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CONSTRUCTION OF KALOLENI WATER SUPPLY IN TAITA TAVETA COUNTY.

TENDER No

LOT 2 KALOLENI WATER SUPPLY-PUMPING STATIONS AND TANK COMPOUNDS

TECHNICAL SPECIFICATIONS

VOLUME 2.

Consultant:

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MARCH, 2017

TABLE OF CONTENTS**PART 1 - STANDARD TECHNICAL SPECIFICATIONS**

1.0	General Specifications
1.1	Introduction
1.2	Extent of Contract
1.3	Precedence of Contract Documents
1.4	Standards
1.5	Quality of Materials and Workmanship
1.6	Trade Names
1.7	Samples
1.8	Testing
1.9	Programme for Execution of works
1.10	Substantial (Practical Completion)
1.11	Nominated Sub-contractors and Nominated Suppliers
1.12	Entry upon Land, working site and adjoining lands
1.13	Preservation of survey beacons
1.14	Land for camp sites
1.15	Existing Services
1.16	Damage to services
1.17	Temporary Roads and traffic control
1.18	Road closure
1.19	Road & Railway crossing and traffic control
1.20	Protection from water
1.21	Weather Conditions
1.22	Protection from weather
1.23	Explosives and blasting
1.24	Liaison with Police
1.25	Provision of water
1.26	Temporary lighting and power
1.27	Sanitation
1.28	Medical facilities
1.29	Signboards
1.30	Setting out and survey equipment
1.31	Backfilling of Holes and Trenches
1.32	Inspection of works
1.33	Testing of Water-Retaining structures
1.34	Testing of Roofs
1.35	Cleaning and sterilization of water-retaining structure
1.36	Contractor's Superintendence
1.37	Normal Working Hours
1.38	Compliance with statutes and Local Regulations
1.39	Accommodation for workmen
1.40	Storage Spaces and sheds
1.41	Office for Contractor
1.42	Office for Project Manager's Representative
1.43	Telephone
1.44	Housing for Project Manager's Site staff
1.45	Maintenance of Project Manager's site staff housing, furniture and Equipment
1.46	Attendance upon Project Manager's site staff
1.47	Insurance

- 1.48 Transports for Project Manager's Representative
- 1.49 Removal of Camps
- 1.50 Site Meetings

2.0 Site Clearance

- 2.1 Clearance of Trees, Bushes
- 2.2 Damage to lands
- 2.3 Clearing the site on completion

3.0 Earthworks

- 3.1 General
- 3.2 Classification of Excavations
- 3.3 Stripping of Top soil
- 3.4 Excavation in open cut
- 3.5 Borrow Pits
- 3.6 Hardcore Filling
- 3.7 Earth Filling
- 3.8 Grass Planting and Topsoil
- 3.9 Anti-Proofing

4.0 Concrete Works

- 4.1 General
- 4.2 Materials and tests
- 4.3 Pre-cast concrete Units
- 4.4 Workmanship

5.0 Builders Work

- 5.1 Concrete Block walling
- 5.2 Plasterwork and other floor wall and ceiling finishes
- 5.3 Carpentry and joinery
- 5.4 Roofing
- 5.5 Steelwork
- 5.6 Ironmongery and other fittings
- 5.7 Glazing
- 5.8 Painting, Decorating and other surface treatment
- 5.9 Staff House

6.0 Pipework

- 6.1 Materials
- 6.2 Handling and storing materials
- 6.3 Excavation of trenches
- 6.4 Laying and jointing
- 6.5 Concrete manholes and plot chambers
- 6.6 Testing
- 6.7 Refilling of Trenches

7.0 Plumbing And Drainage

- 7.1 General
- 7.2 Plumbing

8.0 Road Works And Footpaths

8.1 General

8.2 Roads and paved areas

8.3 Fencing

9.0 Testing, Training & Commissioning

9.1 Testing & commissioning

9.2 Training

9.3 As built and as commissioned drawings

STANDARD TECHNICAL SPECIFICATIONS

1.1 GENERAL SPECIFICATIONS

1.1 Introduction

These specifications cover the construction of the works as shown on the drawings and listed in the Bills of Quantities and shall be read in conjunction **GCC** and **SCC**

All references given are intended solely for the convenience of those using the above clauses in the documents, which may, in the opinion of the Project Manager have any bearing on the point in question.

1.1.1 Location

The works are located at Kaloleni in Voi town to Kalambe in Taita Taveta County and is defined in drawing No. WMCL-KRCS-LM-01 in the book of drawings.

1.1.2 Scope of Works

The works to be executed under this Contract comprises:

Kaloleni Pump Station

- Construction and fitting of generator room at Kaloleni Pumping station.
- Disconnection of existing rising main pipeline from existing, 150m³ tank, realigning and reconnecting the rising main to act as a return distribution.

Kasarani Tank Compound

- Construction of 250 m³ tank at Kasarani. Genap type or similar approved.
- Supply & installation of pipework, fittings and chambers including making connections to existing pipework at Kasarani tank compound.
- Construction of a compacted murram parking space at Kasarani Tank Compound.
- Fencing around Kasarani Tank Compound and erection of a steel gate.

Majengo Tank Compound

- Construction of 250 m³ tank at Marungu. Genap type or similar approved.
- Supply & installation of pipework, fittings and chambers including making connections to existing pipework at Majengo tank compound

1.2 Extent of Contract

The works specified under this contract shall include all general works preparatory to the construction of the works and materials and work of any kind necessary

1.3 Precedence of Contract Documents

Should the provisions of any clauses of any or all of the Contract Document to be shown to be mutually at variance or exclusive, the following order of precedence shall be applied in order to establish which of the said provisions, mutually at variance or exclusive, shall be deemed to be true and correct intent of the contract entered into by Employer, and the contractor shall forthwith be absolved from any liability under the provisions not so proved

to be the true and correct intent of the contract, provided that in the execution of the contract the contractor has, or shall have complied with such true and correct intent.

- (i) Provision of the Standard or Special Specifications shall take precedence over those of the General Conditions of Contract.
- (ii) Provision of Bill of Quantities shall take precedence over the standard specifications unless otherwise indicated.
- (iii) Details shown or noted on the contract drawings shall take precedence over the requirements of both the standard and Bills of Quantities
- (iv) Detail drawing shall take precedence over General Drawings.
- (v) Within the Standard Specifications, the provisions of any section particular to the provisions at variance shall take precedence over the general section, and within any section clauses particular to the provisions at variance shall take precedence over those not so particular. The foregoing order of precedence shall apply also to sections and clauses of the special specifications.
- (vi) Where there is conflict in Units of measurement quoted in standard specifications and Units quoted in Bills of Quantities the Units in latter will apply.

Notwithstanding any fore written provisions, should the application of the foregoing order of precedence fail to resolve any variance or mutual exclusions as to the true and correct intent of the contract to the satisfaction of the Project Manager, the Project Manager may exercise the right to arbitrarily give a ruling as to the true and correct intention of the contract, and the contractor shall have the right to claim additional payment for any additional expense incurred by him as a consequence of such variance or exclusion and arbitrary ruling.

1.4 Standards

In the specifications, Bills of Quantities, and Drawings reference has been made to relevant British Standard Specifications and Codes of Practice- to which the materials and workmanship should comply with. However, the materials and workmanship complying with equivalent Kenya Bureau of Standards (K.B.S) or International Standards Organisation (I.S.O.) Standard for that particular material or workmanship will also be acceptable.

Mixture of different standards in one trade will not be allowed. For instance, if pipes are to be provided to I.S.O Standard, then all the pipes in the works are to be to I.S.O. Standard.

Where the dimension in one standard does not completely correspond to the dimensions of the other standard, which is being used for construction of works, ruling of the Project Manager will be sought and any decision given by the Project Manager will be final and binding upon the contractor.

1.5 Quality of Materials and Workmanship

The materials and workmanship shall be of the best of their respective kinds and shall be to the approval of the Project Manager. In reading of these specifications, the words” to the

approval of the Project Manager" shall be deemed to be included in the description of all materials incorporated in the works, whether manufactured or natural, and in the description of all operations for the due execution of the works.

No materials of any description shall be used without prior approval by the Project Manager and any condemned as unfit for use in the works shall be removed immediately from the site, and without recompense to, the contractor. All works or parts thereof shall be in accordance with the latest edition of either Kenya Bureau of Standards (K.B.S.) specification or British Standard (B.S.) specifications and British Codes of Practice (C.P.) as published by British Standards Institution.

All materials shall be of approved manufacture and origin and the best quality of their respective kind, equal to sample and delivered on to the site a sufficient period before they are required to be used in the works to enable the Project Manager to take such samples as he may require for testing or approval, and the contractor shall furnish any information required by the Project Manager as to the quality, weight, strength, description, etc. of the materials. No materials of any description shall be used without prior approval by the Project Manager and any condemned as unfit for use in the works shall be removed immediately from the site by, and without recompense to, the contractor.

1.6 Trade Names

Trade Names and Catalogue Reference are given solely as the guide to the quality and alternative manufacturers of the materials or goods of equivalent quality will be accepted at the discretion of the Project Manager.

1.7 Samples

Samples of all materials shall be deposited with the Project Manager and approved prior to ordering or delivery to site. The Project Manager reserves his right to test any sample to destruction and retain samples until the end of the maintenance period. No payment will be made for samples and the contractor must in the rates of prices allow for costs of samples. All materials delivered to site shall be equal or better in all respect than the samples delivered to the Project Manager.

All sampling of materials on the site must be done by or in the presence of the Project Manager. All other samples will be deemed not to be valid under the contract.

All materials delivered to the site or intended for the works not equal or better than the samples approved by the Project Manager shall be removed and replaced at the contractor's expense.

