4% by weight of cement

The combined concrete aggregate gradation used in the work shall be as specified, except when otherwise approved or directed by the Engineer. Changes from one gradation to another shall not be made during the progress of the work unless approved by the Engineer.

Naturally occurring sand/gravel mixtures (all in aggregates) shall not be used unless otherwise directed by the Engineer.

2.2.4. WATER

Water for washing aggregate and for mixing of concrete shall be fresh, clean and substantially free from oil, acids, alkali, sewage, and deleterious mineral or organic matter. It shall not contain chlorides such as sodium chloride in excess of 600 ppm or sulphites such as sodium sulphate in excess of 500 ppm. It shall comply in all respects with B.S. 3148.

Water for curing concrete shall not have a pH lower than 5 or more than 7.5 nor contain impurities in sufficient amounts to cause discoloration of the concrete. Sources of water shall be maintained at such depth and the water shall be withdrawn in such a manner as to exclude silt, mud, grass and other foreign matter.

Approval of Source - All sources of water for use with cement shall be approved by the Engineer.

If at any time during construction the water from an approved source becomes unsatisfactory, the Contractor will be required to provide satisfactory water from some other source.

2.2.5. CEMENT

2.2.5.1. General

The cement shall be of approved manufacture and shall be delivered in bags with seals unbroken, or delivered in bulk, it shall be delivered in approved containers. Test certificates from the manufacturers or suppliers shall be submitted for each consignment and shall indicate the results of the tests for compressive strength, setting time, soundness and fineness carried out in accordance with the requirements of the relevant ASTM or British Standards. Further tests may be required by the Engineer after the cement is delivered and stored on the Site. The failure of any sample to satisfy the B.S. or ASTM requirements shall entitle the Engineer to reject the entire consignment from which it was taken. Cement should be stored on the site such a way to keep it away from water at all

times. Sulphate Resisting Cement shall be used unless otherwise directed.

2.2.5.2. Portland Cement

Normal and rapid hardening cement shall comply with B.S.12.

Sulphate Resisting Cement

Sulphate resisting cement shall comply with B.S. 4027.

2.2.5.3. Admixtures

Air entraining agents, plasticizers, water proofing agents, retarders, and other similar admixtures shall comply with British Standard Specifications (5075, 8110, 1014, 3587, 3892) and shall be used in accordance with the manufacturer's recommendations and B.S. Samples of proposed admixtures shall, if required, be submitted to an approved testing authority by the Contractor in order to ascertain its suitability for use in the Works. Use of any admixtures must be approved before hand by the Engineer.

The cost of such admixtures shall be included in the cost of concrete and no extra payment shall be made if they are used. The proportions of cement, fine aggregate and water shall be determined by the Contractor before concreting commences and submitted together with such test results as may be required to the Engineer for approval and the Contractor shall not commence concreting before such approval is given nor shall he alter or vary in any way the proportion of mix unless he submits fresh test results and mix proportions to the Engineer for approval.

The approval by the Engineer of such mix designs does not in any way absolve the Contractor of any of the requirements of the Specifications.

2.3. MIXING AND TESTING

2.3.1. SAMPLES OF AGGREGATES

Samples of both fine and coarse aggregates are to be submitted to the Engineer for testing at least one week before commencing deliveries. No deliveries in bulk are to be commenced until such samples are approved by the Engineer as complying with this Specification.

2.3.2. TRIAL MIXES

Following the engineer's approval of the materials for each class of concrete, the Contractor shall prepare a trial mix of each grade of concrete in the presence of the Engineer' Representative. Each trial mix shall comprise not less than 1/3 of a cubic meter of concrete and shall be mixed in an approved type of concrete mixer similar to that which the Contractor propose to employ on the Works. The quantities of all ingredients of trial mix including water shall be carefully determined by weight according to the approved mix design. Each trial mix shall show no tendency to segregate when handled and compacted by the methods by which the Contractor proposes to handle and compact the grade of concrete in the Works and it shall be capable of adequate compaction by such methods.

2.3.3. WATER/CEMENT RATIO

The quantity of water to be added to the cement and aggregates during mixing shall be just sufficient to produce a workable mix to enable it to be well compacted and worked into corners of formwork and around reinforcement. All mixes shall be designed in respect of the proportioning of water so that the Slump Test as carried out according to B.S.1881 shall be in accordance with the slump specification. Measurement of water on the site shall take into account the moisture present in the aggregates, and Slump Tests shall be taken sufficiently frequently to ensure that variations in the

moisture content of the aggregate are fully taken into account in determining the amount of water to be added.

2.3.4. MEASUREMENT OF INGREDIENTS

The aggregates for the concrete shall be measured by weight but measurement by volume may be allowed in special circumstances with approval of the Engineer.

When the aggregates are to be measured by weight the weight batching machines shall be of a type approved by the Engineer's Representative. They shall be kept clean and in good condition and adjustment. At intervals as the Engineer's Representative may require, the Contractor shall check the accuracy of each weight-batching machine.

When the aggregates are to be measured by volume, the proportions of fine and coarse aggregates shall be measured in well constructed gauge boxes, of dimensions approved by the Engineer's Representative to guarantee that whole multiples of such gauge boxes will ensure the use of one or more whole bags or containers of cement and the capacity of the concrete mixer shall be such as to ensure that no splitting of cement bags or containers is required. Gauge boxes shall be properly filled and struck off level, addition of fine aggregates to allow for bulking due to moisture content being made as required.

An efficient water measuring device shall be fitted to each concrete mixer. Any cement container shall be such as to contain an accurately weighed amount of cement.

2.3.5. MIXING CONCRETE

The concrete shall be mixed in a power driven machine of the batch type, no hand mixing shall be permitted. Mixing shall continue until the mass of concrete batch is uniform in consistency and colour. The method of discharge shall be such as to cause no segregation of the concrete materials. Concrete which has commenced to set before placement shall not be re-mixed and shall be rejected and in no case used in the works.

2.3.6. CONCRETE TESTING - COMPRESSIVE CRUSHING STRENGTH

One set of six test cubes (15cm x 15cm x 15 cm) shall be taken from each 6 cubic metre batch or one set of three test cubes for each individual concrete member (anchor block) if the concrete is batched individually. Minimum 6 cubes shall be taken for each 50 m³ concrete volume. The cubes shall be cured in water at ambient air temperature. Three cubes shall be tested at 7 days and the other three at 28 days. The compressive strength shall be deemed to be the average strength value obtained from the three cubes crushed at 28 days. The result of the 7-day cube compressive strength shall act as an early warning indicator that the 28 day strength may not be achieved. It shall be not less than 75% of 28 days test results. If 7 days cubes compressive strength not achieves a specified strength, the contractor shall be stopped all work until a 28 days test result is appeared. Where the specified 28-day strength is not achieved the Contractor shall replace the defective concrete member at his own cost.

2.3.7. CONCRETE TESTING - WORKABILITY

The contractor shall carry out slump tests on each separate concrete batch or delivery and additional slump tests every one hour on the same batch or delivery if the time for placing concrete exceeds one hour. The cost of slump tests is deemed to be included in the cost for providing and placing concrete.

2.3.8. CONCRETE TESTING - MATERIALS

The Contractor shall also obtain and furnish the Engineer with current Material Test Certificates from the concrete supplier or otherwise for the following parameters;

Grading, fine and coarse aggregate
Flakiness and Elongation Index
Compacting Factor Test
Co-efficient of expansion for the aggregates
Absorption Index
Mix Design.

2.4. TRANSPORTING CONCRETE

Concrete shall be taken from the place of mixing to the place of deposition by methods which shall prevent the segregation or loss of the ingredients and which are sufficiently rapid to ensure that the concrete does not commence to set before it is compacted in position. The concrete shall be deposited as near as possible to its final position in the works and shall not be allowed to flow laterally into position. Deposition of the concrete through shuts shall not be permitted nor dropped freely from a height exceeding 1.50m.

2.5. PLACING CONCRETE - GENERAL

Concrete shall not be placed without the Engineers approval. The approval shall be given on satisfactory completion of checking by the Contractor and the Engineers Representative, which shall include the following;

- Extent of the foundation and preparation,
- Character of the bearing surface preparation,
- Correct alignment, placing and cover to reinforcement,
- Overall cleanliness.

The concrete shall be placed in its final position as soon as possible after it has been mixed, and in any case before the initial set has taken place. The Contractor shall ensure that concrete, which has already been placed in position and has commenced to set is not disturbed by the placing and compaction of further concrete nearby. All concrete shall be carefully worked around and between reinforcement and all other embedded fittings without such reinforcement or fittings being disturbed. Concrete is to be worked well up against whatever surface it joins.

Suitable measures shall be taken by the Contractor to ensure that concrete placed in hot weather conditions shall not impair the quality or strength of the final installed concrete. Due regard shall be paid to ambient and mix temperatures. Surfaces and forms prepared to receive the concrete shall be shaded wherever practicable and moistened with water to prevent drying out of the concrete coming into contact with hot surfaces or reinforcement.

The placing fresh concrete will not be allowed if the free fall is not more than 1.50- 2.00 m, concrete shall not be placed in such manner that is displaced reinforcing bonds, ties, etc.

2.6. COMPACTING CONCRETE

2.6.1. TAMPING

All concrete shall be thoroughly compacted to the maximum with approved tampers without any segregation in its final position before it commences to set. Care shall be taken to avoid the use of spade type tampers, which may cause segregation. Initial compaction shall be with tampers and

compaction with screed boards shall be limited to final shape and finish. During the placing and compaction of reinforced concrete, a competent steel fixer shall be in attendance to adjust and correct if necessary the position of the reinforcement.

2.6.2. VIBRATING

Concrete shall be compacted by vibrating with an approved vibrator. The contractor have to prepare at least two vibrators in the site. The vibrators shall not be attached to any reinforcement or embedded fittings and where immersion type vibrators are used; care shall be taken to ensure that they do not come into contact with the reinforcement or embedded fittings. Freshly placed concrete shall not be vibrated in a manner likely to cause damage to concrete, which has already begun its initial set. Concrete shall not be vibrated excessively where segregation would result. Shutter type vibrators shall not be used. Nor shall immersion type vibrators come into contact with the formwork.

2.7. CURING OF CONCRETE

All concrete shall be protected from the harmful effects of sunshine, drying winds, rain, flowing water, or other adverse effects. For at least 7 days after placing, the concrete shall be prevented from drying out by being sprayed with water and covered with Hessian, clean sand or other approved material, which shall be kept wet.

Concrete curing compound shall be readily distinguishable upon the concrete surface for at least four hours after the application. The colour, if any, shall be inconspicuous on exposed surfaces within seven days after application.

The contractor shall ensure that the concrete is adequately protected against inclement weather until properly set and shall if necessary provide additional protection to that specified above.

2.8. INSPECTION OF CONCRETE

The condition of formed surfaces shall be inspected immediately on striking the shuttering by the Contractor and Engineers Representative, for the presence of defects. Any remedial action approved by the Engineers Representative, such as application of cement slurry or mortar to superficial defects, shall be carried out immediately while the concrete surface is still moist and before any curing membrane is applied.

2.9. DEFECTIVE CONCRETE

The Contractor shall on the written instruction of the Engineer's Representative remove and reconstruct any portion of the work which in the opinion of the Engineer's Representative is unsatisfactory as regards the quality of concrete, incorrect dimension or position of the cast concrete, badly placed or insufficient reinforcement, honeycombing or other such cause as to render the construction defective or non compliant with the specification or which may prejudicially affect the strength or durability of the construction.

2.10. REPAIRS TO CONCRETE

The method of repairing and replacing defective concrete, which the contractor proposes to adopt, shall be submitted to the Engineer's Representative for prior approval and the repair shall be carried out in such manner as he may direct or approve.

The damages shall be repaired by the contractor at his expense.

2.11.SUPERVISION OF CONCRETE WORK

Throughout the progress of the concrete work the Contractor shall employ and provide such supervision as is necessary to ensure the following:

- The day to day control of the quality of the concrete;
- The mixing, transporting, placing, compacting, curing and protection of the concrete;
- The testing of concrete and material constituents specified;
- Investigation of defects as required by the Engineer; and
- Preparation of all concreting records and reports as required by the Engineer.

2.12.FINISHING OF CONCRETE

All concrete surfaces not formed by shuttering shall be trowled to a smooth dense surface with the minimum of cement and fine particles being brought to the surface and shall be free from irregularities.

Shuttered surfaces of concrete may be formed by casting against sawn timber. All other exposed concrete including pre-cast concrete shall be cast against steel, plywood or planed timber formwork and shall be carefully rubbed down with carborundum to remove all imperfections and irregularities.

2.13.DESIGN AND CONSTRUCTION OF FORMWORK

Formwork shall in every respect be adapted to the structure and the required surface finish of the concrete. It shall include all temporary moulds for forming the concrete to the required shape and finish for the support of such moulds. It shall be fixed in true alignment and securely wedged and braced so as to be able to withstand, without displacement, deflection or movement of any kind, the weight of the construction and the movement of persons, materials and plant. Joints shall be close enough to prevent the leakage of liquid and fine materials from the concrete.

The Engineer's Representative may require at the prior submission for approval of the Contractor's proposals for the design and construction of formwork including supports. The formwork shall be constructed so as to permit its removal without damage to the concrete.

2.14.SPACING BLOCKS AND TEMPORARY TIES

Internal spacing blocks and construction ties shall be avoided as far as possible and practicable. Where it is intended that these shall be removed whether before or after the concrete has set, the making good of the concrete shall be subject to the Engineer's Representatives approval. The removal of the blocks or internal ties must not jeopardise the stability of the construction. If, with the approval of the Engineer's Representative, these are allowed to remain in the concrete then they shall be of a material and quality that they do not prejudice the strength of the work. Concrete spacing blocks shall be made of concrete at least equal in quality to the main concrete. Metal ties shall be positioned such that they do not come into contact with any of the reinforcement or fittings and no part of the tie shall be permanently embedded in the concrete nearer than 5 cm to the exterior surface of the concrete.

All holes resulting on the concrete surface from their removal or coming from using patent bars shall be in-filled with approved cement grout according to Engineer approval.

2.15.PREPARATION FOR CONCRETING

Immediately before the concrete is deposited, the formwork shall be thoroughly cleaned out and freed from sawdust, shavings, wire cuttings, dust, sand, soil and all other deleterious and extraneous materials. Temporary openings shall be provided in the formwork to facilitate this work. The

internal surfaces of the formwork shall, immediately prior to final erection, be coated with mould oil. The mould oil shall be of approved type and shall be applied uniformly and the quantities used shall be the minimum consistent with its purposes. The contractor shall ensure that all steel reinforcement and adjoining concrete surfaces are kept free of mould oil.

2.16. APPROVAL BEFORE CONCRETING

The Contractor shall in all cases request the approval of the formwork by the Engineer's Representative in sufficient time to allow an inspection to be made and shall not commence concreting until such approval is obtained. The period between the Contractor's request for approval and his intention to commence concreting shall be not less than 24 hours.

Such approval shall not absolve the Contractor of his responsibilities under the Contract.

2.17. REMOVAL OF FORMWORK

All formwork shall be struck without jarring the concrete or subjecting the concrete to sudden shock. Before striking any formwork the Contractor shall demonstrate to the Engineer's Representative that the concrete has attained adequate strength.

Removal of shutter as follows:

Table (2-6): Specified Time for Shutter Removal

Description	Time for Removal (days)
1- Vertical sides of beams , columns and slabs <ul style="list-style-type: none"> • Less than 1.2 m high • More than 1.2 m high 	1 2
2- Concrete Walls	4
3- Beam and main slabs removal of props in summer	14
4- Beams and main slabs removal of props in winter	18

2.18. BLINDING CONCRETE

Prior to placing any structural concrete on natural surfaces, a blinding layer of (B200) concrete shall be laid to a minimum of 50mm thickness. This blinding layer shall be suitably cured prior to subsequent concrete placement. The blinding shall be clean and free from any dust and impurities prior to subsequent concrete placement.

2.19. CONCRETE BELOW GROUND

All concrete placed below ground level shall be painted with at least two coats of hot bituminous (type 75/25) paint membrane plus one undercoat.

2.20. REINFORCED CONCRETE DESIGN

All reinforced concrete shall be designed to BS 8110 or similar approved by the Engineer.

2.21. CEMENT MORTAR AND GROUT

Mortars and grout shall be composed of Portland cement and sand in the following proportions;

Table (2-7): Mortar and Grout Content Ration

Quality	Portland cement	Sand
G1	1	1
G2	1	2
G3	1	3

The amount of water added shall be sufficient to make the mortar or grout workable, consistent with its purpose.

2.22. READY MIXED CONCRETE

The use of concrete delivered to the site in a plastic condition ready for placing in its final position shall be permitted provided that the constituent materials and the concrete mix shall comply with the requirements of this specification and subject to the following conditions:

- Water shall only be added to the mix under the control of the central batching plant,
- No further addition of water shall be permitted,
- Dry batching with water added on site shall not be permitted,
- The Contractor shall submit details of his proposed supplier to the Engineer for approval including copies of all specified current materials test certificates plus copies of batching plant and dosing meter calibration certificates,

The Concrete shall be placed in its final position within 1-hour maximum of the time of adding cement to the wetted aggregates.

The contractor shall provide one copy of the delivery ticket number together with a record of the slump test on site, times of placing, completion time of placing, position of placing plus the works test cube reference number. If necessary the site test cubes results should be capable of being compared with the central batching plant cube results.

2.23. REINFORCEMENT STEEL

The Contractor shall be responsible for the provision of reinforcement steel in sufficient quantity and of the specified steel grade, diameter, length and shape as shown on the drawings.

All reinforcing steel shall be high yield deformed reinforcing steel bars with yield strength of 420 N/mm².

Mild steel where otherwise specified shall be either deformed or plain bars to BS 4449.

Tying wire shall be No. 16 gauge soft annealed iron wire.

2.24. REINFORCEMENT STEEL FIXING

Prior to concreting the Contractor shall ensure that all reinforcement bars are entirely free from loose mill scale, loose rust, oil, grease, paint, mould oil, and all other deleterious and extraneous material. All hooks, bends and shape codes for bar bending schedules shall be to BS 1478, or equivalent to be approved by the Engineer. Bars shall be bent to the correct radius around proprietary mandrels of the requisite diameter.

All bars to be fixed shall be so positioned to provide the specified cover of concrete. The steel reinforcement bars shall be fixed with tying wire to form a rigid cage.

Reinforcement projecting from the framework for continuation shall be adequately supported throughout concreting and shall not be sent out of position.

The Contractor shall in all cases request the approval of the steel fixing by the Engineer's Representative in sufficient time to allow an inspection to be made and shall not commence concreting until such approval is obtained. The period between the Contractor's request for approval and his intention to commence concreting shall be not less than 24 hours.

Such approval shall not absolve the contractor of his responsibilities under the Contract.

2.25. CONCRETE SPACING

- Concrete spacing blocks shall be used to ensure correct placing and cover of the bars.
- The cover to reinforcement between the outside of the bars and the concrete face shall be 50mm, or as specified in drawings or as instruction of engineer, if concrete face is in contact with soil and or sewage. Where concrete face is in contact with air, the cover shall be 25mm. With straw rope covered by Hessian cloth and secured in place by binding wire which shall be carried under the flange of the gland
- All plain ends shall be adequately protected by straw rope secured in place by binding wire or strap. None of the packing will be returnable. The cost of packing shall be included for in the schedule rates.
- The materials supplied shall be of the appropriate grade and quality and shall be adequately protected against the climatic conditions in the middle East.
All plastic materials shall be protected from direct sunlight and appropriate coverings supplied for use at the delivery and storage areas.

2.26. MEASUREMENT AND PAYMENTS

The prices inserted in the B.O.Q for concrete 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 and subsequent removal to tip of trial panels, mixing, transporting, placing, compacting, curing, surface finishing, protection, construction of expansion joints, repairs to concrete, water stop, formwork and all labor and materials and tests.

3. CONCRETE STRUCTURES

3.1. GENERAL

All concrete structures shall be supplied by the Contractor.

3.2. PRECAST CONCRETE MEMBERS

The Contractor shall cast and install pre-cast concrete beams, slabs and manholes according to details shown on the Drawings. The Contractor shall complete casting of the pre-cast elements in due time, so as to avoid delays to the execution of other Works. The Contractor may either bring to the Site ready-made pre-cast concrete members cast elsewhere or cast them on the Site of Works. In any case casting shall be carried out under the Engineer supervision and the Contractor shall be obliged to obtain the Engineer or his representative approval to the casting methods prior to commencement of Work.

Pre-cast members shall be of concrete class as shown on the Drawings or mentioned in the Specifications and shall pass the required tests.

During casting, concrete shall be well consolidated and vibrated by mechanical vibrators, so as to produce members free of voids or stone pockets.

All pre-cast concrete elements shall conform to the Drawings as to shape and dimensions, all concrete faces shall be straight and leveled, unless otherwise shown on the Drawings. Installation of pre-cast elements on the Site shall be carried out by placing them in position according to details shown on the Drawings. Surfaces resulting from installation of pre-cast elements shall be straight and accurately leveled unless otherwise directed.

Any pre-cast concrete elements damaged during casting or fixing or from any other cause will be rejected by the Engineer or his representative, and the Contractor shall forthwith remove such rejected elements from the Site of Works, and shall provide new elements to replace those rejected, all at the Contractor's expense.

3.3. EMBEDDED METAL PARTS

Parts of metal Work, such as pipes fixtures for wall brackets, hooks and similar parts are to be embedded in the concrete and shall be attached to the forms in their proper position prior to placing of the concrete. All expense for and in connection with the installation of such metal parts shall be included in the unit prices for the concrete in which they are to be embedded.

3.4. OPENING AND HOLES IN CONCRETE

Where it is impracticable, as determined by the Engineer or his representative, to install metal parts in the forms as required under subsection 7.2.3.3, suitable holes or recesses shall be formed in the concrete structure into which the metal parts can be placed and grouted in. The shape and dimensions of such holes shall be as shown on the Drawings or as determined by the Engineer or his representative, and they shall be formed with wooden core boxes, fabricated in such a manner that they can be completely withdrawn or broken up and removed after the concrete has set. All such core boxes shall be set with great accuracy with the aid of templates and securely fixed to prevent displacement during concreting. The supply and installation of all such core boxes and their removal when the concrete has hardened sufficiently is deemed to be included in unit rates for concrete.

Where the holes or openings have not been formed in the concrete during placement, the Engineer or his representative may either order the tearing down and rebuilding of the structure or the part thereof concerned, or permit such holes or openings being cut in the hardened concrete to the dimensions shown on the Drawings or as directed by the Engineer or, his representative. Such cutting shall be kept to the minimum necessary dimensions and shall be done by drilling. Chiseling

or the use of a power tool, all as approved by the Engineer or his representative and in such a manner as not to cause any damage to the concrete structure.

Reinforcement bars passing through such holes or openings shall not be cut without the express written permission of the Engineer or his representative.

Where the forming of the opening or holes has been omitted by the Contractor's neglect, all tearing down and rebuilding or cutting of holes and openings in the hardened concrete as aforesaid shall be done by the Contractor at his own expense, in all other cases the cost thereof shall be born by the Employer and shall be paid for as extra Work.

3.5. BITUMEN COATING OF CONCRETE SURFACES

Bitumen coating of concrete surface where required shall be carried out according to B.S. or Israeli Standards, type 75/25. When bitumen protection is required to the floor of the structure, it shall be applied to the lean concrete layer on which the floor shall be cast. In this case the glass mat fabric of the coating shall be left projecting some 15 cm on every side, and after the floor and wall have been cast it shall be folded upward and fixed to the wall with hot bitumen, and only then shall coating of the outer surface of walls, as specified above, be continued.

The corner formed between the layer of lean concrete and the bottom of the wall shall be filled with bitumen.

Care should be taken to cover properly the vertical edges of the structure by folding over the glass fabric from one wall to the other and sticking it on with hot bitumen.

3.6. WATERSTOPS

3.6.1. 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 250X4mm.

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 C⁰ 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 from oil or grease.

3.6.2. RUBBER WATERSTOPS

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.

3.6.3. 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.

3.7. 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.

3.7.1. 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 shall be either pre-cast or cast in place reinforced-concrete as marked on the Drawings. The cast iron frames and covers for manholes shall be brought to grade by the number of courses of concrete blocks shown on the Drawings and a reinforced concrete frame into which the cast iron frame is embedded. Concrete B300 shall be cast to a minimum thickness of 150mm around the concrete blocks for rigidity.

Manhole walls (rings) 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 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 centre lines of adjoining pipelines all as indicated on the drawings and approved by the engineer.

3.7.2. 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 approved type shall be placed when the concrete cast on stages.

3.7.3. PRE-CAST CONCRETE MANHOLE

This type consists of a cast-in situ or pre-cast 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), pre-cast 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 pre-cast 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.

3.7.3.1.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

3.7.3.2.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.

3.7.4. 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.

3.7.5. 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 square, 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 sewage manholes covers shall have the word (SEWAGE) 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.

3.7.6. 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.

3.8. INTERLOCK BLOCK PAVERS

3.8.1. GENERAL

The work shall consist of the construction of Interlock Block Pavers in accordance with Specifications, Drawings and the Engineer or his representative Instructions. Precast Interlock Block Pavers shall be formed by homogeneous elements 6 cm thickness to be used in sidewalk and 8 cm thickness to be used in drive way.

The maximum dimension deviations from the stated work sizes for Interlock Block Pavers as follows:

- Length+2mm.
- Width + 2mm.
- Thickness + 3 mm.

The finished product shall be of solid appearance with clean face, be free of segregation, honeycombing and no evidence of internal rendering.

3.8.2. MATERIAL

Material shall be conforming to the requirements specified in BS 6717 as specified herein.

The aggregate shall conform to the appropriate British Standard. In composite paving blocks, the surface layer shall be formed as an integral part of block and shall not be less than 5 mm thick. Retarding, color and any admixtures shall not have adverse effect on properties of Interlock Block Pavers.

Interlock Block Pavers shall be made using one or more of binders conforming to the appropriate British standards.

The Contractor shall submit samples of various types of Interlock Block Paver for approval of color and shape by the Engineer or his representative prior to commencing the Work.

3.8.3. COMPRESSIVE STRENGTH TEST

Test shall be carried out on Interlock Block Pavers according to BS 6717 to ascertain the strength. Before laying -Interlock Block Pavers, 16 samples collected, each 2 sample shall represent 5000 blocks. All samples stored for (24 ± 4) h in water maintained at temperature of (20 ± 5) C°. The average compressive strength of 16 samples shall be not less than 490 kg/cm² and crushing strength of any individual block shall not be less than 400 kg/cm².

3.8.3.1. Abrasion Test

Test shall be carried out to a certain surface requirement using Bohme machine according to DIN 52108 with natural abrasion material or artificial corundum.

The average Abrasion of 16 samples shall not exceed 5 mm and not exceed 6mm for each individual sample after 440 revolution of abrasion machine.

3.8.3.2. Absorption Test

Absorption should not be more than 2% after 10 minutes and not more than 5% after 24 hours by weight of each sample.

The wearing layer thickness (bazilet) should not less than 5 mm

3.8.4. CONSTRUCTION

Interlock Block Pavers shall be set on to locations and grades shown on the Drawings and shall be laid directly on a granular material. Granular material shall be placed on the top of a crushed aggregate base course layer to adjust the final level of the Interlock Bloc Pavers and to fill the joints between the Blocks.

All Interlock Block Pavers shall be thoroughly cleaned of all extraneous material prior to approval. All Interlock Block Pavers shall be laid within a tolerance of plus or minus three (3) mm, at, each end of an element, to the lines and grades given on the Drawings.

All Interlock Block Pavers shall be compacted by a compactor plate to the satisfaction of the Engineer or his representative.

4. BLOCK WORKS

4.1. 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.

4.2. MATERIALS

4.2.1. 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.

4.2.2. AGGREGATES

Aggregate for solid and hollow concrete blocks and mortar shall conform to the requirements for fine aggregates in the "Concrete Work" Section.

4.2.3. WATER

Water to be used in block work shall conform to the requirements specified for water in the "Concrete Work" Section.

4.2.4. 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.

4.3. MANUFACTURE OF CONCRETE BLOCKS

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 five (5) standard bags (each weighing 50 kgs) per cubic meter of concrete.

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.

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 or manufactured on the site. If manufactured on site, the blocks shall be press molded in approved molds and vibrating press wire machines with a minimum of 2800 cycles per minute.

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.

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

The nominal width of blocks shall be as indicated on the Drawings and as directed by the Engineer.

Hollow concrete blocks shall comply with the following requirements: -

Compressive Strength at Twenty Eight (28) Days Over Cross-Sectional Area: -

- a) Load-Bearing Walls
 - 60 kgs/cm² average of 12 blocks
 - 50 kgs/cm² minimum for any block
- b) Non-Load-Bearing Walls
 - 30 kgs/cm² average of 12 blocks
 - 25 kgs/cm² minimum for any block

Water Absorption

20% or less of dry weight

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 40mm. 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.