1.8 Testing

As provided in **clause 36** of the **GCC** and in accordance with the specification quoted for any material used on works of this contract, tests may be called upon by the Project Manager to be carried out at the place of manufacture or on the site. The contractor may assume that the tests will be required on soils, workmanship, and materials whether natural or manufactured to verify their compliance with the specifications. Samples of all such materials and manufactured articles together with all necessary labour, materials, plant and

apparatus for sampling and for carrying out of the tests shall be supplied by the contractor at his own expense.

1.9 Programmes for the Execution of Works

- (i) In accordance with **clause 13.1 of GCC** and **as stated in the SCC**, the contractor upon receiving Project Manager's order to commence shall within 28 days draw up a working programme setting out order in which the works are to be carried out with appropriate dates thereof together with delivery dates for materials. The contractor shall together with his work programme supply an expenditure chart showing monthly anticipated expenditure.
- (ii) The programme shall be deemed to have taken into account normal variations in climatic conditions to provide for completion of the works in the order and within the times specified therein.
- (iii) The order in which it is proposed to execute the permanent works shall be subject to adjustment and approval by the Project Manager, and contractor's price shall be held to include for any reasonable and necessary adjustment required by the Project Manager during the course of the works.
- (iv) The contractor shall carry out the contract in accordance with the programme agreed with the Project Manager, but he shall in no manner be relieved by the Project Manager's approval of the programme of his obligations to complete the works in the prescribed order and by the prescribed completion date and he shall from time to time review his progress and make such amendments to his rate or executions of the works as may be necessary to fulfil these obligations.
- (v) Once the proposed programme is approved by the Project Manager, the contractor shall not depart from the programme without the written consent of the Project Manager. In the event of unforeseen difficulties or disturbances arising, which forces the contractor to depart from the approved programme of works, he shall advise the Project Manager in writing of such occurrences without delay and submit proposals for any necessary remedial measures, for which he shall obtain the Project Manager's approval before putting such measures into effect.
- (vi) The contractor shall furnish the Project Manager with a monthly statement of all works done on the contract and of all materials on site.

1.10 Substantial (Practical) Completion

Substantial or Practical Completion of works is to be understood as a state of completion, which leaves out only minor outstanding items that can be readily completed within a period of less than one month without interfering with the normal operation of the works.

The works will not be considered as substantially or practically completed without the works being capable of being used by the Employer in accordance with the purpose of the works.

This means amongst other things, that all final tests have been carried out, the pumping stations and treatment plant fully operational to the required capacity, all storage tanks filled up, operation manuals provided, and clearance of the site upon completion of the works has been carried out, all to the satisfaction of the Project Manager.

The contractor shall allow for a period of one month for the completion by others of as built drawings before the works are handed over to the Employer.

1.11 Nominated Sub-contractors and Nominated suppliers

The contractor shall be responsible for Nominated Sub-contractor in every respect. In particular, it shall be the Contractor's responsibility to ensure that each sub-contractor commences and completes the work in a manner so as to conform to the working programme, as specified above.

It is also the responsibility of the contractor to ensure a satisfactory progress of the works and to ensure that the works are completed to a standard satisfactory to the Project Manager.

The contractor shall accept liability for and bear the cost of General and Specific Attendance on Nominated Sub-contractors which shall be deemed to include for:-

- (i) Allowing the use of standing scaffolding, providing special scaffolding, maintenance and alteration of all scaffolding, retention of all scaffolding until such time as all relevant Sub-contractor's works are complete and removal of all scaffolding on completion.
- (ii) Providing equipment and labour for unloading and hoisting sub-contractor's materials.
- (iii) Providing space for office accommodation, and for storage of plant and materials; allowing use of sanitary accommodation; the supply of all necessary water, power, lighting and watching and clearing away all rubbish.

Cutting away for and making good after the work of sub-contractors as may be required will be measured and valued separately in the Bills of Quantities.

Before placing any orders with nominated sub-contractors or nominated suppliers, the contractor should enter into an agreement with the nominated sub-contractor/nominated suppliers to ensure that the conditions and delivery of materials to site comply with the conditions of contract and the working programme.

Particular clause should be inserted in the agreement with the nominated supplies ensuring the validity of the rates for the supply of materials as per the delivery schedule.

Nominated suppliers who are unable to meet the delivery schedule will not be given allowance for any increases in prices incurred after the delivery time agreed in the delivery schedule.

1.12 Entry upon Land, Working site and Adjoining Lands

The employer shall provide land, right of ways and leaves for the works specified in the contract.

If nothing else is mentioned, the contractor will be allotted for execution of the works only the actual area as necessary for the extent of the construction.

The contractor shall give notice to the Project Manager at least 30 days before he wishes to enter onto the land required to carry out the contract.

The contractor shall not enter onto any land or commence any operations until such time as he receives formal confirmation from the Project Manager that all necessary compensation formalities have been completed and that permission has been obtained from the landowner to enter the land and commence operations. Should the contractor enter onto land or commence operations without first obtaining this confirmation, he shall be liable in whole or in part, at the sole discretion of the Project Manager, for all additional costs and/or legal charges which might arise therefore.

The contractor shall on his own accord obtain rights of admission, and rights of using all other areas which are necessary for storing and manufacturing or for setting up site offices and Project Manager's site office or whatsoever will be necessary.

No separate payment will be made to the contractor on account of these items and the contractor must make due allowance for them in his rates.

The contractor shall take care to prevent injury, damage and trespass on lands, fences and other properties near and adjacent to the works and must in this connection make all necessary arrangements with adjoining landowners, or into the case of Government property with officers appointed for this purpose, and ensure the workmen's observance of all Government rules and ordinances regarding game protection and other matters and provide, maintain and clear away on completion of the works, all temporary fencing which may be required for execution of the works.

Before completion of the works, the contractor must make good or compensate any such injury, damage or trespass on lands, fences and other properties which have no otherwise been provided for in the contract

1.13 Preservation of Survey Beacons

Ordinance Survey Beacons, Bench marks, etc., or around the site of the works shall not be disturbed unless permission has been obtained by the Project Manager from the Survey of Kenya.

In the event of unauthorised disturbance of such beacons, bench marks, etc., in the course of the works being carried out, the contractor shall be responsible for reporting same to the Project Manager and the Survey of Kenya and for payment of any fees due to said Survey of Kenya for replacement of such disturbed beacons, bench marks, etc. The contractor shall not replace such disturbed beacons bench marks, etc. on his own accord.

1.14 Land for Camp Sites

The employer shall make available free of charge to the contractor all land on under or through which the works other than Temporary works are to be executed or carried out all as indicated onto the drawings or as detailed in the specifications. Such land shall exclude land for Project Manager's site offices and the land required by the contractor for his own camps, offices, houses, temporary works or any other purpose.

1.15 Existing Services

Drains, pipes, cables and similar services encountered in the course of the works shall be guarded from damage by the contractor at his own costs to safeguard a continued uninterrupted use to the satisfaction of the owners thereof, and the contractor shall not store materials otherwise occupy any part of the site in a manner likely to hinder the operation of such services.

The contractor shall on the Project Manager's direction arrange for the construction of permanent or temporary diversions of the said drains etc., together with their reinstatement in liaison with the respective departments, bodies, corporations or authorities. No services may be tampered with by the contractor and all works in connection with any kind of services shall be carried out by their respective owners.

It is the responsibility of the contractor to inform the Project Manager immediately any existing service is exposed.

1.16 Damage to Services

The contractor shall be held liable for all damage and interference to mains and pipes, to electric cables or lines of any kind either above or below ground caused by him or his sub-contractors in execution of the works, whether such services are located on the contract drawings or not. The contractor must make good or report to the appropriate authorities the same without delay and do any further work considered by the Project Manager or owner. The contractor shall provide for these contingencies in his rates.

1.17 Temporary Roads and Traffic

The contractor shall provide and maintain all temporary roads, bridges and other work required for the construction of the works including access to quarries, borrow-pits, accommodation etc.

1.18 Road Closure

Where a road used by the contractor for delivery of any materials used in the works is closed under section 71 of the Traffic Ordinance Act 1962 or amendments thereto, the contractor shall obey such closure order and use alternative roads.

1.19 Road and Railway Crossing and Traffic Control

Wherever the pipeline is crossing the classified roads and railway line, the contractor will contact the relevant authorities in advance and obtain necessary permission to dig across the road and railway-line in accordance with requirements of the authorities concerned and shall pay any royalties connected with this work, and the contractor will provide temporary detour road together with any warning signs necessary. There will be no separate payment for this and cost of all expenses connected with road and railway crossing for which no separate items have been included in the Bills of Quantities.

1.20 Protection from Water

Unless otherwise mentioned, the contractor shall keep the whole of the works free from water and allow in his rates for all dams, coffer dams, pumping, pilling, shoring, temporary drains, slumps, etc., necessary for this purpose and shall make good at his own costs all damage caused thereby.

1.21 Weather Conditions

The contractor shall be deemed to take into account all possible weather conditions when preparing his Bid and he shall not be entitled for extra payment by the reason of the occurrence or effect of high winds, excessive rainfall, temperature or any other meteorological phenomena.

1.22 Protection from Weather

All materials shall be stored on site in a manner approved by the Project Manager's Representative and the contractor shall carefully protect from the weather all works and materials which may be affected thereby.

No separate payment will be made for this and contractor will allow in his rates for this.

1.23 Explosives and Blasting

At works requiring the use of explosives, the contractor shall employ men experienced in blasting, and these men must be in possession of a current blasting certificate. The purchase, transport, storage and use of explosives shall be carried out in accordance with the most recent Explosives Ordinance and rules issued by the Government and the contractor shall allow in his rates for excavation and quarrying for all expenses incurred in meeting these requirements, including the provision of suitable stores. Blasting operations shall be carried out with as little interference as possible to traffic or persons and the rates shall include for all flagging, watching, barricades and clearance of debris.