4.4. MORTAR

Mortar shall be prepared in the following proportions with the addition of the minimum quantity of clean water for workability:

Cement and sand mortar (1:3) mix, shall be composed of one part cement to three parts of sand by volume.

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.

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.

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.

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 from the site.

4.5. WORKMANSHIP

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.

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.

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 1.00 m above another at one time, and wall of partition necessarily left at different levels, must be racked back. All per-pends, quoins, internal and external angles, etc. properly bonded together and leveled round. All block work shall be plumbed vertically.

The surface of the walls and partitions prepared for plastering shall have the joints raked out 10 mm into the face of the wall to form key for the plaster.

All block walls shall be bonded to reinforced concrete columns by means of wall ties, complying in all respects with B.S. 1243 latest edition. The ties shall be minimum 200 mm long of which 100 mm shall be embedded in the reinforced concrete column and the remainder set into the block wall at the rate of two (2) ties per meter. Partitions shall be bonded to main wall by tothing at every fourth course into main wall to a depth of not less than 100 mm.

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.

Walls and partitions terminating against soffits of beams or slabs shall be lightly wedged with metal wedges after mortar in bed joints has attained its initial set, and the joint packed with mortar.

Cut and fit block work next to reinforced concrete door, window, jambs and sills, and form chases for the ends of the door and window lintels. No hollow blocks shall abut any built-in fixtures e.g. door and window frames, apertures, louvers, etc.

The cavity between skins of block work shall be 100 mm (nominal) wide and kept clear throughout the construction of the hollow walls. The skins of hollow walls are to be tied together with butterfly twist type galvanized steel wire to the approval of The Engineer and built into each skin one meter apart horizontally and every alternate course, staggered.

5. FLOOR, WALL, AND CEILING FINISHES

5.1. GENERAL

This section of the specifications covers plaster works and other floor, wall and ceiling finishes intended for the works all in accordance with the drawings, bill of quantities, and as directed by 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 makes, 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, pre-cast terrazzo tiles, ceramic tiles, and aluminum profiles.

5.2. PLASTERWORK

5.2.1. MIXING OF INGREDIENTS

Except where hand-mixing of small batches is approved by the Engineer, mechanical mixers of an approved type shall be used for the mixing of plaster.

Frozen, caked or lumped materials shall not be used. Mechanical mixers, mixing boxes and tools shall be cleaned after the mixing of each batch and kept free of plaster from previous mixes. Plaster shall be thoroughly mixed with the proper amount of water until uniform in colour and consistency. Re-tempering will not be permitted and all plaster which has begun to stiffen shall be discarded.

All plastering shall be executed in a neat workmanlike manner and internal and external angles shall be true, straight and plumb. Plaster shall be made good adjacent to wood or metal frames, skirtings and around pipes or other fittings.

All tools, implements, vessels and surfaces shall at all times be kept scrupulously clean and strict precautions shall be taken to avoid the plaster or other materials becoming contaminated by pieces of partially set material which would tend to retard or accelerate the setting time.

5.2.2. PREPARATION OF SURFACES

All surfaces to be plastered shall be clean and free from dust, grease, loose or projecting 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.

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.

Before plastering is commenced all junctions between differing materials shall be reinforced. This shall apply where walls join columns and beams, particularly where flush, 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 45cm 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 meter cube of sand shall be applied and allowed to dry before rendering is commenced. All surfaces of walls shall be wetted immediately prior to applying the first coat of rendering and this shall be allowed to thoroughly dry out before the next coat is applied.

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.

5.2.3. APPLICATION OF COATS

5.2.3.1.Base-Coat (Rendering)

After the application of the spatter-dash "Rasheh" the base coat shall be applied after the spatter-dash coat has set but in no case earlier than 24 hours after the application of the spatter-dash coat.

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 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 2 days and then allowed to dry out.

5.2.3.2.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. 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 skirtings and around fittings and pipes. Angles shall be rounded to a 6mm radius.

5.2.4. PROPORTIONS FOR INTERNAL AND EXTERNAL PLASTER

Internal and external plaster shall be composed of 400kg of cement per one cubic meter of salt free sand.

Plastering shall be applied in three (3) coats unless otherwise specified or indicated on the Drawings and Bill of Quantities.

Finishing coat shall have a reasonably uniform thickness of approximately 5mm.

Screeds shall be laid and ruled as necessary to allow for a total thickness of 15mm for external and internal plaster and the rendering shall be applied to the required thickness.

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 splicers, hangers, clips and wall mounting next to walls. The system shall be installed complete in accordance with the manufacturer's instructions.

The metal grid suspension system shall be concealed and shall allow for the whole of the ceiling to be demountable.

All concealed ferrous metal members such as channel runners, Z-bars, clips and splines shall have an approved corrosive-resistant finish.

5.2.5. METAL LATH

At all junctions of dissimilar materials (i.e. concrete and blockwork or steel elements) the joint shall be covered by metal lath strips not less than 200mm in width securely fixed to the surface.

5.2.6. TYROLEAN PLASTER (FINE GRAIN)

5.2.6.1.General

The Tyrolean plaster shall be executed to the extent shown on the Drawings and as directed by the Engineer.

The contractor shall provide sample(s) of Tyrolean plaster, for the approval of the Engineer prior to commencement of Tyrolean work.

5.2.6.2.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.

5.2.6.3.Proportions

Proportions of materials for tyrolean, by volume shall be as follows:

1. Scratch Coat
 - 1 part Ordinary Portland Cement
 - 3 parts fine aggregate
2. Finish Coat
 - 1 part of white portland cement
 - 3 parts fine selected aggregate

No lime shall be allowed in either scratch or finishing coat, scratch coat shall be set on spatterdash.

5.2.6.4. Application of Tyrolean

- **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 20mm. thick (i.e. spatterdash, cratch coat and one tyrolean coat).

All exterior corners of tyrolean shall be slightly rounded. Tyrolean on soft surfaces shall be pitched forward to form a drip

- **SCRATCH COAT:**

Shall be approximately 14mm. thick and shall be applied under sufficient pressure to form goods keys and shall be brought to a plumb, true even surface. The scratch coat shall be damp-cured 48 hours before the finish coat is applied.

- **FINISH COAT:**

Shall be approximately 6mm, thick. 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 fogspraying. 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. The Contractor shall set up samples of different degrees of fineness for the Engineer's approval. The Engineer may choose different degrees of fineness for different parts of the works and the Contractor shall allow for this in his rates.

- **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.

- **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.

5.3. TERRAZZO TILING

5.3.1. MATERIALS

Pre-cast terrazzo units shall be formed with A 1:2.5 mix of white or tinted cement and granular marble chipping for the topping (wearing layer) set on a cement and sand backing of 1:3 mix, and

shall be obtained from an approved manufacturer and shall be in accordance with the requirements of BS 4131 or 4357.

These units (tiles) shall be cast in heavy steel molds under pressure to form the dimensions and patterns as stated in the bill, grinding shall be done wet by means of a no. 80 carborundum stone. Filling shall be carried out with a neat cement grout of the same color as the facing mix in order to fill all voids & air holes. 24 hours later, wet polishing by means of a no. 140 carborundum stone shall be carried out, and all units cured by immersion in clean water for 24 hours. Samples shall be subject to Engineer's approval prior to work.

5.3.2. INSTALLATION

Terrazzo units shall be laid on a bed of sand with a 1:3 mix of cement and sand mortar with a lime admixture.

Grouting shall be done neatly using a matching color or cement, and all tiling, surrounding surfaces, and surplus cement shall be cleaned off carefully.

Upon completion all terrazzo surfaces shall be wet polished using a no. 140 carborundum stone.

All units shall be well shaped with straight edges perfectly flat and free from defects, which effect appearance and serviceability.

Chipped units or units with cracks or defects will not be accepted and shall be replaced at the Contractor's expense and to the satisfaction of Engineer.

5.4. CERAMIC AND WALL TILING

5.4.1. MATERIALS

Ceramic floor tiles shall be first quality Spanish Type 20x20cm vitreous clay non-slip tiles with keyed backs, and a minimum thickness of 6mm or of the sizes indicated on the drawings. Samples of tiles shall be submitted to Engineer for approval of quality and color prior to order. For walls tiles shall be first quality Spanish type 20x20cm and a minimum thickness of 6mm. Glazed samples shall be submitted to the Engineer for approval.

5.4.2. 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.

All joints shall be as close as possible and shall in no case exceed 0.5 mm in width on face. Tiles shall be neatly cut and fitted around pipes and other obstructions.

The surface of the floor and wall shall be very gently rubbed with a wood block to bring the tile surface to true planes. Excess slurry shall be removed, and the floor shall be rubbed with burlap to clean the tiles and finish the joints to the satisfaction of Engineer.

5.5. MARBLE FLOOR TILING

Marble slabs for flooring, skirtings and the like shall be first quality local marble obtained from an approved supplier.

The marble slabs shall be of the dimensions and thickness shown on the drawings and in the Bills of Quantities and shall be uniform in color and texture, smooth and free from voids, earth veins, lamination and the like, and shall be of an approved color and to the pattern and sizes shown on the drawings.

Samples of marble slabs shall be submitted to the Engineer for approval prior to order.

Marble slabs shall be cut square, true and shall be uniform in shape in thickness. Mortises shall be carefully cut without causing any damage to marble, and rebates shall be carefully formed by special machines to the width and depth required to the satisfaction of the Engineer.

Marble slabs for floor finish and marble treads shall be laid 1' on a bed of sand with cement and sand mortar (1:3) mix.

All marble slabs shall be backed with stain proofing in accordance with the manufacturer's instructions.

Marble skirtings and rises shall be bedded with same mix as for floor marble but without the bed of sand.

All joints shall be thoroughly grouted with unstained cement and cleaned well before it sets hard.

All exposed faces and edges of marble shall be polished, smooth, free from scratches or other defects and properly protected from damage by means of timber casings. All workmanship shall be of the best of its kind and shall be carried out in a manner satisfactory to the Engineer.

5.5.1. MARBLE THRESHOLDS AND WINDOW SILLS

Unless otherwise shown on the drawings or stated in the Bills of Quantities, marble thresholds and window sills shall be first quality local marble obtained from an approved manufacturer. Thresholds and window sills shall be of the thickness and widths shown, of one piece and full length of the opening, leveled on both sides with hone finish on all exposed surface. Ends of thresholds shall be fitted accurately to jambs.

5.5.2. PROTECTION AND CLEANING MARBLE

Great care shall be taken to protect delivered and erected marble from chipping and staining during the course of the work. Delivered marble shall be stored in a water free area on raised platforms and shall be covered with tarpaulins or similar material until required for use.

Erected work shall be protected at corners, etc., with non-staining wood formwork, boards, etc. Floors shall be protected with suitable boarding, etc. after laying. Any work damaged or stained at the time of handing over shall be replaced or cleaned as required by the Engineer.

After completion of setting, all marble work shall be thoroughly cleaned by scrubbing with fiber brushes and mild alkaline solution that contains no caustic or harsh fillers. The use of wire brush or acid solution will not be permitted. Cleaning shall begin at the top of the building and proceed downwards. Upon completion all marble shall be left clean and free from stains or traces of cleaning fluid and with all joints pointed and to the entire satisfaction of the Engineer.

5.5.3. FLOOR DRESSING

The granular abrasive powder shall be troweled into the finishing surfaces of the screed applied as desired hereinabove; working out of the dressing shall strictly conform to the method of application recommended by the manufacturer of material.

Marble Works shall be of the following specifications:

- Local marble (Yatta) 3cm thick will be used for doors entrances WCs, main entrances, staircases and roof parapets and Window sills.

6. METALWORK

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.

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. 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.

6.2.3. GALVANIZED STEEL PIPES

Galvanized steel pipes shall conform to the requirements of B.S. 1287 - I.S.O. "Medium Series".

6.2.4. PAINT

Paint for Metalworker shall comply with the applicable requirements as specified under "PAINTING".

6.2.5. ALUMINUM

All aluminum elements shall be manufactured of extruded sections of aluminum alloy, mechanically jointed. Fittings shall be aluminum alloy in accordance with B.S. 1331 the latest edition.

All parts and members shall be of aluminum commercial quality like (Al-Mg-Si) heat-treated, free from defects impairing its strength and durability and containing not more than 0.4% copper. All exposed surfaces shall be polished to a mirror-like surface, free from defects, and shall be as shown on Drawings and as directed in writing by the Engineer. Aluminum shall be treated to comply with B.S. 1615 and B.S. 3987.

All aluminum sections shall present clear straight and sharply defined lines and shall be free from defects and imperfections that may impair their strength.

All screws, bolts and other necessary accessories shall be of aluminum or other non-corrodable material and shall match in color and consistency the finish of the approved aluminum.

Aluminum elastic glazing beads shall be provided to all windows and doors which are assembled by pressure to fit with the relevant groove in the profile.

The glazing bars shall be threaded or interlaced at points of intersections and machine tenoned to frame.

6.2.6. STAINLESS STEEL

Stainless steel sections, sheets and strips shall be of authentic non-magnetic steels, 18/10/3 chromium nickel-molybdenum group as explained in publication PD 6290 New designation system for stainless steel issued by the British Standard Institution.

6.3. MANUFACTURE

6.3.1. GENERAL

The Contractor shall be responsible for the correctness and accuracy of the dimensions of the finished articles.

He shall therefore carefully check the dimensions indicated on the Drawings, verify any change ascertain the sizes at 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 be placed after the Contractor has obtained in writing the approval of the Engineer on the above Drawings.

The steel sections where specified to be factory rust-proof shall be rust-proofed by hot dip galvanized, metalizing or sheradizing process. The rust-proofed shall be sufficient to withstand the 72 hours salt-spray test as provided for in B.S. 1391. If the rustproof coating shall be damaged during the progress of work, the damaged part shall be recoated to minimum the original thickness to the satisfaction of the Engineer.

6.3.2. 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 sheet steel 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 No. 8 anchors, one end welded to frame and other end dovetailed.

6.3.3. HOLLOW METAL DOOR FRAMES

Hollow metal door frames shall be purpose made to the profiles and sizes shown on the drawings and obtained from an approved manufacturer. The door frames shall be from 2.5mm thick, twice laminated steel sections and be delivered to site complete with a factory applied anti-corrosive plastic coating., ties cast on 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.