In all cases previous permission from the Project Manager must be obtained before commencing any blasting operation.

If, in the opinion of the Project Manager, blasting would be dangerous to persons or property, or it is carried out in a reckless manner, the Project Manager can prohibit any further use of explosives.

1.24 Liaison with Police, etc,

The contractor shall keep himself in close contact with the police, Labour Officers and other officials in the areas concerned regarding their requirements in the control of workmen, passage through townships, or other matters and shall provide all assistance and/or facilities which may be required by such officials in execution of their duties in connection with the works.

1.25 Provision of Water

The contractor shall provide water for use in the works. He shall supply all hydrants, hose, cocks, vessels and appliances necessary for the distribution thereof and shall provide pumps, tanks, carts, vessels and appliances, transport and labour when and where-ever it is necessary for water to be carted for use at the works. All water used in connection with the works shall if possible be obtained from a public water supply and the contractor shall make all necessary arrangements and pay all the charges for connections to mains and for water used.

1.26 Temporary Lighting and Power

The contractor shall provide all artificial lighting and power for use on the works, including all sub-contractors and Specialists' requirements and including all temporary connections, wiring, fittings, etc., and clear away on completion. The contractor shall pay all fees and charges and obtain all permits in connection therewith.

1.27 Sanitation

The site shall be kept in a clean and proper sanitary condition. No nuisance shall be committed on or around the work, and latrines for the workmen and staff shall be provided in accordance with the requirements of the Medical Officer or Sanitary Authorities. The contractor shall be responsible for the sanitary discipline of his labour.

1.28 Medical Facilities

The contractor's attention is drawn to Legal Notice No. 79 of 22nd September, 1978 by which it is mandatory that every contractor employing more than twenty people should appoint (in writing) a safety supervisor. A safety supervisor advises the management on all matters regarding safety, hygiene and welfare of the people affected by the Contractor's undertaking on the site. The safety officer may in addition carry out other duties.

The contractor shall provide adequate first aid equipment on the site, and ensure that at least two of his site staff is competently trained in first aid.

1.29 Signboards

The contractor shall erect signboards in prominent positions adjacent to the works to the satisfaction of the Project Manager.

1.30 Setting out and Survey Equipment

The contractor must before commencing any construction works, make sure that levels shown on the drawings correspond with levels found on the site.

Should any discrepancy be discovered between the levels shown on the drawings and those found on the site, which may affect the levels and dimensions of any part of the works, the contractor shall notify the Project Manager, who if necessary, will issue drawings showing the amended levels and dimensions.

The Contractor shall allow for in his rates, the cost of the necessary qualified and experienced staff to set out the works and during the continuance of the contract for the sole use of the Project Manager, provide approved new and accurate instruments together with all other requisites, all necessary chairmen and other attendance and transport required for setting out and checking the works or purposes in connection therewith.

The major requirements are as a minimum but not limited to the following:

- a) Theodolite accurate to 1 second including the following accessories:
 - (i) 2No. Equipment Tripod
 - (ii) 4m ranging rods (12no)
- b) Survey level (2 No.). Including the following accessories;
 - (i) 2No. Levelling staves;
 - (ii) 2No. Equipment tripod
- c) 50m steel tapes (2no.)
- d) m pocket tapes (6No.)
- e) Bush Clearing tools (various as necessary)

The contractor shall clear the site and set out the works well in advance to enable the Project Manager to inspect and approve the setting out prior to commencement of the works.

1.31 Backfilling of Holes and Trenches

The contractor shall immediately upon approval of any work at his own expense and to the satisfaction of the Project Manager backfill all holes, trenches and temporary quarries which have been made.

1.32 Inspection of Works

The contractor must give due notice in writing to the Project Manager's Representative when any part of the works are ready for inspection.

1.33 Testing of Water Retaining Structures

All water retaining structures shall on completion be tested for water tightness in the following manner:-

The structure shall be filled with portable water in stages and held at each stage for such time as the Project Manager may require. Should any dampness or leakage occur at any stage, the water shall be drained off and the defects made good. The procedure shall be

continued and finally the structure shall after a period allowed for absorption remain full for seven days. Within those seven days, the level of the structure of the water should be recorded and measurements made at intervals of 24 hours. The total leak must not exceed 0.3% of the total volume of water in the tested structure.

If the structure does not satisfy the conditions of the test, and the daily drop in water level is decreasing, the period of test may be extended for a further 7 days, and if the specified limit is then not exceeded, the structure may be considered as satisfactory.

1.34 Testing of Roofs

Where structures are used for the storage of portable water, adequate precautions should be taken to ensure that the roof is watertight in order to give protection against a potential source of pollution.

The roof should be tested by lagging the concrete slab to a minimum depth of 75mm for a period of 3 days, the roof slab should be regarded as satisfactory if no damp patches occur on the soffit. The roof screed should be completed immediately after testing.

1.35 Cleaning and Sterilizing Water Retaining Structures

The interior of all potable water retaining structures shall be thoroughly cleaned and washed after the water tightness test has been approved by the Project Manager in order to remove all contaminations.

The structure shall then be filled to overflow level with clean water containing 50 parts per million of chlorine and left for a period of at least 24 hours. The chlorinated water shall then be drained away and the structures refilled with clean water from which samples shall be taken for bacteriological examination and for tests of residual chlorine. If any of the results of the tests are unsatisfactory when compared with those of the control sample of the supply water, the sterilizing process shall be repeated until the results of the tests are satisfactory.

1.36 Contractor's Superintendence

The contractor shall give or provide all necessary superintendence during the execution of the works and as long thereafter as the Project Manager may consider necessary for proper fulfilling of the contractor's obligations under the contract.

1.37 Normal Working Hours

The contractor shall inform the Project Manager in writing, at the time of submitting the work programme, the normal working hours. The contractor shall respect all public holidays. Where the contractor wishes to work outside these hours, he shall request the Project Manager in writing at least 24 hours in advance for consideration.

1.38 Compliance with Statutes and Local Regulations

In addition to requirements of the **GCC 3.1** and **as stated in SCC**, the contractor shall be responsible for acquainting himself with all current valid statute ordinance or bye-laws or regulations which may affect the works and shall include these in the item provided in the

Bills of Quantities. This applies to training levy and other similar taxes for which no claim on the part of the contractor other than the one inserted in the bills of quantities will be allowed.

1.39 Accommodation for Workmen

The contractor shall provide and maintain suitable shelters and mess facilities for his workmen and supervisory staff. The contractor shall throughout the contract provide an adequate supply of potable water for the workmen.

1.40 Storage Spaces and sheds

Suitable temporary stores and workshops shall be erected and later removed on completion of the works.

1.41 Office for Contractor

The Contractor shall erect an office near the works on a site to be approved by the Project Manager. This office shall be kept open at all hours during which the work is in progress.

Any notice to be given to or served upon the Contractor shall be deemed and taken to be effectively given or served upon by the delivery there-of at such office on the site.

1.42 Office for the Project Manager's Representative

The Contractor shall provide and maintain an office inclusive of furniture; staffs etc to enable the Project Manager's Representative perform his duties. This will be as provided in the B.O.Q. The facilities shall revert to the Contractor when not needed or otherwise as specified in the B.O.Q.

The Contractor shall be paid for Project Manager's Office in the following manner where applicable:

- (i) 40% (Forty per cent) of the sum when the offices have been erected, furnished, equipped and handed over to the Project Manager.
- (ii) 40% (Forty per cent) of the sum in equal monthly instalments spread over the period from the time the offices are taken over by the Project Manager until the end of the Contract. (in the event of an interim certificate not being issued in any month, then the instalment shall be added to the subsequent certificate).
- (iii) 20% (Twenty per cent) of the sum when the building has been removed and the site is left neat and tidy to the satisfaction of the Project Manager.

All the above payments of the sums shall be subjected to deductions of retention money. No payment for offices will be made unless their erection has been ordered in writing by the Project Manager.

1.43 Telephones

The Contractor shall arrange to provide one post office telephone for the exclusive use of the Project Manager's site staff. The telephone shall be installed in the Project Manager's site Office, on the onset of the Contract.

Upon the completion of the contract, the contractor shall arrange to provide telephone installations in the treatment plant.

A provision sum item has been allowed in the Bills of Quantities for the payment of the cost of telephone installations and telephone Bills.

1.44 Housing for the Project Manager's Site staff

A Provisional Sum has been entered in the Bills of Quantities to cater for the housing needs of the Project manager's site staff. This sum shall be paid to the contractor as a reimbursement of renting approved accommodation for these staff. The contractor shall further furnish these houses as scheduled.

1.45 Maintenance of the Project Manager's Staff Houses, offices, furniture and Equipment

For the entire duration of the Contract, the contractor will:-

- (i) For rented houses, ensure that the Landlord attends to any maintenance problems regularly. The furniture shall be maintained by the contractor.
- (ii) Keep all buildings provided by him, for the use of the Project Manager and his staff, in well maintained, clean and fully habitable condition, and shall maintain all access roads, car parks, footpaths, fences, gates, drains, potable water supplies, gas, electricity and water-borne sewage disposal system in good stage of repair, all to the satisfaction of the Project Manager.
- (iii) The Contractor shall also provide an adequate refuse collection for all houses and offices provided by him.
- (iv) The Contractor shall maintain all furniture and equipment provided by him in a reasonable state of repair and usable condition and shall replace promptly any item which becomes unserviceable or is lost.
- (v) The Contractor shall provide day and night watchmen for the Project Manager's staff houses whether rented or constructed by him.

1.46 Attendance Upon Project Manager and his Staff

For the duration of the Contract:-

- (i) The Contractor shall provide all assistance including labourers, chainmen, clerks and junior staff as and when required by the Project Manager for checking, setting out, surveying measuring or for testing of work. The Contractor shall also provide a full time assistant in Project Manager's site office.
- (ii) The Contractor shall provide all tools and protective clothing, wooden pegs, iron pins and pickets, water cement and aggregate for concreting, transport for

labourers and materials as may be required by the Project Manager and his staff for checking, setting out, surveying, measuring or testing of the work.

1.47 Insurance

All buildings, furniture and equipment provided by the contractor for the Project Manager's Representative shall be insured by the Contractor against loss or damage by accident, fire, theft and other risks ordinarily insured against for the duration of the Contract. The theft shall include personal belongings of the tenants in the Project Manager's staff houses.

1.48 Transports for Project Manager's Representative

The Project Manager's Representative shall have exclusive right of use of the vehicles stated in the Bills of Quantities and drivers shall be at the Project Manager's Representative's disposal within all working hours.

The contractor shall bear all costs of purchasing the vehicle's road licenses, comprehensive insurances, safety belts, car identity protection, drivers, maintenance, fuel and lubricants and must keep the vehicles clean and in a good roadworthy condition throughout the contract. The vehicle is however, to be registered in the joint names of contractor and the employer.

All maintenance shall be carried out at the prescribed intervals by an approved dealer.

In the event of service and repairs with duration of more than one day, the contractor shall provide suitable replacement vehicles to the approval of the Project Manager.

The costs of the above shall upon presentation of receipts be paid against the Provisional Sums entered in the Bills of Quantities.

At the completion of the works, the Contractor will bring each vehicle to the relevant dealer for testing. The dealer shall then recommend to the Project Manager any necessary repairs in addition to the ordinary service. Upon such recommendation, the Project Manager will give the necessary instructions.

The Contractor shall be solely responsible for safe custody of the vehicles during the construction period. In case of theft or loss of any vehicle, the Contractor shall replace such vehicle at his own cost. The registration book (Log book) shall be deposited with the Project Manager's Representative and only taken by the Contractor when renewing road licenses or similar activity.

1.49 Removal of Camps

On the completion of the Contract, the Contractor shall if so requested take down and remove all structures connected with his camp, and shall take up all pipes, drains and culverts, backfill trenches, fill up all latrine pits, soak ways and other sewage disposal excavations and shall restore the site as far as practicable to its origin condition and leave it neat and tidy to the satisfaction of the Project Manager.

1.50 Site Meetings

Site meetings will normally be held monthly, but will be called for whenever the progress of the works so require or when demanded by the Project Manager.

The Contractor shall at all meetings be represented by a responsible representative other than the Site Agent, who has the powers to commit the contractor in all matters concerning the contract.

In the event, no responsible representative of the contractor is present at the meetings; any decision taken by the Project Manager at the meeting will be binding upon the contractor.

2 SITE CLEARANCE

2.1 Clearance of Trees, Bushes, Scrub, Huts, etc.

The contractor shall unless otherwise directed cut down all trees, remove bushes, plantations, crops and other vegetable growth and grub up all roots, take down all huts, buildings, walls fence and any other obstruction and handle and transport salvaged usable materials, to a site approved by the Project Manager. All salvaged and usable materials are the property of the respective owners. The clearing and demolition here-in described shall be carried out to a width of the minimum excavation plus 1.50m on either side.

With exception of the salvaged material fore-mentioned, the contractor shall destroy or otherwise remove the whole of the rubbish from the site to an approved tip or number of tips provided by him.

Trees shall be cut down to as near the ground level as possible and the rates entered in the Bills of Quantities shall include for cutting down, removing branches and foliage, cutting into suitable lengths, grubbing up stumps and roots, stacking up, burning or disposing of as directed.

Before commencing any site clearance, general clearance, clearance of pipelines etc, the contractor shall inform the Project Manager's Representative of his intention. The Project Manager's Representative will be visiting the section of works concerned, determine the extent of the clearance expressly required.

2.2 Damage to Lands, etc.

Except where necessary for the proper execution of the works, the contractor shall not interfere with any fence, hedge, trees, land or crop forming the boundary of the site, or elsewhere. In the event of any interference, the contractor shall make good any damage to such fence, hedges, tree, land or crop to the satisfaction of the Project Manager and the owner thereof.

Where the work is to be executed in private land, the Employer will be responsible for negotiating and obtaining rights of way and the serving of all notices as may be required upon the owners and/or occupiers of the land and it shall be the obligation of the contractor to keep the Employer and the Project Manager fully informed concerning the rate of progress and of his intention to enter and begin work within any way leave as provided for under the condition of contract and required by this specification.

2.3 Clearing the Site on Completion

On completion of the works, the contractor shall clear the site of all plant, building, spoils, dumps, rubbish, etc. and leave the site to the satisfaction of the Project Manager.

Borrow pits and temporary quarries shall be made good and covered with vegetable soil. Dumps for waste material shall be covered with at least 0.5m of soil of which at least a 0.10m layer in top shall be vegetable soil.

3 EARTHWORKS

3.1 General

Excavation shall be made to such lengths, depths and inclinations as may be necessary for the construction of the works or as shown on the drawings or as the Project Manager may direct.

3.2 Classification of Excavation

The Project Manager or his Representative and the Contractor or his Representative shall be present during classification of materials.

Where the terms "rock excavation" and "soft excavation" or "excavation" are used in these specifications, the following definitions shall apply.

3.2.1 Rock Excavation

Rock excavation includes all solid rock in place which cannot be removed until loosened by blasting, barring, wedging, and all boulders or detached pieces of solid rock more than 0.25 cubic metres in volume. Solid rock under this class is defined as sound rock of such hardness and texture that it cannot be loosened or broken down by hand- drifting picks.

All materials containing more than 50% by volume of boulders exceeding 0.25 cubic metres in volume shall be classified as rock excavation.

3.2.2 Soft Excavation

Common excavation includes all material other than rock excavation: including, but not restricted to earth, gravel, and also such hard and compact material as hardpan, cemented gravel, and soft or disintegrated rock together with all boulders or detached pieces of solid rock not exceeding 0.5 cubic metres in volume.

3.3 Stripping of Topsoil

3.3.1 Stripping

Stripping shall consist of removing, transporting and disposing of topsoil, stumps, roots, buried logs, debris, humus and similar objectionable matter.

Areas to be stripped are all areas required for the permanent constructional works, borrow-pits and embankment fills.

The limits of stripping shall extend 2 metres beyond the limits of excavation or toes of fills.

The depth of stripping shall normally be 0.2m, but deeper stripping might be needed to remove stumps.

3.3.2 Disposal

Materials from stripping suitable as topsoil shall be spread in approved areas. All other non-combustible materials shall be buried in approved disposal area; covered with a minimum of 0.5m of excavation spoil. These disposal areas shall be left with neatly graded surfaces and stable slopes that assure drainage. Alternatively, the non-combustible material shall be removed from the area by the contractor.

3.4 Excavation in Open Cut

3.4.1 General

All open cut excavation shall be performed in accordance with this section to the lines, grades and dimensions shown on the drawings or as directed by the Project Manager. The Project Manager reserves his right to at any time during the progress of the work to vary the slopes or dimensions of the excavations from those previously specified.

Any damage to the works due to the contractor's operations, including shattering of the material beyond the required excavation lines, shall be repaired at the expense of and by the contractor. All excess excavations and over-excavation shall be filled with compacted concrete grade 10 furnished and placed at the expense of and by the contractor.

All excavation for structure foundations shall be performed in the dry.

If excavations are carried out in roads, footpaths, separators, or within 5m of buildings, the contractor is requested to execute the work in a way that will minimise damage and disturbances.

3.4.2 Mechanical Excavation

- (a) A mechanical excavator shall be employed only if the sub-soil is suitable and will allow timbering of trenches or other excavations to be kept sufficiently closed up to ensure that no slips fall or disturbance of the ground takes place or there are no pipes, cables, mains or other services or property which may be disturbed or damaged by its use.
- (b) When mechanical excavators are used, a sufficient depth of material shall be left over the bottom of the excavation to ensure that the ground at finished excavation level is not damaged or disturbed in any way. The excavations shall then be compacted by hand to the finished levels required.

3.4.3 Rock Excavation

The contractor shall trim all rock faces in cuttings according to the dimensions shown on the drawings and upon completion leave them safe from rock falls to the satisfaction of the Project Manager.

3.4.4 Foundation for Structures

(a) Common Material

The bottom and side slopes of common material upon or against which concrete is to be placed shall be finished accurately to the established lines and grades, and

loose materials on surfaces so prepared shall be moistened with water and tamped or rolled with suitable tools and equipment to form a firm foundation for the concrete structure. If, at any point, material is excavated beyond the established excavation lines, then the over-excavation resulting voids shall be filled with consolidated concrete grade 10 at the contractor's expense.

If the excavation is carried out in advance, a protective layer of 150mm thickness shall be left above the foundation level until immediately before the contractor is ready to pour the blinding concrete.

(b) **Rock Materials**

The bottom and side slopes of rock material upon or against which concrete is to be placed shall be excavated to the required dimensions as shown on the drawings or established by the Project Manager. No material will be permitted to extend within the neat lines of the structure. If at any point in the rock material, material is excavated beyond the limits required to receive the structure, the additional excavation shall be filled solidly with concrete grade 10.

All soft or loose materials shall be removed by the use of stiff, brooms, picks, hammer or jets and cavities backfilled with concrete grade 10, grout or compacted rock fill as directed.

(c) **Levels and Dimensions of Foundations**

Levels and dimensions of foundations shown on the drawing may be changed by the Project Manager to suit actual site conditions.

The additional volume shall be measured net and paid according to the rates in the Bills of Quantities.

3.4.5 Trench Excavations for Pipe Laying

All surface material including top soil which differs in any nature whatsoever from the sub-strata shall in every case be carefully set aside and stored separately from other excavated material. No extra claim will be allowed for setting aside surface matter or topsoil for later use.