6.3.4. ALUMINUM WINDOWS, DOORS

The aluminum windows and doors etc... with all necessary accessories and fittings shall be of the pattern, design, dimensions and thickness shown on the Drawings and obtained from an approved manufacturer.

Prints of shop Drawings for aluminum windows, doors, frames etc... showing the dimensions, sizes, thickness, materials, finishes, joining, attachments, fasteners and the relation of this section to

adjoining work, shall be submitted to the Engineer for approval before ordering any material. All work shall be fabricated and erected in accordance with the approved Drawings.

All aluminum windows, doors, frame, etc... shall be factory assembled and reinforced to the Drawings, complete with hinges, glazing gaskets and anchors. The only Site work allowed on Aluminum units is fixing in position and glazing. The finished surfaces shall present a clear surface free from alloy defects, scratches, or other surface blemishes.

6.4. WORKMANSHIP

6.4.1. STEEL ELEMENTS

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.

All steel members in contact with the soil shall be painted with two (2) coats of protective asphalt paint. All doors frame staircases, etc... shall be given at least one (1) coat of approved rust inhibiting primer before delivery to Site.

Frames for doors and windows shall be provided with not less than (3) adjustable type anchors on each jamb; maximum distance between anchors shall be eight hundred (800) mm.

All joints shall be machined to a close fit and all pins and screws shall be countersunk and dressed flush after assembly.

Forging shall be sharp and true curbs and intersections, members of the same size shall be halved together.

The plain surfaces shall be smooth, free from warp or buckle. Moulded members and mitres shall be clean, cut, straight and true. Construction joints shall be welded their full length and cleaned off flush on exposed surfaces.

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.

Hardware for steel doors, etc... shall be as specified in the B.O.Q.

6.4.2. ALUMINUM WINDOWS AND DOORS

The Contractor shall furnish and install all aluminum units as indicated on the Drawings. Workmanship and installation shall be in accordance with recommended standard of First Class Aluminum Manufacturers.

All aluminum work shall be performed in a shop where grade of metalwork is of recognized quality acceptable to the Engineer. All items shall be installed plumb, straight, square, level and in proper elevation, plane location and alignment with other work. All work shall be designed for adjustment to field variations, fitted with proper joints and intersections, adequately anchored in place, strictly in accordance with best practice. Where aluminum surfaces come in contact with metals other than stainless steel, zinc, white bronze or small areas of other metals compatible with aluminum surfaces they shall be kept from direct contact with such parts by painting the dissimilar metal with a prime coat of zinc-chromate primer or other suitable primer, followed by one or two coats of aluminum metal-and-masonry paint or other suitable protective coating, excluding those containing lead

pigments or a non-absorptive tape or gasket shall be placed between aluminum and dissimilar metals. Steel anchors and connecting members shall be hot dip galvanized or zinc plated after fabrication.

Aluminum surfaces in contact with lime mortar, concrete, plaster or other masonry materials shall be painted with alkaline-resistant coating such as heavy-bodied bituminous paint or water white methacrylate lacquer.

Aluminum in contact with wood or absorptive materials which may become repeatedly wet shall be painted with two coats of aluminum metal-and-masonry paint or a coat of heavy-bodies bituminous paint. Alternately paint the wood or other absorptive material with two coats of aluminum house paint and seal joints with a good quality of caulking compound.

Where aluminum is in contact with treated wood, wood shall be treated with pentachlorophenol, 5% minimum concentration or approved equal, followed with the protective measures described for aluminum in contact with wood or other absorptive materials.

The aluminum work shall be designed and anchored to that the work will not be distorted nor the fasteners overstressed form the expansion and contraction of the metal.

Before shipment from the factory, aluminum surfaces requiring protection shall be given a coating which will protect the metal during construction in areas where appearance of the finish on Aluminum items is important, a coating of methacrylate type lacquer shall be applied as specified hereinafter.

Apply two sprayed coats of water-white methacrylate lacquer having a total minimum thickness of 0.015 mm, which when applied to the aluminum surface shall be capable of withstanding the action of lime mortar for a period of at least one week in an atmosphere of 100% relative humidity at 40°C, the action of 10% (by weight) muriatic acid for a period of six hours at 20°C, and the action of atmospheric weathering for a period of 12 months. The coating shall be applied in the manufacturer's plant to the exposed surfaces of all aluminum components subject to staining from alkaline mortar and plaster, abrasion and other construction abuses. Before application of lacquer, the manufacturers shall remove all fabrication compounds, moisture, dirt accumulations and other foreign materials to ensure proper lacquer adhesion.

Upon completion, the Contractor shall clean all aluminum work as required by removing protective tape or other coating, using mild soap or detergents and clear petroleum spirits.

Acids, caustics and abrasives shall not be used. Where cleaners are used to remove excess sealings compounds care shall be exercised to prevent damage to seals or staining or damage to adjacent work.

The Contractor shall be responsible for the protection of all aluminum work until the completion of the works, and only units in perfect working order and in perfect conditions shall be accepted.

6.4.3. 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.

6.5. 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 be submitted to the Engineer for approval before ordering the materials.

6.6. 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 be built into walls truly level and in vertical lines as shown on the Drawings or directed by the Engineer.

6.7. 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.

6.8. STEEL HANDRAILING AND 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 shall wherever possible be horizontal and circular. Horizontal and side palm plates shall be secured (I) by not less than three bolts of not less than 12mm diameter and 75mm length. Hand railing, base and palm plates shall be I painted after erection. Painting shall be deemed to be included in the Contract rates for hand railing.

6.9. 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 be supported on galvanized mild steel frames. The frames shall have mitred 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 be carried out after all welding and fabrication is complete.

6.10. 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 be supplied complete with the fixing supports which must be galvanized steel pipes, 2" diameter.

6.11. 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 steel in building. Part 2: Metric Units).

6.12. MEASUREMENT OF STEELWORK AND METALWORK

Unless otherwise specified, the cost of preparation for and application of protective systems and paint to steelwork and metalwork shall be included in the Contract Rates for the various items of steelwork and metalwork.

The forming of all necessary holes and recesses in concrete work to receive steelwork and metalwork shall be deemed to be included in the Contract Rates for the relevant steelwork and metalwork.

The Contract Rates for structural steelwork shall include for designing, detailing, supply, preparation, painting and erection of structural steelwork complete all as specified. Structural steelwork will be measured by weight and for this purpose the weight will be calculated from the length of each section required when fixed in the permanent structure and the weight per unit length of that section as listed in British Standards or if not so listed then as given in the steel manufacturer's tables. No allowance will be made for any rolling margin and no measurement will be made of any nuts, bolts, paint, welding materials or the like, but no deduction will be made in respect of any bolt hole.

The Contract Rates for miscellaneous metalwork shall include for supply, preparation and painting or galvanizing, fixing and building in complete with all necessary fixings, nuts and washers. Miscellaneous metalwork including iron steps, galvanized steel cover metalwork, ladders and others will be measured as supplied and fixed as specified. Contract Rates for galvanized steel covers shall include for supplying and fixing complete with frame hinges, locking hatch and lifting handles as specified on the Drawings.

Fencing will be measured as the length supplied and fixed as specified. The Contract rates shall include for supplying and installing complete with all hinges, ties, plunger bars, as specified on the Drawings including all excavation, backfilling and concrete work as necessary.

7. PAINTING

7.1. 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, Bills 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 or finish coats.

All painting works shall be applied by skilled workmen experienced in this work.

7.2. MATERIALS

7.2.1. MATERIALS IN GENERAL

The materials to be used shall be of the best quality and of approved types, obtained from an approved manufacturer.

All paints shall comply with the following requirements:

- a. The product shall be thoroughly mixed and ground.
- b. The color of the paint shall match the approved samples.
- c. Paint shall show no evidence of cracking, chipping or flaking.
- d. Paint in the containers during and after application shall not be abnormally pungent, offensive or disagreeable.
- e. 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.
- f. 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, highlighted spot or brush marks. Tinted paints shall dry to a uniform color.
- g. Re-coating of a previous painted surface shall produce no lighting softening or other film irregularities.

7.2.2. 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 shall be in accordance with B.S. 1336 latest edition.

7.2.3. 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.

7.2.4. FILLERS

Shall be "Polyfilla", "Alabastine" or approved equal.

7.2.5. STOPPING

Stopping shall be hard stopping composed of white lead paste, gold size (oleo resinous medium) and other fillers obtained from an approved supplier.

7.2.6. 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.

7.2.7. THINNERS

Shall be an approved turpentine or white spirit, except where the paints are specified to be water thinned, fresh water shall be used.

7.2.8. PIGMENTS

It shall be pure tint colors that will easily dissolve and mix with the various coatings and shall conform to the requirements of B.S. 1014: 1961 "Pigments for cement, magnesium oxychloride and concrete".

7.2.9. RUST INHIBITOR

Shall be "Galvafroid" primer, manufactured by "Seconrastic Ltd" .Brackwell, Berks, England" or Crown Chorinated Rubber Zinc Rick Primer-Product Data Sheet No.56, manufactured by the Walpamur co. Ltd., Darwen Lancs" or approved equivalent.

7.2.10. PRIMERS

Primers applied to surface of different materials shall be as follows:

- a. Interior or exterior plastered surfaces:
Alkali resistant primer as recommended by the manufacturer.
- b. Ferrous Surface:
Lead based or zincs Chromate and Calcium Plumbate as recommended by the Manufacturer.
- c. Non-ferrous surface:
Mordant solution of an approved brand and rust inhibiting primer.
- d. Woodwork Surface:
Leadless grey primer in accordance with B.S. 2524 latest edition.

7.2.11. UNDERCOATING PAINTS

For exterior or interior shall be as follows:

- a. 2 coats of whitewash or color wash as shown on the Schedule of Finishes and the Drawings.
- b. White lead bases undercoating in accordance with B.S. 2525: Colours shall be similar to the finishing paint.

- c. Other undercoating paints to be applied as recommended by the manufacturers of the finishing paint.

7.3. FINISHING PAINTS

Shall be as follows unless other wise indicated on the Drawings:

- a. Interior plastered surfaces and exposed concrete surfaces as shown on the Drawings:
Float enamel paint or approved emulsion paint for interior use of an approved colour and supplier.
- b. Exterior exposed and plastered surfaces as shown on the Drawings:
Approved emulsion paint for exterior use of the colour indicated on the Drawings.
- c. Interior or exterior ferrous and nonferrous surfaces, ditto:
- d. Interior woodwork surfaces:
Oil paint semi-gloss finish of an approved manufacturer.

7.3.1. WORKMANSHIP

7.3.1.1.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 that the material is at 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 judged necessary by the Engineer the paint samples may be tested 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 products 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 etc... 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 surface, 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 *F'* painting shall be so programmed that dust and other *i'*2 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 attention to insure that they -receive and 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 sand papered smooth.

7.3.1.2.Plastered Surfaces 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 reappears in which case it shall be brushed off 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.

All plastered and concrete surfaces shall be twice stopped with approved putty filler. 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 sand paper until smooth surface is achieved.

A minimum of two (2) 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.

7.3.1.3.Ferrous Surfaces:

Surfaces shall be thoroughly cleaned to remove dirt, wire brushed and scraped to remove scale and rust. One coat of approved putty shall be applied on the surface and left to dry 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 "Galvafroid" primer or other 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 surface 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 re-primed 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 under-coat 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.

7.3.1.4.Non-Ferrous Surfaces

Galvanized steel surfaces to be painted shall be solvent- cleaned or painted with mordant solution before the application of paints as described above for ferrous surfaces.

7.3.1.5.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 present shall be removed by washing, rubbing down and burning off as necessary. Oily 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 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.

8. SANITARY INSTALLATIONS

8.1. GENERAL

8.1.1. SCOPE OF WORK

The Contractor shall furnish all labor, materials, equipment tools, appurtenances, services and temporary work, to provide complete the several plumbing and drainage systems all in perfect working order. This work shall include but not be limited to the following:

- a. Sanitary fixtures.
- b. Water supply systems including: cold water and hot water services.
- c. Waste disposal system.
- d. Rain water services.
- e. External gravity sewer network..
- f. 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 Tenderness.

8.1.2. 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 of 500 liters capacity fed from the main city network.

Hot water is generated by means of electrical water heater and stored in hot water storage tank of 60 liter capacity.

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.

Rain water is collected from roof and discharged to any nearby outlet.

8.2. SANITARY FIXTURES

8.2.1. GENERAL

All sanitary fittings shall be of an approved quality obtained from an approved manufacturer. Sanitary fittings and their connections, services, wastes, etc., shall be located as shown on the Drawings and shall be designed and installed to the satisfaction of the Engineer. Unless otherwise required by the Particular Specification or shown on the Drawings, the quality and sizes of the fittings shall be according to B.S. Standards as follows:

8.2.2. SINKS

It shall be either white glazed fire clay complying with B.S. 1206 or stainless steel complying with B.S. 1244 fitted with chromium plated hot and cold water mixer, combined overflow and trapped waste, plug and chain.

Sinks shall be fixed on pair of cantilever brackets built into wall or on frame and supports of 1.0 inch diameter galvanized steel pipe or on block work piers as detailed on the drawings, or directed by the Engineer.

8.2.2.1.Kitchen Sinks

It is manufactured from a single piece of high grade white glazed fireclay kitchen basin, as a result of this process no welding is necessary, and a much stranger produced. Sink with one bowel fitted with chromium plated swan neck tap, combined overflow and trapped waste, plug and chain will be considered as shown in the drawing & as mentioned in B.O.Q.

8.2.2.2.Baths

It shall be white porcelain enameled cast iron complying with B.S. 1189, with rectangular tops and Side and end panels were required, fitted with two 3/4 in diameter chromium plated pillar valves, overflow and 2 in diameter trapped waste, plug and chain. Where baths are fitted with a shower this shall be of either the overhead type or the telephone type. In all cases the shower hose and exposed piping shall be chromium plated and the connections to such showers shall be through chromium plated mixing valve. The baths and showers shall be fixed as detailed on the Drawings or directed by the Engineer. The recommended type is Colored Porcelain wash basin without pedestal (Bracket type-Italian Made).

8.2.2.3.European Water Closet

It suites shall comprise white glazed fire clay pan complying with B.S. 1213, weighing approximately 20 kg and having 'S' or 'P' trap with 3 1/2 in bore outlet, Two-gallon capacity high or low level white enameled cast iron or white -glazed flushing cistern fixed to walls with cantilever brackets or concealed fixing 1 1/4 in (high level) or 1/2 in (low level) diameter flush pipe, non-corroding valves siphon, 1/2 in low-pressure ball valve and union, 3/4 in overflow and union either flushing handle or pull and chain, and with double flap solid section plastic ring seat complying with B.S. 1254.

Paper holder for all toilets should be provided.

The recommended type is Colored Porcelain WC closet with plastic cistern

Ample application of petroleum jelly shall be applied to all surfaces of exposed chromium plated piping, valves and fittings and stainless steel fixtures immediately after installation.

Concealed brackets, hangers and plates shall have a shop coat of paint.

The location and disposition of all items shall be as indicated on the relevant drawings.

8.2.2.4.PIPES

The pipes shall be un-plasticized polyvinyl chloride (U.P.V.C.) pipes SN8, as shown on Drawings or as detailed. Pipes shall be laid in position by means of a leveling instrument. Supporting wedges will not be permitted. Where necessary, cutting of, pipes shall be carried out.

Special attention is directed with regard of turning down the cut ends to the correct outside diameters.

8.3. DOMESTIC HOT AND COLD WATER

8.3.1. DOMESTIC HOT WATER TANK

Tank shall be of the double cylinder storage type for vertical mounting. Tank shall be constructed of welded sheet steel galvanized after fabrication and tested at 12 atmospheres and a working pressure of 6 atmospheres.

8.3.2. STORAGE TANKS

Water tank used is PVC local made / Rotoplas or approved equivalent 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 manufacturer's instructions i.e. (Tank foundations, Mechanical float valve, fittings, vent pipe, overflow, drain, connections, tank foundation and the required accessories).

8.3.3. ELECTRIC HOT WATER HEATERS

Enameled series or approved equivalent water heaters are recommended 60 liters capacity. The boiler, made with thick steel tested at 16 atm and provided with safety valves. It's protected with exclusive glass lining and the magnesium anode. The boiler shall be of a large plane flange which makes inspections extremely easy.

The insulation consists of a thickness of 2.5cm of expanded polyurethane, thus reducing heat dispersion to minimum values.

8.3.4. WATER DISTRIBUTION NETWORKS

All the materials used in the main water distribution lines are galvanized steel pipes from the main municipal networks up to storage tanks and down to main distribution box. All the internal cold water pipes will be galvanized steel pipes schedule 40. Hot water pipes will be steel pipes schedule 40. All under ground pipes shall be galvanized steel coated with bitumen.

8.4. TESTING

8.4.1. 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 void 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 Practice.

8.4.1.1. Water Supply Systems

All water supply piping shall be tested under hydrostatic pressure of not less than 1.5 times working pressure p. s .i maintained for four hours. 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.

8.4.1.2. 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.

8.4.1.3. 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.

8.4.2. WORKING DRAWINGS AND ORDERING

Immediately the Contractor has been awarded the Contract shall prepare detailed working drawings showing exact position of all sanitary fixtures and position and size of all water pipe work, drainage, and piping clearly indicating fittings proposed. These drawings, when approved by the Engineer, shall be used for ordering purposes.

9. PROOFING AND WATERPROOFING

9.1. SCOPE

These specifications cover, waterproofing and roofing systems intended 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. MATERIALS

9.2.1. PRIMER

The material used as a primer shall conform to ASTM Specifications D41, for primer for use with Asphalt in Dam-proofing and waterproofing below or above ground level for application to concrete and masonry surfaces.

9.2.2. BITUMEN

The bitumen for Dam-proofing and waterproofing shall be a soft, adhesive Self-healing" asphalt which flows easily under the mop and which is suitable for use below ground level on horizontal and vertical surface under uniformly moderate temperature conditions both during the process of installation and during service.

The bitumen shall be homogeneous and free from water and shall conform to the requirements of ASTM Specifications D449-73 "Type A.

The bitumen for built-up felt roof shall comply with B.S. 1162:1966 or B.S. 988:1966 Mastic Asphalt for roofing and B.S. Code of Practice C.P. 144, Part 4: 1966 Mastic Asphalt.

9.2.3. MASTIC ASPHALT

Mastic asphalt for damp proofing and waterproofing shall comply with B.S. 1097, B.S. 1418 and with B.S. Code of Practice C.P. 102-Protection of buildings against water from the ground. Mastic asphalt for roofing purposes shall comply with B.S. 988 B.S. 1162 Code of Practice C.P. 144, Part 4-Mastic Asphalt.

9.2.4. ROOFING FELT

The roofing felt for built-up roofing shall comply with B.S. 747: Part 2: 1970 (Metric units) Roofing felt, class 1A and as described in B.S. C.P. 144: Part 3: 1968.

9.2.5. AGGREGATE LIGHTWEIGHT CONCRETE SCREED

The aggregate for lightweight concrete screed shall conform to B.S. 3797: 1964 lightweight aggregates for concrete. The lightweight aggregate shall be such as 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 the bats stacked not more than 3.00 meters high.

9.2.6. FINE AGGREGATE, CEMENT AND WATER

The fine aggregate (maximum size 10mm), ordinary Portland Cement and water, for use in topping screed for lightweight concrete screed, shall be as specified under "CONCRETE WORK" and floor, wall and ceiling finishing.

9.3. WORKMANSHIP

9.3.1. DAM-PROOFING AND WATERPROOFING

9.3.1.1. Primer and Asphalt

The primer and asphalt, as specified under "Materials" shall be used as a damproof and waterproof course to accessible underground surfaces of reinforced concrete structures to the extent shown on the Drawings, and shall consist of one coat of primer and two coats of asphalt.

All surfaces to be damproofed and waterproofed shall be properly prepared by brushing, cleaning and leaving the surfaces free from dirt, dust, grease, loose or projecting particles of mortar or concrete, all traces of salt shall be thoroughly sprayed with water and allowed to dry and disappear from the surfaces before the application of the priming coat.

Asphalt shall be applied hot in two coats for both horizontal and vertical work. Each coat of asphalt shall be allowed to dry for a period of at least 24 hours before the second coat is applied. Warm, clean and properly make good junctions between horizontal and vertical asphalt, with two coats angle fillets at all internal angles.

9.3.2. LIGHTWEIGHT CONCRETE AND TOPPING SCREED

9.3.2.1. General

The work shall consist of laying and finishing the lightweight concrete screed to the thickness and falls shown on the Drawings and as described in the Bills of Quantities to the entire satisfaction of the Engineer.

All roof decks shall be graded to drain water freely into rainwater outlets. Rainwater connections shall be set up to permit smooth flow of water.

9.3.2.2. 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 lightweight aggregate and the following mixing table shall be strictly observed.

NOMINAL MIX	LIGHTWEIGHT AGGREGATE	METER	CEMENT CONTENTS	WATER
8:1	1:00	CUBE	150 kgs.	200 LITERS

9.3.2.3. Mixing 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 lightweight 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 28 days 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.

9.3.3. BUILT-UP ROOF

9.3.3.1.General Requirements

All roof decks shall be graded to drain water freely into downpouts, and shall be smooth, firm, thoroughly set, and dry.

9.3.3.2.Storage and Handling for Materials

Rolls of felt and containers of bitumen shall be stored on end. Rolls of felt shall be properly covered and all materials shall be kept clean and dry. In cold weather plied felts shall not be thrown or dropped since the shock of impact can fracture adhesive between plies causing them to separate. Such a condition, often considered a factory defect, more frequently is caused by rough handling.

9.3.3.3.Preparation of Materials

Bitumen shall be placed in kettles, melted and frequently stirred to prevent burning. Cutting back, adulterating or fluxing of bitumen with any other material shall not be allowed.

Felts shall be unrolled, turned over, piled up and permitted to flatten. Then they shall be re-rolled in the opposite direction before application.

9.3.3.4.Application of Materials

Before work is started all rubbish shall be removed and, during the work, the deck shall be maintained clean and free of loose or foreign materials and obstructions other than tools and appliances of the roofer.

Decks that are scaling or that are covered with dust shall not be primed until thoroughly cleaned. Leaky containers for bitumen shall not be used since splashes seldom can be removed entirely.

A sufficient quantity of bitumen shall be used so that it will flood ahead of the roll in an unbroken line so that the felt will be completely embedded.

The felts shall be rolled closely behind the mop so that at no time shall the mopping be more than one meter behind in while the bitumen is still hot. The suitable type of broom or squeegee shall be used for this purpose.

In applying felts on built-up roofs it is important that they be laid so that the flow of water is over or parallel to (never against) the laps of the finishing felts. Care shall be taken to ensure that all surfaces upon which felt is to be laid are dry, smooth and clean.

Felts shall be applied in three layers of the felt lapping each felt 600mm over the preceding one. Mop the full width under each felt with the asphalt.

The felt shall be dressed and bonded into mouths of rainwater outlets and well fitted and sealed around openings.

When roofing abuts against vertical surfaces such as walls or parapets, it shall be carried up for a minimum height of 150mm and 150mm back off the walls or parapets forming triangular fillets as a skirting or base continuous with the root membranes.

Pipes and other structures piercing the roof shall be primed with a bitumen solution and shall have a collar of hot bitumen formed up to them at 45°C. The roofing felt shall be dressed up and capping

layer of flashing felt shall be dressed over the collar, bonded to the pipe and secured with four turns of stout copper wire.

At angles or other obstacles wherever felt needs cutting, a mastic joint or seal shall be used to ensure the continuation of the waterproofing membrane.

All roof finishes shall be carefully worked or fitted around pipes or openings. On completion all roofs are to be left sound and water tight and in a neat and clean condition.

9.3.3.5. Minimum Materials

Table (9-1): Minimum materials required per 9 square meters of roof area for built-up roof

Coat layer	Number of layers	Approximately weight (kg)
Prime coat	As recommended by the asphalt manufacturer	
Felts	3 layers of saturated asphalt felt	20
Bitumen	Mastic asphalt for mopping each layer of felt	10
	For flood coat to receive	136 Chippings

They shall include all enclosure fittings. Wooden strips shall be as specified under JOINERY AND IRONMONGREY.

Care shall be taken during installation not to cause any damage to the waterproofing material laid on roof deck.

9.4. PROTECTION AND CLEANING

Roof coverings and finished shall be protected from damage until the completion of the Works. Should any damage be caused it shall be made good to the satisfaction of the Engineer at the Contractor's expense.

9.5. AGGREGATE BASE COURSE

9.5.1. DESCRIPTION

Aggregate base coarse shall consist of furnishing, spreading, and compacting aggregate base coarse in accordance with the details shown on drawings and these specifications.

9.5.2. MATERIALS

Aggregate material base course shall consist of hard, durable screened gravel or crushed stone, and shall be free from organic matter or other deleterious substances. Granular base coarse aggregate shall be as directed by the Engineer.

9.5.3. CONSTRUCTION

Aggregate for road base shall be delivered to the roadbed as uniform mixture and shall be spread in layers not exceed more than 15 cm for each layer. Segregation shall be avoided and the base shall be free from pockets of course of fine materials.

The base course shall be spread by grader or other approved mechanical methods, watered, shaped and compacted to the required grade and cross-section. The finished surface of the road base shall not vary at any point more than 5 mm. above or below the grade established by the Engineer.

The aggregate base shall be compacted to not less than 100 percent of the maximum density determined in accordance with the latest BS 1377 Part 4. Particle size analysis of soils for sieve analysis of fine and coarse aggregate shall be carried out in accordance with AASHTO T88, T87. The base shall be maintained in a condition satisfactory to receive any subsequent base coarse or surfacing material. Base which does not conform to the above requirements shall be reshaped or reworked, watered and thoroughly re compacted to conform to the specified requirements.

Where directed by the Engineer a Sieve analysis shall be carried out on the material recovered from 5 consecutive field density tests. Where this sieve analysis shows an oversize material content of 10% or greater the area of construction will be removed and the source of the material rejected until further notice. Where considered necessary other areas of work which were carried out using material from the same source shall be tested in a similar manner.

The contractor must provide to the site the base coarse material from the known resource by presence of the supervision engineer.

The supervision engineers have to reject the sample provided to the site by visual inspection if it does not conform to the specification required, and the contractor must be removed from the site immediately.

Aggregate for use in base course construction shall be crushed stone. Aggregate may be washed, if directed, to remove excessive quantities of clay, salty clay or salts.

Crushed stone and crushed gravel shall consist of hard, durable and sound particles or fragments of stone, free from other deleterious substances not mentioned below, other requirements are gypsum, or flaky particles. Other requirements:

- Gypsum content (expressed as SO₃) 2% max.
- Clay Lumps and friable particles 8% max.
- Elongated and Flaky particles for crushed rock
(Determined in accordance with BS812 Part 1: 1975)
- Granite & Basalt 40% max. each
- Lime Stone 35% max. each

Chart content (determined as percentage by weight insoluble in hydrochloric acid) to be specified in special technical specification.

Methods used in production of crushed rock shall ensure that the finished product will be as uniform as possible. Crushing shall result in a product such that, for particles retained on 4.75 mm (No. 4) sieve at least 80% by weight shall have at least two factored faces.

Any material passing 4.75 mm (No. 4) sieve and product in crushing process shall not exceed 7% from the sample.

Crushed aggregate for base course delivered to road site shall meet the requirements of Class A as shown in (Table I) when tested in accordance with AASHTO T 27 after dry mixing and just before spreading and prior to compacting. The Class of aggregate 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 and smooth within the specified limits for each Class. Gap graded aggregate will not be accepted. If tested gradation is tested after compaction a tolerance of 3% allowed in upper limit for percentage of material passing sieve 200.

Table (9-2): Gradation of Base Course Aggregate by Class

Percent by weight passing Sieve Designation (Square openings)	Class A
mm (2 in.)	
mm (1 - 1/2 in.)	100
mm (1 in.)	75- 100

Percent by weight passing Sieve Designation (Square openings)	Class A
mm (3/4 in.)	60- 90
mm (1/2 in.)	45- 80
mm (3/8 in.)	40- 70
mm (No. 4)	30- 65
mm (No. 10)	20- 40
mm (No. 40)	8- 20
mm (No. 200)	5- 10

The material shall contain a minimum of 35% sand equivalent and not exceeds of 50% at any stage of constriction.

The loss in weight shall not exceed 40% after 500 revolutions, when tested in accordance with AASHTO T 96 (Los Angeles Abrasion Test).

Percent of maximum allowed 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% modified proctor AASHTO (T 180-D) and tested in accordance with AASHTO T 193.

When tested for soundness in accordance with AASHTO T 104, the material shall not show signs of disintegration and loss by weight shall not exceed 12% in the case of the sodium sulphate test and 18% in the case of the magnesium sulphate test.

The liquid limit (L.L.) is not more than 25 %.