Trench excavation shall be carried out with great care, true to line and gradient and as near as practicable to the size required for construction of the permanent work. Nowhere shall the external dimensions of the excavations be less than the dimensions of the permanent work shown on the drawings or as directed by the Project Manager.

If the bottom of the excavation becomes weathered prior to pipe laying, due to fault of the contractor, the weathered soil shall be replaced with suitable compacted material to the original formation level at the contractor's expense. The pipe trench shall be excavated to a depth of 150mm below the invert level of the pipe and refilled with sand, gravel or other selected materials free from stones and well rammed in order to provide a smooth bed for the pipes.

Where concrete pipes are laid in concrete, the pipe trench shall be excavated to a depth of 150mm below the invert level of the pipe and the width shall be equal to the breadth of concrete bedding for the pipes plus 150mm on either side.

Excavation for pipe trenches shall be of sufficient depth to give a minimum cover of 600mm over the top of the pipe. Where pipes/sewers cross under roads, minimum cover shall be 900mm, or such cover as may be directed by the Road Authority.

Where the pipeline is required to be laid at depth, which does not satisfy the minimum cover conditions set out above, the ground surfaces shall be brought up to the required level by banking the backfill or as directed by the Project Manager.

No pipes shall be laid and no excavation filled in or covered with concrete until the formation has been inspected and permission to proceed with the work obtained.

Where P.V.C. or Polythene pipes are being laid, the bottom of the trench must be completely free from stones, and a smooth bed of fine material must be provided. Where the bed of the trench for P.V.C. or Polythene pipes is excavated in rock, it must be excavated to a depth of not less than 100mm below the bottom of the pipe, and refilled with selected fine granular material to make a smooth bed for the pipe.

The width of the trench to be excavated will depend on the size and type of pipe being laid. Sufficient width must be excavated to allow the pipe to be correctly bedded and aligned, and to allow for the joints to be correctly made.

Any excavated material stored on site for backfilling or other purposes shall be deposited alongside the excavation at a minimum distance of 0.5m in such a manner that it will cause no damage and as little inconvenience as possible.

3.4.6 Timbering of Excavation

The contractor shall supply and fix outside the limits of the permanent works all the timber necessary for support of sides and bottoms of the excavations, for the security of adjacent structures and properties and for every other purpose for which it may be required, all to the satisfaction of the Project Manager. The contractor shall maintain such supports until in the opinion of the Project Manager, the works is sufficiently advanced to permit the withdrawal of the support. Such withdrawal shall be executed only under the personal supervision of a competent foreman.

The Project Manager may order excavations to be timbered or to be close timbered or may order timbering to be driven ahead of the excavation, or may order the adoption of any other method of supporting the sides and bottoms of the excavations as may appear to be necessary, and the contractor shall adopt and shall make no charge for executing the adopted method.

The contractor shall be responsible for any injury to the work and any consequential damage caused by or arising out of the insufficiency of the support he provides for his excavations or caused by or arising out of the removal of that support, and any advice, permission, approval or instruction given by the Project Manager relative to that support or removal thereof shall not relieve the contractor of his responsibility.

Any instruction given by the Project Manager will be directed to the provision of stronger support than that proposed by the contractor, and will be given only when, in the opinion of the Project Manager, the support proposed by the contractor is insufficient.

Where timber has been used in excavations any such timber left in position shall be at the expense of the contractor except where the Project Manager has ordered the timber to be left in place or if any timber should be left in place with the prior approval of the Project Manager. The timber approved or ordered to be left in place will be paid for at the rates entered in the Bills of Quantities.

For the purpose of this clause, the words "timber" and "timbering" shall be construed to include trench sheeting and steel or concrete sheet, piling or any other means adopted by the contractor for supporting excavations.

3.4.7 Refilling Excavations

The refilling of excavations shall be commenced as soon as practicable after the permanent works have been tested where so required and inspected and approved by the Project Manager. In particular, the back filling of trenches shall be carried out expeditiously to reduce lengths of trenches open at any one time.

Backfilling shall be executed with selected materials in 150mm layers (300mm layers of a mechanical hammer are used) each layer being well rammed and watered to obtain the maximum compaction. Care shall be taken to ensure that no stone or other material, which could damage pipes or other work, is placed within 300mm of such work.

As soon as P.V.C. or Polythene pipes are laid and jointed in their final positions, they should be protected from possible damage by carefully backfilling of fine granular material brought up to about 150mm over the top of the pipe, for the full width of the trench, and well compacted.

Joints must be left open for inspection until the pressure test is completed.

Backfilling over steel pipes shall be generally as described above, except that the initial protective filling around the pipe is not necessary.

3.4.8 Reinstatement of Surfaces

Generally, all trenches and backfilled excavations shall be reinstated to equal surfaces as before excavation.

Trenches in any existing road shall be refilled to the level of natural soil below the road with sub-soil in 75mm layers, each layer being carefully tamped with rammers. The remaining top layer shall be filled to the road surface with materials equal in type, Quantity and compaction to materials used for the existing road.

The trench shall then be left to settle for 30 days. At the expiration of this period, the surface shall be made up to level and tamped or rolled to the approval of the Project Manager, who will decide on the particular surfacing employed in accordance with the existing surface of the road.

Before expiration of the maintenance period, the contractor shall make good any defaults in reinstatements.

3.4.9 Removal of Surplus Excavated Material

Excavated material, which is not needed either for backfilling trenches or other excavations or use in embankments or otherwise, shall be removed and disposed of to tipping places obtained by the contractor. All rubbish and waste material shall similarly be removed by the contractor. All surplus excavated material shall be spread and levelled in the tipping places in accordance with such directions as the Project Manager may give, and the contractor's rates for disposal shall include for the costs of such operations.

The contractor shall take every practical precaution against causing any nuisance, damage, injury or inconvenience in the handling, stacking, carting or disposal of excavated materials or any other operation matter or thing in connection therewith.

No excavated material shall be placed in any position here it may be washed away or may be liable to fall or spread into any private property or across a road or footpath, should such occur, the contractor shall forthwith remove the same at his own costs.

Should the Project Manager direct the contractor to tip certain surplus excavated materials in a particular place (other than the tipping places obtained by the contractor) the contractor shall abide by such instruction and shall make no charge in consequence thereof unless the place specified entails a longer haul than what would be incurred by tipping at the place obtained by the contractor.

In the case of bulk excavations, the contractor shall unless otherwise directed by the Project Manager prior to the commencement of any excavation prepare grid plans of the various sites showing the existing ground levels at intervals of not more than 10m. For any particular part of excavation, the mean ground level shall be determined from the aforesaid grid plan and the depth shall be calculated from the above mean ground level

Rates for excavation shall also include for working in a manner that causes no interference with the stability of adjacent structures and properties; for the cost of all timber or other support left in place unless ordered or approved to be left in place by the Project Manager: for ground stabilization by means of de-watering, chemical processes or other approved method whether affected by floods, storms or otherwise; for the provision and sealing of temporary channels, drains and dumps; for temporarily storing excavated materials required for backfill or other purposes; for temporarily supporting, protecting, diverting, maintaining utility services; for maintaining flows in sewers and water found necessary for the proper execution and safety of the works.

3.5 Borrow Pits

No borrow pits will be allowed to be opened on the site unless permission in writing has been obtained from the Project Manager.

Before the excavation of an approved borrow area is commenced, the contractor shall clear the surface and strip the topsoil in accordance with clauses 3.

Borrow excavations shall be regular in width and shape and shall be properly graded and drained and finished with neatly trimmed slopes, and if so directed soiled and grassed.

3.6 Hardcore Filling

Hardcore fill shall consist of clean hard broken stone or rubble with measurements not below 200mm and not exceeding 500mm in any one direction with sufficient murrum added to fill the interstices. The hardcore shall be well packed, rammed and where possible rolled with a 5 ton roller. Where rolling is impossible, compaction shall be by hand or by mechanical tampers. Before any concrete is laid on hardcore, the hardcore shall be levelled and blinded with fine stone chipping, rolled and watered as necessary. Hardcore filling is measured after compaction.

3.7 Earth Filling

3.7.1 General

Earth not suitable to be used in filling may at any time is rejected by the Project Manager. If there is a deficit of soil, the contractor shall from approved borrow pits supply selected material in the ordered amount.

Before earth filling, the sand or gravel bedding of the pipes, according to the drawings shall be made. Soil filled to 500mm over the top of pipes shall be free from stones and be filled in by hand with the utmost care to avoid replacement of pipes.

3.7.2 Compaction of Fill

The 500mm fill over the pipe shall be compacted carefully by hand. In other areas, after removal of topsoil as specified, fill material shall be spread in even layers over the full width of the area to be filled. Each layer shall not exceed 300mm in thickness after compaction.

The water content of the earth fill material prior to and during compaction shall be distributed uniformly throughout each layer of the material. The allowable ranges of placement water content are based on design considerations. In general, the average placement water content will be required to be maintained at the Proctor Laboratory Standard Optimum Condition. This standard optimum water content is defined as, "That water content which will result in a maximum dry Units weight of the soil when subjected to the standard Proctor Compaction Test".

Proctor compaction tests are to be carried out in accordance with BS 1377 and the contractor shall provide the Project Manager with facilities to carry out such tests, or cover the cost of tests carried out elsewhere.

As far as practicable, the material shall be brought to the proper water content in the borrow pit before excavation. Supplementary water, if required, shall be added to the material by sprinkling on the earth fill and shall be mixed uniformly throughout the layer.

Compaction of fill shall be carried out to 95 per cent standard proctor if not otherwise indicated on the drawings.

In case of unsatisfactory compaction test results, the contractor shall re-compact or remove the fill to the satisfaction of the Project Manager.

The number of tests to be made shall be agreed upon by the Project Manager and the contractor at commencement of the work.

The machinery the contractor intends to use for compaction (pneumatic, vibrating, static or other rollers) must be approved by the Project Manager before employment.

The contractor shall take care that each separate layer is formed with side slopes to ensure that water cannot gather on the surface, thus causing softening of the soil. Compaction shall start from the side of the embankment and continue towards the middle.

Earth fill shall be measured after compaction.

3.8 Grass Planting and Top Soil

Top soil shall be selected vegetable soil, well compacted and except where otherwise specified of 150mm thickness.

The contractor shall trim the faces of the side slopes to open channels and elsewhere where directed to the dimensions, inclinations and curves shown on the drawings, remove all excess material and make good all depressions with suitable material.

Where instructed by the Project Manager, the contractor shall plant Kikuyu or other approved grass at the rate of 16 plants per m² corresponding to 250mm c/c. The Project Manager shall satisfy himself that natural growth of grass will not take place within a reasonable time before instructing the contractor to grass specified areas.

The contractor shall be responsible for obtaining suitable grass plants and for making all necessary arrangements with the owners and/or occupiers of the land from which they are to be obtained. The contractor shall be responsible for the preparation of the embankment for planting, and for maintaining adequate grass cover and necessary watering during the Contract and Maintenance Period.

3.9 Anti Proofing

Where an ant-proof course has been specified, it should be made by application of Rentokil Termite Soil Concentrate or equal diluted one part concentrate to forty parts water (by weight) at the rate of 5 litres solution to 1 square metre to the whole area of the building immediately before (36 hours maximum) the concrete is poured. Additionally to all critical areas, i.e. both sides of wall foundations, piers and porches the application should be 5 litres per running metre. Treatment should not be made when the soil is excessively wet. Precautions should be taken to prevent disturbance of the treated areas before they are covered.

4 CONCRETE WORKS

4.1 General

All materials and workmanship for concrete shall comply with BS 8110 and BS 8007 where applicable.

4.2 Materials and Tests

4.2.1 Cement

Cement shall be ordinary Portland cement complying with BS 12. The cement shall be delivered in properly sealed, unbroken bags.

Rapid hardening Portland cement complying with BS 12 may be used with the approval of the Project Manager.

Quantities in excess of one ton shall be stored in a water-proof shed with a raised floor. The cement shall be used in the order in which it has been received.

Quantities of less than one ton for early use may be stored on a raised floor and covered by a water-proof tarpaulin.

Any cement damaged by water or proving defective shall be removed from the site immediately.

4.2.2 Aggregates for Concrete

The aggregate shall comply in all respects with the requirements of BS 882.

The aggregate shall be free from dust, decomposed material, clay, earthy matter, and foreign substance or friable, then or laminated material. The fine aggregate shall be of approved river sand.

Coarse and fine aggregate shall be stored on the sites in separate heaps so that no possibility of any intermixing of the two shall occur. Any materials, which have been intermixed, shall be removed by the Contractor forthwith.

A sample of all aggregates shall be delivered to the site for the approval of the Project Manager, and it shall remain on the site until all concrete work is finished.

Should the Project Manager so require, the Contractor shall furnish a certificate from an approved testing laboratory in connection with each source of fine and coarse aggregates showing that materials comply with the specification. All such testing shall be carried out at the Contractor's expense.

4.2.3 Water

All water to be used for concrete, mortar and curing shall be of good drinkable quality, free from humus acid, chemicals, salts or other matters that in any way whatsoever, may be

harmful to the concrete, either by diminishing the strength or causing a discolouration of the concrete.

Generally, water from public mains shall be used, but if this is not possible, the Contractor shall obtain water from other sources approved by the Project Manager. The Contractor may be requested to provide test analysis according to BS 3148 from an approved laboratory.

4.2.4 Admixture

Admixture of any kind of accelerating the setting of cement, plasticizers, water proffers, etc shall not be used except by written permission of the Project Manager. The Contractor must by request supply all details of any admixture.

4.2.5 Concrete Mixes

Concrete shall be "Designed mixes" for reinforced concrete and "Nominal Mixes for Mass Concrete" to BS 8110 and used as shown on the drawings and in the Bills of Quantities. The concrete mixes, maximum aggregate sizes, maximum water/cement ratio and minimum cement content shall be in accordance with the following table.

Concrete Grade	Maximum size of Coarse Aggregate	Minimum Cement Content	Maximum water/cement Ratio
10	40mm	210 /kg/m ³	
15	40mm	250 kg/m ³	
20	20mm	320 kg/m ³	0.5
25	14mm	390 kg/m ³	0.5

4.2.6 Trial Mixes

The actual concrete shall be determined prior to starting of concrete works according to BS 8110

For each grade of concrete three separate batches shall be made using the actual aggregate.

The workability of each of the trial batches should be determined and two times three cubes made from each batch for test at 7 days and 28 days.

The average strength of the nine cubes shall exceed the following values:-

Concrete grade	Minimum average at 7 days	Strength of 9 cubes at 28 days
20	21 N/mm ²	31.5 N/mm ²
25	24.5 N/mm ²	36.5 N/mm ²

For all the trial mixes the mix proportion shall be as specified under clause 6.3 of BS 8110.

4.2.7 Testing of Concrete

Testing of concrete shall comply with BS 8110.

All test cubes shall be manufactured, cured and tested as detailed in BS 1881.

The Contractor shall provide at his own expense all the necessary labour, equipment, moulds, etc, required for manufacture of the test cubes. All test cubes requested by the Project Manager shall be tested by Ministry of roads and Public Works, materials Branch and the Contractor shall allow in his rates for concrete for all costs in relation with test cubes.

Should the Contractor require independent tests, he shall make them at his own expenses, and the results of such tests shall not be valid unless test cubes are manufactured in the presence of the Project Manager and tested by an approved agency and to the requirement in all details of the BS mentioned above.

Sufficient moulds and equipment shall be provided to enable a minimum of six test cubes to be prepared on each day when concrete is being mixed or such other number as the Project Manager may direct. The Contractor shall be responsible for delivery of the cubes to the Ministry of Roads and Public Works, materials Branch, or other approved testing laboratory.

The precise location of the concrete, which the test cubes represent and the time of placing, shall be noted on the drawings or elsewhere.

Where the concrete in the work is compacted by mechanical vibration, the test cubes shall be compacted by mechanical vibration, and where the concrete in the work is compacted by hand, the test cubes shall also be compacted by hand as specified in BS 1881.

The Project Manager may in the Laboratory make test cubes for any purpose from site materials, and the Contractor shall supply such materials required free of charge.

The test cubes shall be stored at the site of construction at a place free from vibration under damp sacks for 24 hours after which time they shall be removed from their moulds, marked and buried in damp sand or under water until the time for delivery to the testing laboratory.

The cubes shall then be paced in damp sand or other suitable damp material and sent to the testing laboratory, where they shall be similarly stored until the date of test. Test cubes shall be kept on the site for as long as practicable but for at least three-fourths of the period before testing, except for tests at ages less than seven days.

4.2.8 Standards for Acceptance of Cubes Tests

The result of all cube tests shall be accepted by the Contractor and Project Manager as true results of the crushing strength of the cubes. The cube strength shall be calculated from the maximum load sustained by the cube at failure.

The appropriate strength required may be considered to be satisfied if the requirements in BS 5328: Part 4, clause 3.16, are fulfilled.

If the tests fail to give the required strength, further testing of the concrete shall be carried out. If these tests fail to prove the strength of the concrete used, the Contractor shall at his own expense remove and replace all such concrete as directed by the Project Manager.

4.2.9 Slump Tests

Concrete consistency shall be determined by a slump test carried out in accordance with BS 1881 and at the Contractor's expense.

Unless otherwise specified by the Project Manager, the following are the slump for the particular class of work.

Compaction by vibrator or	Compaction by hand
Reinforced Concrete	30 to 60 mm
Mass Concrete	0 to 30 mm, 30 to 80 mm

Concrete having a slump test value exceeding the values here-in specified may be rejected by the Project Manager.

4.2.10 Steel Reinforcement

Steel for reinforced concrete shall be stored under cover clear of the ground and shall comply with BS 4449, BS 4461 and BS 4483.

All steel reinforcement shall be supplied by an approved manufacturer, and the Contractor may be required to obtain a manufacturer's test certificate in respect of steel reinforcement supplied. In the absence of such a test certificate, the Contractor may be required to submit samples to be tested at the Contractor's expense in such a manner as the Project Manager may determine.

4.3 Pre-cast Concrete Units

Precast concrete shall be cast in properly made strong moulds true to the shapes required. For work described "Finished Fair" the moulds shall be lined with hardboard, sheet metal or other approved material.

The concrete shall be thoroughly tamped in the moulds and shall not be removed from them until 7 days after placing the concrete, but the sides may be removed after 3 days, provided the moulds are such that the sides are easily removable without damaging the concrete.

The pre-cast work shall be cast under sheds and shall remain under same for 7 days in the moulds and a further 7 after removal from the moulds. During the whole of the period, the concrete shall be shielded by sacking or other approved material kept wet. It shall then be removed from the sheds and stacked in the open for at least 7 days to season.

All pre-cast work shall be cast in lengths convenient for handling unless otherwise described.

4.4 Workmanship

4.4.1 Inspection of Reinforcement and Formwork

No concreting shall commence until the reinforcement and formwork have been inspected and approved by the Project Manager. Reinforcement in walls and columns shall be inspected and approved before being enclosed in the formwork. Before concreting any part of the work, the Contractor shall give at least 24 hours notice in writing to the Project Manager and obtain his approval.