The plasticity index (P.I) from 3% to 6%

The Elongation and Flakiness is not exceeding more than 35 % for the both.

At the compaction test for every layer should be taken three 3 sample.

Linear Shrinkage not more than 3%

9.5.3.1.Tolerances

The fully compacted and completed base course shall conform to the lines, grades and cross sections as shown on the Drawings.

The elevations of the finished base course shall be checked by the Contractor in the presence of the engineer.

The tolerance on elevations of finished surface shall be plus 5 mm.

MECHANICAL WORK AND PIPING

10. MECHANICAL AND ELECTRICAL SPECIFICATIONS

10.1. SPECIFICATION FOR SUBMERSIBLE SEWAGE PUMP

10.1.1. REQUIREMENTS

Furnish and install submersible non-clog wastewater pumps. Each pump shall be equipped with specified kW, submersible electric motor connected for operation to the required power supply. The pump shall be equipped with submersible cable (Sub cab). The power-cable shall be sized according to IEC standards. The pump shall be supplied with a mating cast iron discharge connection. Additional working point of the specified TDH must be covered by the pump-curve. Each pump shall be equipped with a lifting chain with a working load of twice the pump-weight

10.1.2. PUMPS DESIGN

The pump(s) shall be automatically and firmly connected to the discharge connection, guided by no less than two guide bars or stainless steel cable extending from the top of the station to the discharge connection. There shall be no need for the personnel to enter the wet-well. Sealing of the pumping unit to the discharge shall be accomplished by a machined metal to metal watertight contact. Sealing of the discharge interface with O-ring, gasket or diaphragm which has to be replaced will not be acceptable. No portion of the pump shall need any support directly on the sump floor.

10.1.3. PUMP CONSTRUCTION

Major pump components shall be of gray cast iron, ASTM A – 48 Class 35B, BS 1452 Grade 260 or DIN 1691 GG25 with smooth surfaces devoid of blow holes or other irregularities. All exposed nuts, bolts and washers shall be of AISI type 304 stainless steel or better. All metal surfaces coming in contact with the pumpage, other than stainless steel or brass shall be protected by a factory-applied spray coating of alkyd primer with oxiranesther paint finish on the exterior of the pump. Sealing design of major pump components shall incorporate metal to metal contact between machined surfaces. Critical mating surfaces where watertight sealing is required shall be machined and fitted with Nitrile or Viton O-rings. Fittings will be the of controlled compression of rubber O-rings in two planes and O-rings contact of four sides without the requirement of a specific torque limit. Neither rectangular sectioned gaskets neither requiring specific torque nor scaling compound shall be considered as equal.

10.1.4. COOLING SYSTEM

Each unit shall be provided with an adequately designed cooling system. Provisions for external cooling and seal flushing shall be provided. The cooling system shall provide for continuous pump operation in liquid temperature of up to 40°C.

10.1.5. CABLE ENTRY SEAL

The Cable entry seal design shall preclude specific torque requirements to insure a watertight and submersible seal. The cable entry shall consist of a single cylindrical elastomere grommet, flanked by washers, all having a close tolerance fit against the cable outside diameter and the entry inside diameter and compressed by the body containing a strain relief function, separate from the function of sealing the cable the assembly shall provide ease of changing the cable. The cable entry junction chamber and motor shall be separated by a terminal board, which shall isolate the interior from foreign material gaining access through the pump top. Epoxies, silicones, or other secondary sealing systems shall not be considered acceptable.

Cable holder for holding the cable and regulating the height of the level regulators

10.1.6. MOTORS

The pump motor shall be a squirrel cage induction motor, shell type design, housed in an air-filled watertight chamber. The stator windings and stator leads shall be insulated with moisture resistant Class H insulation rated for 180° C. The stator shall be dipped three times in Class H varnish and shall be heat-shrink fitted into the stator housing. The motor shall be designed for continuous duty handling pumped media of 40°C and capable of up to 30 evenly spaced starts per hour. Thermal switches set to open at 125°C and closed at 70°C shall be embedded in the stator load coils to monitor the temperature of each phase winding. These thermal switches shall be used in conjunction with and supplemental to external motor overload protection and shall be connected to the control panel. The junction chamber containing the terminal board shall be hermetically sealed from the motor by an elastomer o-ring seal. Connection between the cable conductors and stator leads shall be made with threaded compression type binding posts permanently affixed to a terminal board. Wire nuts or crimping type connection devices are not acceptable. The motor and pump shall be designed and assembled by the same manufacturer. The combined service factor (combined effect of voltage, frequency and specific gravity) shall be a minimum of 1.15 the motor shall have a voltage tolerance of plus or minus 10% the motor shall be designed for operation up to 40°C ambient temperature and with a temperature rise not to exceed 85°C. This chart shall also include data on starting and no-load characteristics. The motor and the cable are capable of continuous submergence underwater without loss of watertight integrity acc. To protection class IP68 (20m) the rated power shall be adequate so that the pump is not overloaded throughout the entire indicated pump performance curve.

Power cable includes two conductors 1.5 mm for the monitoring of thermal switches and optional protecting sensors.

10.1.7. BEARING

The pump/motor shaft shall rotate on two permanently grease lubricated bearings. The upper bearing shall be a single row roller bearing. The lower bearing shall be a two row angular contact ball bearing to compensate for axial and radial forces.

10.1.8. MECHANICAL SEAL

Each pump shall be provided with a tandem mechanical shaft seal system consisting of two independent seal assemblies. The seals shall operate in an oil-reservoir that hydro-dynamically lubricates the lapped seal faces at a constant rate. The lower, primary seal unit, located between the pump housing and the oil-chamber, shall contain one stationary and one positively driven rotating tungsten carbide ring. The upper, secondary seal unit, located between the oil-chamber and the motor housing, shall contain one stationary tungsten-carbide seal ring and one positively driven rotating tungsten-carbide seal ring. Each seal interface shall be held in contact by its own spring system. The seals shall require neither maintenance nor adjustment nor depend on direction of rotating for sealing. For special applications other seal face material shall be available. Other seal types shall not be considered acceptable or equal to the dual independent seal specified. Each pump shall be provided with an oil chamber for the shaft sealing system, the drain and inspection plug, for the oil, shall be accessible from the outside.

10.1.9. PUMP SHAFT

Pump and motor shaft shall be the same unit. The pump shaft is an extension the motor shaft. Couplings shall not be acceptable. The shaft material shall be AISI type 1035 Carbon steel and shall completely isolate from the pumped liquid.

10.1.10. IMPELLER

The impeller shall be of gray cast iron GG-25, (ASTM A-48 Class 35B), or stainless steel grade 316 dynamically balanced, double shrouded non-clogging design having a long through let without acute turns. The impeller shall be capable to handling solids, fibrous materials, heavy sludge and other matter found in normal wastewater. Whenever possible, a full vaned, not vortex, impeller shall be used for maximum hydraulic efficiency, thus, reducing operating costs. The pump is equipped with a N-impellor, a semi open two-vane impeller. All impellers shall be coated with alkyd resin primer. Mass moment of inertia shall be provided by the pump manufacturer upon request.

10.1.11. WEAR RINGS

A wear ring system shall be used to provide efficient sealing between the volute and the suction inlet of the impeller. The wear ring shall be stationary and made of brass or rubber-cladded steel frame, which is driven, fitted to the volute inlet. These pumps shall also have a stainless steel impeller wear ring heat – shrink fitted to the suction inlet of the impeller to mate the stationary wear ring.

10.1.12. VOLUTE

Pump volute shall be single-piece gray cast iron (ASTM A-48 Class 35B) non-concentric design with smooth passages large enough to pass any solids that may enter the impeller. Minimum inlet and discharge size as specified. The volute shall have a mating flange machine, and provided with a blind-flange, correct positioned for a flushing valve.

10.1.13. PROTECTION

All motors shall incorporate thermal switches in each phase winding, serial connected. The thermal switches shall open at the temp. 125°C and stop the motor and activate an alarm

Option that shall be available:

Float leakage sensor (FLS) to detect water in the stator housing. When activated, the FLS will stop the motor and activate an alarm. When using optional monitoring, the manufacturer shall provide a control and status relay (CAS) to be mounted into any control panel.

10.2. GENERAL INSTALLATION REQUIREMENTS**10.2.1. SAFETY**

This operating manual contains basic instructions, which must be observed during installation, operation and servicing. Therefore it is imperative that this manual is read prior to assembly by the fitter and relevant skilled staff/and operators and it must always be kept within the locality of the machine/plant.

With regard to safety, not only those instructions listed under the main heading of safety must be observed, but also all other special safety instructions that have been included under any other main heading must be strictly adhered to.

The symbols contained within this manual calling attention to situations where non-observance could endanger lives are specially identified such as:

Warning sign in accordance with DIN 4844 – W9

Calling attention to electric current with warning sign in accordance with DIN 4844 – W8.

Safety instruction relating to situations where non-observance could damage the machine and its functions are identified with the word: Attention

Any instructions which are actually printed on the machine such as:-

- Arrow indicating direction of rotation
- Identification for fluid connections
- Must be observed without fail and be kept clean and legible.

10.2.1.1. Safety Instructions for Operators

- If hot or cold machine parts are considered a danger, then these parts must be protected where contact is possible.
- Safety equipment to prevent contact with hot or cold movable parts must not be removed whilst the machine is in operation.

Danger caused by electric supply must be eliminated (in this respect see details of any regulations enforced by individual countries of the VDE and/or the local power supply stations.

10.2.1.2. Safety Instruction during Maintenance, Inspection and Installation

The operator carries the responsibility to ensure that all service, inspection and maintenance work is carried out by authorized and fully trained personnel, who have read and are familiar with the operating instructions.

Basically all work to the plant should only be carried out when the machine is not operating. The operating instructions relating to the method of switching off the equipment must be adhered to without fail.

Once maintenance work is completed all safety equipment must be reinstated again and checked to ensure they function correctly.

10.2.1.3. Transport and Storage

The chain or lifting wire, which is supplied, must only be used for lifting the appropriate pump unit. General use for lifting heavy loads is not permitted.

Do not lift the pump unit by the motor cable.

The motor housing/cover of the pump has been prepared for attaching the chain supplied with the unit. For lifting the unit during unpacking only this prepared fixing should be used for attaching the lifting chain. Furthermore, attention is drawn to the fact that the design of this fixing point on the motor housing varies according to method of installation – whether stationary or transportable.

10.2.2. PUMP CASING

The pump casing is fitted with radial outlet branch and standard flange-connection.

Use of appropriate assembly kit will permit either stationary or transportable installation of the pump unit.

10.2.3. INSTALLATION

10.2.3.1. Installation Methods

Submersible pumps can be installed at low cost.

The following installation methods can be used:

- Stationary wet installation guide pipe
- Checking Procedure Prior to Commencement of Installation
- Construction layout must be in accordance with measurements set out on the table of dimensions. The construction of the base/concrete foundations should be sufficiently strong (Min. BN 150) to ensure secure and functionally correct installation in compliance with DIN 1045 or equivalent standard can take place.

10.2.3.2. Checking of Operating Data

A check must be carried out to ensure that the details stated on the data agree with the order and pump data (for example operating voltage, frequency and pumped media temperature etc.).

10.2.3.3. Oil Level Control

The oil chambers of our submersible pumps have been filled with environmentally friendly non-toxic paraffin oil of medical standard quality.

The oil level must be checked prior to initial operation of the unit.

10.2.4. ELECTRICAL CONNECTION

The electrical connection must be carried out by a trained electrician and in compliance with local regulations. Recommendation VDE 0100 and for flameproof equipment VDE 0165.

The voltage must comply with the voltage indicated on the data plate.

Electrical installation must be in accordance with “Electrical installation lay-out” and “performance lay-out” for the appropriate motor sizes.

The pump is delivered completely assembled with and including cable diameters 4x35 mm².

Attention: The protection cover, which is situated at the cable gland, should not be removed until immediately before installation.

Within the flameproof the flameproof area all electrical cabling must be connected to earth with flameproof terminal boxes or approved cast resin sockets (in accordance with VDE 0165).

10.2.4.1. Fitting of Electric Cabling

During installation of the electric cabling it is advised to position the motor supply cable upwards and if possible fastened it to avoid it being affected by the swirl created by the pumped liquid.

For correct installation of the electric cabling within the pump sum we recommend using cable socks, which can be supplied as an additional extra. Slack installation of cables could cause damage to the electric cabling during vibration when the pump is operating.

10.2.4.2. Over-Current Relay

The unit has been supplied with monitoring equipment to prevent overloading. The motor has to be protected against overloading by a thermally retarded over-current relay to comply with VDE 0660. This should be adjusted to the nominal motor current as indicated on the data plate on the motor. The regulating value for star delta is NX0, 58. However, this only applies when the over load relay between star delta combination and motor has been switched on.

10.2.4.3. Level Control Switch

Stations with automatic pump operation should be fitted with a level control switch. Cut-off control prints should be adjusted to comply with dimensions table this will cause the pump to stop and avoid possible dry running.

10.2.4.4. Direction of Rotation

Once the electrical connections are complete as indicated above, the following should be noted:

Correct direction of rotation of the impeller is of utmost importance for problem-free operation of the pump. The pump cannot reach its duty point if the direction of rotation is incorrect, vibrations and overheating will occur. There is the danger of causing damage to the plant.

Seen from the pump suction opening direction of rotation should be anti-clockwise. In addition there is an arrow on the pump casing pointing in the correct direction of rotation.

If the correct phase sequence is known, then, if the connection is carried in accordance with the standard, correct direction of rotation of the pump will result automatically (anti-clockwise rotation of the motor).

Prior to carrying out any tests please check that there are no foreign bodies within the pump casing never put hands or any objects into the pump.

Do not permit the pump to dry run for long periods – brief switching on is permitted and should not be dangerous.

10.2.5. STATIONARY INSTALLATION/GUIDE PIPE

Stationary installation provides the facility to insert and lift out the pump unit at any time regardless of liquid level within the sump by means of a double stainless steel guide pipe sh .10s (2.77 mm th.).

Guided securely by two parallels, previously tightened stainless steel wires the pump slides into the well or container and attaches itself to the duck-foot bend, which has been fitted to the bottom. The weight of the pump acts as seal between the pump and duck-foot bend. A profile seal between pump and duck-foot bend achieves a pressure-proof elastic connection. Walking on the well is not permitted during inspection and maintenance work.

The pipe must be from stainless steel.