The concrete shall be placed in layers as directed by the Project Manager over the whole area to be concreted and the second layer shall not be commenced until the first is completed. Sloping beds will not be allowed when placing concrete. Should any accidental segregation occur, the affected area shall be thoroughly turned over by hand until homogeneous mix has been obtained.

4.4.2 Mixing Concrete

Concrete for grade 20 and grade 25 shall be mixed by weight batching only, unless approval has been obtained from the Project Manager for the concrete materials to be mixed by volume. Concrete for grade 10 and 15 can be mixed by volume.

The weight of coarse and fine aggregate in each batch shall be so computed that each batch contains one or more full 50 Kg bags of cement.

All concrete is to be mechanically mixed in a batch mixer of an approved type. The dry materials for concrete shall be mixed in the mixer until a uniform colour is obtained after which the gauged Quantity of water shall be gradually added. After all the water has been added, the mixer shall continue to mix for a period of not less than two minutes.

The mixers shall be equipped with an adjustable device capable of supplying a predetermined amount of water.

On the completion of each mixed batch of concrete, the mixer drum shall be completely emptied before a fresh batch is placed therein. On the cessation of work, the mixer and all handling plant shall be washed out and shall always be left clean and free from hardened concrete.

Any mix considered to be unsatisfactory by the Project Manager for any reason, will be discharged to waste at the Contractor's expense, as and where directed by the Project Manager, well clear of all mixed and placing operations in such a manner as to avoid the risk of defective concrete being incorporated in the works.

The mixer shall be maintained in a first class condition throughout the contract and any mixer or plant, which is faulty in any respect, shall not be used. The drums of all mixers shall revolve at the speed recommended by the makers. A mixer which has been out of use for more than 20 minutes shall be thoroughly cleaned out before any fresh concrete is mixed.

The Contractor shall always have one spare mixer ready on the site to avoid interruption in the mixing and casting of concrete.

4.4.3 Transport and Placing of Concrete

Concrete shall be transported in a manner which shall avoid a segregation of the constituent material, and placing in the forms shall be completed before the concrete has taken its initial set. In no case shall concrete be placed in the works more than 30 minutes after mixing. Concrete shall not be dropped through a height greater than 1.2m. Chutes may be used if they are constantly kept free from coatings or hardened concrete or other obstructions. Pumping of concrete through delivery pipes may be used, but only with the prior approval of the Project Manager.

Concrete of any Units or section of the work shall be carried out in one continuous operation, and no interruption of the concreting will be allowed without the approval of the Project Manager.

The concrete shall be placed in layers as directed by the Project Manager over the whole area to be concreted and the second layer shall not be commenced until the first is completed. Sloping beds will not be allowed when placing concrete. Should any accidental segregation occur, the affected area shall be thoroughly turned over by hand until a homogeneous mix has been obtained.

When concreting walls and columns, the mix proportions of the first 250mm depth of concrete placed in contact with the horizontal joint should be adjusted by reducing the amount of coarse aggregate.

4.4.4 Compaction

After the concrete has been placed in a position it shall be compacted by vibration with a rigid poker type with internal vibrator approved by the Project Manager. The Concrete shall be worked well up against the form, joints and around the reinforcement and be free from voids and other imperfections. Under no circumstances shall the concrete be shifted or transported inside the form with vibrator.

The Contractor shall always have one spare vibrator ready on the site to avoid interruption in the mixing, casting and vibrating of concrete.

In the case of reinforced concrete, a competent steel fixer shall be in constant attendance during the placing of concrete to adjust and correct the position of the reinforcement, if so required, immediately before the concrete is placed. In no case shall the vibrators be attached to or be allowed to come into contact with the reinforcement.

Each freshly placed layer of concrete must be thoroughly compacted and worked into the preceding one but care shall be taken that no damage is done to previous work that has already set. Excessive compaction of concrete shall be avoided.

The upper surface of slabs shall be compacted by approved external vibrator.

4.4.5 Placing of Concrete under Water

Concrete shall only be placed under water with the prior approval of the Project Manager who shall likewise approve the methods to be used and the precautions necessary to prevent loss of material. In no circumstances shall concrete be dropped or placed in water in a loose condition or be placed in flowing water. In all cases the cement content shall be increased by 25% for each class of concrete at the Contractors' Expense.

4.4.6 Placing of Concrete on Earth Surface

Earth surfaces on which concrete is to be placed shall be clean, firm and free from standing or flowing water. After the excavation has been completed to the approved lines, levels and dimensions it shall be kept as damp as practicable to reduce absorption of water from the concrete to a minimum. No concrete shall be placed until the prepared earth surface has been approved by the Project Manager.

4.4.7 Construction and Expansion Joints

The position and arrangement of construction and expansion joints shall be as shown on the drawings. Where additional joints are requested, the positions must be approved by the Project Manager.

All construction joints shall be rebated to form a key with subsequent work. Concreting of any Units or section of the work shall be carried out in one continuous operation up to construction joints and no interruption of the concreting will be allowed without approval.

Where shown on the drawings, construction and expansion joints shall be provided with water bars of P.V.C or other approved material. The widths and shapes of the water bars shall be as specified on the drawings and all joints shall be used. The trade mark of the water bars shall be approved by the Project Manager before commencement of work, and fixing and jointing of water bars shall be approved by the Project Manager before commencement of work, and fixing and jointing of water bars shall be approved by the Project Manager before costing.

The fusing of water bars shall be performed in a way so as to secure that the two bars are joined over the entire width. The fused joint shall be able to withstand tension and shall be intact after 10 consecutive bending. The Project Manager may request that the fusing is carried out by specialists.

Where shown on the drawings, joints shall be provided with a joint sealing compound. The sealing compound shall be a two component polysulphide rubber sealing compound complying with BS 4254, and the trade mark shall be approved by the Project Manager. The compound shall be placed in a chase made by a fillet strip in the formwork. The concrete shall be dry and a suitable primer shall be applied to the joint before applying the sealant. The procedure for the workmanship shall be approved by the Project Manager before commencement of work, but the Contractor shall have the full responsibility for the water tightness of the joints.

It should be noted that the lower part of the concrete walls shall be cast together with the floor slab and no joint directly on the slab will be permitted.

Before depositing fresh concrete against which the already set, the face of the latter shall be roughened to expose the coarse aggregate, all cement latency removed whilst the

concrete is still green and the surface thoroughly wetted with water and cleared of foreign matter. Cement mortar grout mixed in the proportion of one part of cement to two parts of sand shall be spread to a thickness of 5mm over the face of the set concrete before fresh concrete is deposited.

4.4.8 Curing and protection of Concrete

Curing shall be as soon as the surface of the concrete has hardened sufficiently. All exposed concrete surfaces shall be cured for a period of seven days by covering them with a layer of sand, hessian canvas or other approved material kept damp. Concrete shall be protected from sun, wind, heavy rains and flowing water for at least three days after placing.

4.4.9 Finishes of Horizontal Surfaces

Concrete surfaces for floor shall be true to level and falls as shown on the drawings. Water coming to the surface when vibrating shall be removed. After casting the surface shall be smoothed with a wooden flat. After some hours, when the surface has dried up, the surface shall be towelled smooth with a steel trowel.

All other horizontal surfaces shall have the same surface finish except for the final towelling with steel trowel.

4.4.10 Finishes of Vertical Surfaces

The shuttering for exposed concrete faces shall be so constructed that the latter shall be true to line and surface. The concrete shall be consolidated as specified against the shuttering to keep the face of the work free from honeycombing and other blemishes.

After removal of the shuttering, no concrete surfaces shall be treated in any way until they have been inspected by the Project Manager.

If upon removal of the shuttering, the line of surface of the work is, in the opinion of the Project Manager, unsightly and not in accordance with the requirements of the contract, the Contractor shall at his own expense cut out and make good such portions of the work as the Project Manager directs.

Rendering over defective surfaces shall not be permitted. Areas of honeycombing shall with the approval of the Project Manager be made good immediately upon removal of the shuttering, and isolated superficial air and water holes shall be filled. Care shall be taken not to leave mortar or cement on parts of the surface which have been cast smooth and without pores.

Unless otherwise instructed, the face of exposed concrete placed against shuttering shall after removal of the shuttering be rubbed down with a carborundum stone or in other approved manner to remove fins and other irregularities, and washed perfectly clean.

Concealed concrete faces shall be left as from the shuttering, except that surfaces with honeycombing shall be made good.

4.4.11 Accuracy of Finish

The arrangement of all formwork shall be made in such a way that all dimensions shall comply as exactly as possible with those given on the drawings. The following tolerance shall be respected.

Foundations	50 mm
Position of columns and Walls	5 mm
Thickness of walls	5 mm
Lateral dimensions of columns	5 mm
Level of slabs, beams	5 mm
Slab thickness	5 mm
Lateral dimensions of beams	5 mm
Plumb of columns and walls	3 mm in each storey (non/accumulative)
Window and door opening sizes	5 mm

Surfaces and edges must not show any noticeable wrapping. On a length of less than 10m the deviation may be 10mm at the most.

The Contractor shall be responsible for the cost of all corrective measures required by the Project Manager to rectify work which is not constructed within the tolerance set out above.

4.4.12 Construction of Formwork

All formwork shall be substantially and rigidly constructed of timber or steel or pre-cast concrete or other approved materials and shall be true to the shape, line, level and dimensions shown on the drawings.

Timber shall be well seasoned, free from loose knots and or fork worm of exposed concrete faces be planned to thickness. Faces in contact with concrete shall be free from adhering grout, projecting nails, splits, or other defects that will mark the concrete surface. Formwork for foundations and other concealed work may be undresses or rough timber.

All joints shall be sufficiently tight to prevent leakage of cement grout and to avoid the formation of fins or other blemishes, and all faulty joints shall be caulked.