10.2.6. INSTALLATION OF PUMP WITH CLAW CONNECTION

Use schematic drawing wet well installation stationary with guide pipe

Prior to lowering the pump fit claw to the discharge flange of the pump housing. The screws have to be tightened in accordance with instructions. Prior to securing the claw insert butt strap into the slot on the outlet branch. Fit claw in such a way that the raised boss comes to rest against the back of the flange. To prevent loosening of the hexagonal screw the locking washer tab should be bent upwards. Fit profile seal into the groove of the claw/pump-casing flange. This profile seal will serve to seal the duck-foot bend during installation.

10.2.7. FITTING OF THE MOUNTING BRACKET/DUCK-FOOT BEND/GUIDE PIPE

Construction of the base / concrete foundations should be sufficiently strong (minimum DN 150) to ensure a functionally correct fixing of the guide wire equipment and duck-foot bend.

Refer to the drawing as illustrated in “Wet well Installation stationary with guide pipe” all installation tasks outlined below.

1. Secure mounting bracket using anchor bolt (dowels) at the sump opening rim. Drill hole diameter for bolts fixing for pumps up to size 200-400 form part of the consignment / order. For larger pumps all fittings and fixing have to be specially ordered by the customer and they have to comply with construction and site conditions.
2. Fit threaded bolt with clamping piece support piece to the mounting bracket. Do not unscrew hexagonal nut too much, just enough to allow sufficient play for tightening the wire subsequently. Ensure that the two clamping pieces are fitted correctly to a support piece.
3. The duck-foot bend should be positioned and secured to the base of the sump. Should construction/pipe-work etc. require the pipe to run off the vertical, then a maximum angle of 5° should be adhered to thus ensuring safe fitting function. Securing of the duck-foot bend is carried out by using bolts or foundation bolts regardless of pump size or material variation.
4. Place shackle into the mounting bracket to enable the lifting chain to be attached at a later stage.

10.2.8. FITTING OF CHAIN/LIFTING PIPE STATIONARY WET WELL INSTALLATION

Installation of this equipment should be carried out in accordance with “General pump outline” by inserting the chain/lifting wire into the loop opposite the outlet branch. Further details can be found in “Wet well installation stationary with guide wire with parts list”

This type of fixing achieves a forward inclination of the pump towards the outlet branch and permits fitting pump to the duck-foot bend.

10.2.8.1. Installation of the Pump

See “General arrangement of installation” Guide the pump from above over the support piece and thread into the guide pipe. Then lower slowly.

After lowering the pump it will fasten itself to the duck-foot bend and it is then ready for operation and connected to the inlet pipe.

10.2.9. INSTALLATION OF PUMP

Transportable installation permits the pumps to operate in different locations.

10.2.10. DRAINING OF MINES

- Emergency draining of canals
- Pumping water out rivers etc.

For such applications the pump must be installed in a vertical position with the motor on the top a fitted to a firm base.

10.3.PIPE WORK AND FITTINGS

10.3.1. GENERAL

Pipes and fittings for general purposes (water, sludge, and air) shall be made of steel, galvanized steel, ductile iron or gray 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 is minimized and is of a magnitude acceptable to the machinery or equipment manufacturer.

Pressure gauges shall be of the oil 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 20 mm nominal bore shall be compression jointed heavy gauge copper unless otherwise approved by the Engineer. The diameter of ball valve for pressure gauges is 0.5 inch.

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 there from to the gauge shall contain a suitable clean fluid.

10.3.2. 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.

The used steel pipes for the pressure line shall be externally anticorrosive protection of three layers extruded polyethylene or polypropylene and internally with cement lining to conform to the international standards & in accordance with DIN 30670 & DIN 30671.

10.3.3. OTHER MATERIALS FOR PIPES AND FITTINGS

The following materials shall comply with the ISO standards or equivalent approved by the Engineer:

- PVC pipes and fittings
- Polyethylene pipes and fittings
- Copper pipes
- Stainless steel pipes
- Galvanized steel pipes
- Flanges shall comply with iso 2531 for PN 16.

10.3.4. LADDERS, HAND RAILING AND ACCESS PLATFORMS

Ladders and hand railing shall be made of stainless steel pipe sh. 10 s grade 310

Access platforms shall be made of aluminum alloy 5052-0 tested to ASTM No. B210, Light Duty Aluminum and shall be not less than 750 mm wide, and shall sustain a uniform loading of not less than 5 KN/m², 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.

10.3.5. CONSTRUCTION AND INSTALLATION

The contractor shall stake out the location of each run of pipe and all valves and equipment location prior to ditching. Before installation is started in any given area, the Engineer will check all locations and give his approval if found satisfactory.

The main, sub-main and lateral lines shall be installed to the depths as shown on the drawings.

10.3.6. DELIVERY OF PIPES AND FITTINGS

The Contractor shall follow the pipe manufacturer's recommended procedures for delivery, unloading, stacking and handling pipes and fittings.

Loading and unloading shall be carried out by lifting with hoists, using ropes or slings in order to avoid shock or damage. Fittings shall be loaded and unloaded individually. Pipes handled on skid ways shall not be skidded or rolled against pipes or other materials already on the ground. No dragging on the ground will be allowed.

Pipes shall be stacked by placing the first layer on level timber. pipes shall not rest on sockets or joint faces. Pipes of the same diameter shall be stacked together. Pipe stacks shall be suitably covered if directed.

10.3.7. PIPE LAYING

Pipe laying operations, including handling, laying, jointing, connections, anchoring and testing, shall be carried out in conformity with all relevant requirements in other sections of these specifications and with the following requirements.

All pipes shall be examined for damage of any sort to the pipe barrels and lining, before laying. Pipes shall be tested for soundness in accordance with the manufacturer's instructions. Damaged or otherwise unsatisfactory pipes shall not be incorporated in the Works.

When pipes are being jointed, the manufacturer's instructions and recommendations shall be followed regarding cleanliness of joint surfaces, lubricant or solvent used, correct location of components, provision of correct gaps between end of spigot and back of socket for flexible joints, etc. Flexible joints shall not be deflected beyond maximum permissible angles given by the manufacturer and/or relevant standard, whichever is the smaller. Special instructions issued by a manufacturer of proprietary joints, e.g. patent detachable flexible joints, shall be complied with when laying and jointing.

At every fitting causing a change in the direction of flow, the Contractor shall construct a thrust block of Class 25 concrete to the dimensions shown on the Drawings. Thrust blocks shall be provided for all fittings of 100 mm in diameter and over. If the manufacturer recommends thrust blocks for smaller diameters, they shall be constructed in accordance with the manufacturer's recommendations. The additional excavation required to obtain a firm thrust face against undisturbed soil shall be made after the pipeline has been jointed. Concrete for the thrust block shall be placed the same day as the pipe laying is carried out. Concrete shall cure for at least 3 days before any pressure is applied to the thrust blocks.

Where flotation of pipes may occur due to flood water or otherwise, water shall be excluded from the interior of pipe and sufficient backfill shall be placed above the pipe to prevent its flotation. Open trenches shall be kept clear of ponded water at all times. Any pipe that has floated shall be removed and its bedding shall be corrected prior to relaying.

The outside surfaces of pipes to be built into structures shall be cleaned immediately before installation. Protective coatings to metal pipes shall be removed as ordered. Plastic pipes shall be painted with appropriate solvent cement and sprinkled with dry coarse sand whilst wet. Two flexible joints or flexible patented joints shall be provided adjacent to structures. The first joint shall be placed not more than one pipe diameter from the face of structure and the second joint not more than 2 pipe diameters away from the first or 0.6 m for pipes up to 350 mm diameter.

The interior of pipes shall be kept free from dirt and debris and when pipe laying is not in progress, open ends of pipe shall be closed by approved means.

Sub-main lines shall be laid in such a manner that there will be a minimum loss of head upgrade, otherwise the natural slope of the terrain should be followed in longest possible straight line. Provision shall be made for expansion and contraction as recommended by the manufacturer. Plastic pipe shall be cut with a hand saw or hack saw with the assistance of a square in sawing vice, or in a manner so as to ensure a square cut. Burrs at cut ends shall be removed prior to installation to ensure a smooth unobstructed flow. All plastic-to-plastic joints shall be solvent-weld joints, using solvent recommended by the pipe manufacturer. All plastic-to metal joints shall be made with plastic male adapters. All plastic pipe and fittings shall be installed as recommended by the manufacturer and the Contractor shall make arrangements with the manufacturer for any field assistance that may be necessary. The Contractor shall be responsible for correct installation

10.3.8. WELDING OF PIPES AND FITTINGS:

Welding of circumferential joints in the pipeline shall comply with the latest edition of API Standard 1104 and AWS D 10.12 and as further specified herein.

All welding shall be carried out in accordance with the specific procedures prepared by the Contractor and submitted to and approved by the Engineer.

Adequate precautions shall be taken to protect welding operations from the adverse effects of weather, such as wind, rain and blowing sand.

Longitudinal seams of joined pipe shall be staggered by not less than 20 degrees. Where the Contractor chooses to weld pipes and/or fittings together outside the trench prior to installation, the resulting joint shall be straight within the limits imposed by API Standard 5L.

Welds rejected by the Engineer may, at his discretion, be repaired in accordance with API Standard 1104, Section 7, subject to the following:

Repairs to the filler weld which would penetrate the stringer bead will not be permitted.

Arc burns shall not be repaired by welding, but shall be removed by grinding provided that no reduction in wall thickness is made in excess of that permitted by the specifications.

The Contractor shall maintain records of all repairs of whatever nature to pipe and pipeline describing and locating such repairs.

Welding pipe together where welds have been cut shall be done with one weld if it is practical to pull the line into position; otherwise, two welds shall be made by setting in a piece of pipe at least 2m in length.

10.3.8.1. Welder Qualifications:

All welders employed on the works shall be full qualified and shall have successfully passed tests required by API codes for the type of work required.

Welder qualification tests or re-tests shall be carried out on the Site where they may be witnessed by the Engineer or his representative.

The Contractor shall provide necessary labor, pipe welding, materials and equipment for performing welder qualification tests on site.

Arrangements for laboratory tests of components, if required, shall be made and paid for by the Contractor.

The Contractor shall maintain a list of approved welders agreed with the Engineer and no other person shall perform welding operations on the Permanent Works.

10.3.8.2. Welding Procedure:

Pipe ends shall be swabbed with a leather or canvas belt disc to remove dirt, loose mill scale, rust, oil, grease, and other matter which may be injurious to the weld.

Cleaning of pipe ends shall be done by power wire brushing or grinding. Pipe ends damaged such that they no longer meet joint specifications shall be re-chamfered by a suitable machine.

Stringer beads on transmission pipelines shall be applied by at least two welders welding in opposite quadrants.

The numbers of filler and finish beads shall be in accordance with the approved procedures.

Completed welds shall have a substantially uniform cross section around the entire circumference of the pipe. At no point shall the crown surface be below the outside surface of the pipe or proud of the parent metal by more than 1-1/2mm.

No welding shall be done when the shade temperature is below 5°C and falling unless approved by the Engineer who may require preheating of the pipe.

All joints on which welding has started shall be completed before the end of each day's work. At night or when work is not in progress, the open ends of the pipeline shall be securely capped with suitable covers to prevent the entrance of dirt, small animals, water, and foreign matter into the pipeline.

Tie-ins shall be carefully aligned to limit residual and/or reaction stresses after completion of the weld. Tie-ins shall be made within the temperature range of 10°C to 30°C. In very hot weather, fully-welded lengths between restraints shall be protected from excessive heat to avoid buckling.

10.3.8.3. Quality Control of Welding:

All production welds shall be subject to visual inspection by the Engineer. Visual inspection may be carried out at any stage of the welding of a joint.

Each weld shall be clearly marked adjacent to the weld indicating the identification of the welder. Steel diestamping will not be permitted.

Non destructive testing will be carried out by an approved independent organization during the course of the work as required by the Engineer including the 100% examination of all field welds by radiography. The Contractor shall pay for the testing by the independent organization without any compensation from the Employer.

Welds rejected by the Engineer shall be cut out and replaced by the Contractor

10.3.9. UPVC GRAVITY SEWAGE PIPE

All UPVC pipes must to be solid type and the wall thickness according to pipe diameter is listed below:

Table (10-1): Wall Thickness for UPVC Pipes (SN8)

Thickness (cm) SN8	Nominal diameter (cm)
0.8 + 3.2	110
4.7 + 0.7	160
5.9 + 0.8	200
7.3 + 1.0	250
9.2 + 1.2	315
10.4 + 1.3	355
11.7 + 1.4	400
13.2 + 1.6	450
14.6 + 1.7	500

10.3.9.1. Pressure Sewage Pipe Line UPVC

The following table is showing the thickness of the UPVC pressure pipe according to pipe diameter and all pipes must have bill and suitable spigot & sockets for pressure works.

Table (10-2): Physical Properties of UPVC Pipes

Bar	6.0		8.0		10.0		12.5		L mm
D mm	S mm	Wt Kg/m	S mm	Wt Kg/m	S mm	Wt Kg/m	S mm	Wt Kg/m	
75	2.2	0.83	2.9	1.05	3.6	1.29	4.5	1.58	110.2
90	2.7	1.19	3.5	1.52	4.3	1.84	5.4	2.26	116.0
110	2.6	1.42	3.4	1.83	4.2	2.23	5.3	2.76	122.9
140	3.3	2.29	4.3	2.94	5.4	3.63	6.7	4.43	133.1
160	3.8	2.98	4.9	3.79	6.2	4.76	7.7	5.80	140.3
225	5.3	5.87	6.9	7.51	8.6	9.27	10.8	11.45	161.0
280	6.6	9.06	8.6	11.67	10.8	15.47	13.4	17.73	181.4
315	7.4	11.46	9.7	14.82	11.9	18.00	15.0	22.31	192.2
355	8.5	14.28	10.9	18.09	13.4	22.08	16.9	28.35	206.4
400	9.4	18.48	12.3	23.93	15.0	28.85	19.1	36.20	220.0
450	10.6	23.42	13.8	30.17	16.9	36.61	21.5	45.83	235.0
500	11.8	29.02	15.3	37.32	19.1	46.15	23.9	56.71	255.0
630	14.8	45.85	19.3	59.30	23.9	72.68	30.0	90.17	295.0
710	16.7	58.90	21.8	75.45	27.2	93.67	-	-	320.0

10.3.10. FIELD TESTING OF PIPELINES

The Contractor shall provide pumping equipment, pressure gauges instruments and water needed for hydrostatic field testing. Tests shall be carried out in the presence of the Engineer.

Pipelines shall be partially backfilled before testing. Fitting and joints shall be permanently anchored before testing and lift exposed for checking. Pipe work shall be clean and swabbed.

Each test section shall be limited 500m or the length between valve positions, which ever is shorter. Ends of test sections shall be securely plugged and strutted. Ends of risers shall be plugged and all air purged.

No testing shall be carried out against a closed valve or against or through the pressure reducing valves. The setting of the pressure reducing valves shall not be changed for testing purposes. Pressures shall be applied by approved manually operated or motor driven test pumps.

Exposed joints shall be examined for visible leaks and repaired where necessary. Should a test section fail, leaks shall be located and defective pipes or joints made good or replaced and the pipeline re-tested

Test records shall be kept in an approved form, and the original copy shall be submitted to the Engineer immediately after completion of each test.

10.3.10.1. Hydrostatic Test for Pipelines

The pipeline shall be filled slowly with water from the lowest point. After filling with water, absorbent pipes shall be allowed to stand for at least 24 hours before testing to allow for complete absorption.

In-trapped air shall be bled and pressurizing shall then proceed until the specified test pressure reached lowest part of the pipe line section under test. further quantities of in-trapped air shall be bled while the pressure is being raised.

Unless otherwise specified, the test pressure shall be equal to 1.5 times the maximum working pressure of the pipeline as shown on the Drawings or as determined by the Engineer on site, but shall in no case exceed 75% of the factory hydrostatic test pressure

The test pressure shall be maintained for 1 hour by pumping using separate test pump. Pumping shall then stopped for 2 hours, at the end of the volume of water pumped into the line recorded . The pipeline shall be deemed to have failed the test if visible leaks are detected (regardless of leakage being within the allowable specified limit) or if the volume of water pumped to restore original test pressure after the period when pumping was stop exceeds 0.8 ltr/day per km of pipe per mm of pipe diameter for each 3kg/sq. cm of applied pressure for asbestos cement types, or 0.1 ltr/day per km of pipe per mm of pipe diameter for each 3 kg/sq. cm of applied pressure for other pipe material.

10.3.11. 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.

10.3.12. GENERAL VALVES SPECIFICATIONS

10.3.12.1. General

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 sulfide is likely to be present.

Where “operation by tee key” is 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 itself 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 and 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.

10.3.12.2. Gate Valves Water Supply

Unless higher pressure rating is required for the pipeline, gate valves shall have a nominal pressure designation of 16 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 16 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.

10.3.12.3. Gate Valves for Sewage and Related Fluids

Unless higher-pressure ratings are required for the pipeline, gate valves shall have a nominal pressure designation of 16 bars which shall be marked on the valve body. Unless detailed to the contrary to suit existing pipe work, flanges shall have a nominal pressure designation of 16 bars and shall be drilled accordingly. The face to face lengths of the valves shall be in with ISO 5752 Series 3 valves with lengths to Series 14 may be used with suitable make up pieces to achieve the Series 3 lengths.

Valves shall normally be metal seated with valve bodies of iron and the seating copper alloy faces. The gates shall be of wedge pattern, copper alloy faced with inside screw non-stuffing box seal.

Where resilient seal gate valves are detailed the valve bodies shall be of iron. The gates shall be of iron and wedge pattern with nitrile rubber covering and with inside screw non-rising stems of stainless steel or iron. The gates shall be of iron and wedge pattern with nitrile rubber covering and with inside screw non-rising stems of stainless steel or forged bronze. They shall have a seal of nitrile rubber O rings.

Where actuator operated, valves larger than 300 mm shall have copper alloy faced guides and slippers. When 300 mm diameter and smaller actuator operated valves are installed other than in a vertical position they have machined guides and gates.

Valves shall normally be provided with hand wheel.

Gate Valve (RAFEEL)

Parts Specification

DENOMINATION	DESIGN A – Code
Wedge coating	NBR/EPDM
O – Ring	NBR – ASTM D2000
Retaining Ring	X12 CRNI 1771
Stuffing Nut	Copper Alloy- UNE37
Gland	Delrin
Circlip	Steel + Nickel – DIN 1722
Dust Guard	NBR- UNE53571
O Ring stuffing nut	- ASTM-D2000
Retaining Washer	Bronz Rg.s DIN 1705
Body	DIN 1693 GGG 50
Hand wheel	Cast Iron GG 20
Wedge lock NUT	Copper alloy – UNE37-103
Body bonnet Gasket	NBR/EPDM
Packing	NBR/EPDM

10.3.12.4. Air Valves

Air valves for pumped pressure pipelines will be the special high pressure “ Dual” large orifice type with a maximum working pressure of PN16 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.

Air Release Valve for Sewage (SAAR) ARI

Parts Specification:

Part	Material
Drainage Elbow	Polypropylene
Seal Plug Assembly	Nylon, Fiberglass Reinforced
Float	Foamed Polypropylene
Clamping Steam	Nylon, Fiberglass Reinforced
Body	Nylon, Fiberglass Reinforced
Cover	Nylon, Fiberglass Reinforced
O-Ring	Buna-N
O-Ring	Buna-N
Slotted Nut	Stainless steel SAE 303
Plastic Base	Nylon, Fiberglass Reinforced
Inlet for flushing	Steel SCH 40
Stopper	Acetal
Spring	Stainless Steel SAE 303
Bolt and Nut	Galvanized steel Chromate plated
Stem	Stainless Steel SAE 303
Float	Stainless Steel SAE 316

Part	Material
Ball Valve	Brass ASTM B- 124
Body	Steel Din st.37

10.3.12.5. Non-Return Valves

Unless higher-pressure ratings are required for the pipelines non-return valves shall have a pressure designation of 16 bars. Unless detailed to the contrary to suit existing pipe work, flanged valves shall have their flanges to a pressure of 16 bars and be drilled accordingly.

The face to face lengths of the valves shall be either $2 \times ND + 100$ mm or ISO 5752 Series 10, 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 diameter.

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° 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° . The switch shall provide one normally open and one normally closed electrically separated contacts of the make before break type.

Non Release Valve (ARI NR-040)

Parts Specification

Part	Material
Body	Cast iron ASTM A-48CL.358
Arm	Bronze ASTM – B – 26
Arm Pin	Stainless Steel SAE 304
Cotter Pin	Stainless Steel SAE 304
cover	Cast Iron ASTM A48 Cl.S36
counterweight	Steel DIN ST.37
Lifting Ring	Bronze ASTM – B – 62
Cover O – Ring	Buna – N
Cover Nut	Galvanized Steel
Cover Bolt	Stainless steel SAE 304
Disc	Bronze ASTM B-62
Sealing Ring O – Ring	Buna – N
bolts	Stainless Steel SAE 304

Part	Material
Hinge Shaft	Stainless Steel SAE 303
Plug Bolt	Stainless Steel SAE 304
Plug	ASTM – B – 124
Plug O –Ring	Buna – N
Hinge O - Ring	Buna – N
Spacer	Brass ASTM B – 124
Counterweight	Steel DIN st.37
Sealing Ring	Bronze ASTM B-62

10.3.12.6. Pressure and Compound Gauges

Pressure gauges for use with sewage and sludge shall be Borden gauges. The pressure transmission system shall be 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 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 = 1.00 of range or = 2.50 m bar. Gauges shall have 100-mm diameter circular faces.

10.3.12.7. General Specification:

- Flange Drilling PN 16 to BS 4505 or DIN 2501
- Pressure Rating (See Table No 6) 10/6/4 BAR
- Body Material Cast Iron BS 1452 GR 250
- Gate Material Stainless Steel BS 970 GR 304

10.3.12.8. 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.

10.3.12.9. Other specifications:

- Standard ISO 9001 / 9002 or BS equivalent.
- Cable 20 m length.
- Electrical waterproofs IP65.

10.3.12.10. 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 16 bar.

10.3.12.11. Finishes to Valves

Internal unmachined surfaces of valves shall be coated with two coats of 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.

10.3.13. FLOW METER

A flow meter shall be provided on the outlet line where shown on the drawings or as otherwise specified.

The flow meter for use on the outlet line shall be electromagnetic flow meter. It shall be fitted with flanges completed with sensors, separate convector, integrator, transmitter, remote indicator, coveter installed at panel door showing flow rate & volume including all cabling (no joint) and accessories with IP68. The capacity of the meter shall be related to the main diameter and should be the most suitable for the different flows encountered.

The meter shall have an easy to read register consisting of a six digit integrator calibrated in cubic meters of total flow.

Manufactured by ABB, Elstor Magmaster Splits, or approved equal.

10.3.14. VERTICAL SCREEN UNIT

10.3.14.1. Description

The contractor shall supply one Automatic Basket screen unit with the size capable to handle the specified maximum flow and suitable for installation in the sump wall at the inlet of raw sewage to the pumping station in complete fit to the drawing and specifications. The screen shall be installed to screen the sewage with a reciprocating rake installed to remove the screening automatically.

The Screen shall be capable of removing screenings from the sewage flow collected on 10mm wide bars spaced at 15mm spaces.

The Automatic Basket screen shall have the following operating conditions:

Maximum Flow for P.S.	:	37 liter/second
Bar Width	:	10mm
Bar Spacing	:	15mm

Note: all the components parts of the basket screen inside the wet pit must be made from stainless steel

The Basket Screen has a frame made of 2 U shaped on both side supported by 2 angel rods on the pumping station roof.

A basket shaped of 2 triangular sealed plates on both sides. A bar screen is in front the inlet pipe. A door on the rear side is near the wall. And 2 sliding cast iron blocks at both sides hanged on electrical hoist.

A cover automatically operated, covers the opening in the basket screen roof.

Most of the time the basket is located down, at its screening position, in front of the inlet pipe. Normally in 3-4 hours it goes up to empty. The cover opens automatically and let the basket to pass. When the basket leaves its screening position (even for very short time) a gate raise up remains in front the inlet pipe to prevent the solids to enter.

At the top position of the basket, its door opens, and a rake helps to clean it. The screening fall down through the delivery plate to the container, then it goes back to its original situation.

The upper section of the screen rake shall be completely free and open to enable all screening on the rake to be totally removed.

The Parts Specification for screen is as follows:

Part	Material
Guides	S.S 304
Basket material	S.S 304 spacing between bars 15 mm
Door frame	S.S 304
Lifting eye	S.S 304
Basket door	S.S 304
Legs	Galvanized steel
Door	S.S 304
Pulley holder	Galvanized steel
Rake frame	Galvanized steel
Rake	Galvanized steel
Rake holder	Galvanized steel
Sliding gate	S.S 304
Legs stabilizer	Galvanized steel
Cable holder	S.S 304
Door stop	Galvanized steel
Control cabinet holder	Galvanized steel
Slake cable control	Galvanized steel
Cable dram	Galvanized steel
Gear motor	1.5 Hp, 3 ph, 400 V, 50 Hz
Proximity switch	N.C Ø 30 mm, 24 VDC, NPN
Proximity switch holder	Galvanized steel
Junction box for proximity switch cable	PVC
Control cabinet	Reinforced polyester
Lifting cable	S.S 316
Steel cable	S.S 316
Dead plate	S.S 304
Hopper	S.S 304
Rake shaft	Steel (S.A.E 1040)
Dram shaft	Steel (S.A.E 1040)
Cable holder	S.S 304
Gear box holder	Galvanized steel

Part	Material
Door switch	Steel
Pulley	Bronze
Pulley shaft	S.S 304
Basket guide	S.S 304
Rake stop	S.S 304
Wheel	bronze

10.3.15. SLUICE GATE

The sluice gate (TBS Stainless steel Penstock with integrated wall sealing, type RVSA) must be a wall and Channel Mounting

The Parts Specification for TBS sluice gate is as follows

Part	Material
Frame	Fabricated: Stainless Steel, 304
Door	Fabricated: using Stainless Steel 304
Bearing house	Fabricated: using Stainless Steel 304
Cross bar	Fabricated: using Stainless Steel 304
Spindle	Fabricated: using Stainless Steel 304
Nut block	Fabricated: using Bronze G-CuSn10
Sealing ring	Fabricated: EPDM.
Wedges	Fabricated: using Stainless Steel 304
Fixing material	Fabricated: using Stainless Steel
Sealing faces *	Fabricated: EPDM.
Fasteners **	Fabricated: using Stainless Steel

* The sealing between the gate and frame and between the frame and the wall is made of EPDM, which is elastic and waste water resistant. It can be easily renewed without having to dismantle the gate of the frame.

Note: Both sets of seals are specially designed for replacement under situation conditions.

** Fasteners: All nuts bolts washers etc. used in the construction of the units will be stainless steel.

The TBS Operating Conditions must be supplied to suit the heads they will encounter in service generally up to a maximum of 6 meter. The maximum pressure and two directions should be stated on the gate.

The expected Leakage Tolerance with the correct installation, leakage should not exceed 0.33 liters per minute per meter of the seating perimeter.

10.3.16. LIFTING DEVICE

Supply and install I beams IPN 300 with sufficient length and all needed accessories for fixation with concrete beams in order to lifting and lowering of the submersible pumps. The device shall have a lifting capacity as specified in the Bill of Quantity.

The lifting device shall be manufactured with dimensions according to Drawings. The crane beam shall be supplied with a hand push hoisting tackle according to the recommendation of the manufacturer of the electrical chain hoist the system include sun/rain protections.

The design, supply and erection of all electrical equipment shall be in accordance with the following standards, codes and regulations listed in the order of increasing priority:

Lifting speed	16 fpm
Horse power	single phase (1 hp)
Service height	10 m
Load capacity	1 ton
IP 66- protection	

ELECTRICAL WORKS

11. ELECTRICAL WORKS

GENERAL REQUIREMENT

PREREQUISITE CONDITIONS

All applicable sections of the general Specifications are included by reference to the work required by this division of the specifications.

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.

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.

POWER SUPPLY

The system of distribution will be fed from a 230/400 volts 3-phase, 4 wire 50 Hz.

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.

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.

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.

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.

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.

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.

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.

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.

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 fail to do so, he shall be herder responsible and shall make good such errors or any damage caused at his own expense.

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.

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.

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.

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

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.

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.

DIRECTOR OF WORKS

The Contractor or his representatives should be on the Site daily for taking any instructions from the director of works (Engineer).

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.

MISCELLANEOUS WORK

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.

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.

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.

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.

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.

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.

GENERAL CONDITION OF THE DIFFERENT PARTS OF INSTALLATIONS

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 than 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.

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.

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.

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.

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].

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

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.

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

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.

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.

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.

LABELS

All circuits shall be labeled in English language and to be of the black sandwich type and engraved.

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.

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.

ON - OFF SWITCHES

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.

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.

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.

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.

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

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.

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