All formwork shall be thoroughly cleaned and coated with an approved type of oil before it is fixed in position. Immediately before concreting the formwork shall be watered thoroughly and washed out to remove sawdust, shavings, or other rubbish. Where the appearance of the concrete face is important, the position and direction of the joints shall be as directed.

Filet strips shall be fixed in the formwork to form a chamber 20mm by 20mm on all external corners of the concrete.

Openings for inspection of the inside of the formwork for walls, beams and similar work and for the escape of wash water shall be formed in such a way that they can be conveniently closed before starting to place the concrete.

Connections between formwork elements shall be constructed to allow for easy removal of the formwork, and shall be either nailed, screwed, bolted, clamped, braced or otherwise fixed securing a sufficient strength to retain the correct shape and line during compaction of the concrete.

Bracing members placed in the formwork to keep two sides of formwork in exact position shall be approved by the Project Manager. Holes in the concrete after bracing arrangement shall be made good by plugging with approved material.

Top formwork shall be provided to concrete faces where the slope exceeds 1 vertical to 2¹/₂ horizontal. Such formwork shall be counterweighted or otherwise anchored floating.

The formwork shall be so designed that the formwork for soffits of slabs and for sides of beams, columns and walls may be removed first leaving the formwork for the soffits of beams and their supports in position. Wedging or other suitable ways of adjustment shall be provided to allow accurate adjustments of the formwork and to allow a gradual removal of the same without jarring the concrete.

On demand the Contractor shall provide such drawings and calculations as necessary for determination of the structural strength of the formwork. The Project Manager's approval of such drawings and calculations will not relieve the Contractor of his responsibilities under the contract.

Formwork shall be erected true to line and braced and shuttered to prevent deformation under the weight and pressure of the wet concrete, construction loads, wind pressure or other forces. Forming for beam soffits shall be erected with an upward camber as shown on the drawings or as directed by the Project Manager or of 2mm for each 1m of horizontal span.

Re-propping of beams will not be approved except when props are re-instated to relieve the beams of loads in excess of the design load. Vertical; props shall be supported on folding wedges on sole-plates, or other measures shall be taken whereby the props can be gently lowered vertically when commencing to remove the formwork.

If, in the opinion of the Project Manager, the formwork is faulty, inadequate or does not comply with the specifications, then the Contractor shall at his own cost modify the formwork until it meets the approval of the Project Manager.

4.4.13 Mould Oil

All faces of formwork that will come in contact with wet concrete shall be treated with approved mould oil or other coating to prevent adherence to the concrete. Such coatings shall be insoluble in water, non-staining, nor injurious to the concrete, shall not become flaky and shall not be removable by rain or wash-water. Liquids that retard the setting of cement shall only be applied to the shuttering when approved. Mould oils and similar coatings shall be kept free from contact with the reinforcement.

4.4.14 Holes for Pipes, Cast-in Items etc., General

The Contractor shall be responsible for the co-ordination with the sub-contractors for the setting out and fixing of all pipes and holes, pockets and chases for pipes. Sleeves provided by the sub-contractors are to be accurately set out and cast in and cutting away in completed concrete work is to be minimized.

Details of all holes etc. required in a structural work for services must be submitted to the Project Manager who will assess the necessity for extra trimming reinforcement.

No opening, holes, chases, etc, are to be formed in the concrete without the approval of the Project Manager and details of fixtures or fixings to be cast in must be approved.

4.4.15 Pipes through Water Retaining Walls

Pipes passing through water retaining walls and floors shall, wherever possible, be built into the structure in-situ. Shuttering shall be formed closely to the outside of the pipe, and concrete shall be placed and compacted thoroughly round the pipe.

Pipes, bolts and other steel items cast into the concrete in water retaining structures must not in any way be in contact with the steel reinforcement.

When not possible to build in place, pipes shall pass through preformed holes. Holes shall be formed with formwork which shall be stripped cleanly and without shock to the concrete. As soon as the shuttering is tripped, the hole shall be thoroughly wire brushed to expose the aggregate. The hole shall be as neat as possible to allow the pipe to be passed through the wall, while the corners shall be chamfered or rounded.

The pipe shall be set and the hole filled up as soon as possible. Immediately before filling, the hole shall be continuously soaked so as to saturate the concrete, and the surface coated with a stiff mix of 1:1 sand grout. Shutters shall be fixed true to the faces of the wall, and stiff mix of concrete packed in until the hole is completely filled, particular care to be taken to ensure that the spaces beneath the invert of the pipes and beneath the slopping soffit of the whole are completely filled. Shuttering shall be stripped as soon as possible and filling rubbed smooth. The filling and the surrounding concrete shall be kept wet for 7 days after filling.

4.4.16 Removal of Formwork

Formwork shall be left in position until the concrete has attained sufficient strength to be self-supporting. The Contractor shall be responsible for the safe removal of the formwork without shock or vibration - which would damage the concrete.

Any work showing sign of damage through premature removal of formwork or through premature loading shall be entirely reconstructed at the contractor's expense. The Project Manager may delay the time of removal of formwork if necessary. Subject to the above, the minimum period for removal of formwork shall generally be as follows:-

Slabs	Soffits (props left under)	7 days
	Props	21 days
Beams	Sides	3 days
	Soffits	21 days
Walls and Columns	(unloaded)	3 days

When formwork is removed after 3 days, it will be necessary to ensure that the exposed surfaces of the concrete are kept thoroughly wet for the period of curing.

4.4.17 Reinforcement

All bending, cutting and fixing to comply with BS 8110 and BS 4466. Normally bending schedules are incorporated into the Contract Drawings, but the Contractor shall satisfy himself about their accuracy and about their complete coverage of the work involved. Any omission, inaccuracy or other errors observed by the Contractor shall be reported to the Project Manager before commencement of the work.

In case of errors in bending schedules, no extra payment will be approved, provided the reinforcement is shown correctly on the contract drawings.

Bars shall be of the shown lengths, and lapping, except where indicated on the drawings, is not permitted unless approved by the Project Manager.

Spacing between bars shall not differ more than 5mm from the required spacing. Any inaccuracy in the total length of a bar as cut shall be compensated for in the end hooks or other approved parts of the bar.

The internal radius of a bend shall neither be less than allowed by BS 4466 nor less than the radius given in the Bending Schedule. The steel reinforcement shall be assembled and fixed in the form of a rigid case. To prevent displacement before or during concreting the bars shall be secured one to the other with approved binding wire at each intersection. In slabs and walls binding at every second intersection is sufficient.

Concrete cover blocks (mix 1:3) shall unless otherwise directed be used between the reinforcement, the bottoms and sides of the forms to ensure the specified concrete cover to the bars. Variations of cover shall be kept within plus/minus 3mm from the specified cover.

The minimum clear horizontal distance between adjacent bars shall be of 25mm or the diameter of the bar whichever is the biggest, and 25mm vertically. Space bars shall be inserted at such intervals that the bars do not perceptibly sag. Projecting bars shall be adequately protected against displacement both during and after concreting.

At the time of fixing and when concrete is being placed, all reinforcement shall be free from oil, painting, grease, dust and scale or any other coating which would destroy and bond with the concrete. The Contractor must obtain the Project Manager's approval of the reinforcement when places, before any concreting is commenced.

5.0 MASONRY WORKS

5.1 Concrete Block walling

5.1.1 Precast Concrete Blocks

Concrete Blocks shall comply with BS 6073. The blocks shall be solid or hollow as specified on the drawings, with a minimum comprehensive strength of 3.5 N/mm², tested as described in BS 6073.

All blocks must be left with goods sharp edges. The standard face size of blocks for use in the works shall be 440mm x 190mmx190mm and this size of blocks shall be used whenever practicable.

The Contractor shall be responsible for making test blocks and experimenting with available materials to ascertain what mix will be necessary to attain the required strength. If suitable materials are not available locally, the Contractor shall obtain them from other approved sources.

Manufacture shall be carried out under shelter and after casting, the blocks shall be struck under shelter to protect them from sun and weather, and properly cured by covering with sand or sacks and sprayed daily for not less than 14 days.

5.1.2 Wall reinforcement

Reinforcement in walls made of solid blocks shall where so specified consist of a 25mm wide strip of "Exempt" or similar block reinforcement centrally in joints at a approximately 450mm centre (vertically) for the fullness of the walls, lapped and crumped 300mm at running joints and full width of walls at angles and intersections.

5.1.3 Sand

The sand for mortar shall be fine sand.

5.1.4 Mortar

The cement mortar shall consist of 1 part of Portland cement to 4 parts of sand by volume or as specified on the drawing.

5.1.5 Damp-Proof Coarse

All Damp-proof coarse shall be of bituminous felt to BS 743 weighing not less than 3 Kg/m² free from tears and holes, lapped 150mm at running joint and for full width of wall at angles and intersection and bended and including at 12mm levelled screed of cement mortar.

5.1.6 Workmanship

Blocks shall be laid in regular even courses and shall be bedded in cement mortar consisting of 1 part of cement to 3 parts of sand or as indicated on the drawing.

All bends and vertical joints shall be filled completely with mortar when the blocks are laid.

All exposed faces of wall for plastering are to be left rough and the joints raked out while mortar is green to form adequate key.

All other faces shall be cleaned down on completion with wire brush or as necessary and mortar dropping, smear marks, etc removed.

Where block work faces are to be left exposed, blocks shall be chosen for their uniformity, and unmarked faces and unbroken arises and shall be finished with a fair face and pointed with a neat joint recessed from the face pf the blocks.

5.1.7 Block work Tanks

The concrete blocks shall be solid, type A with a minimum comprehensive strength of 7N/mm², tested as described in BS 2028 for circular block work tanks, the blocks shall be manufactured as the required shape to fit the curvature of the tank, and all block shall be immersed in water for 24 hrs before being laid.

Internal plaster shall be of mix 1:2, made water proof by use of approved additive.

5.2 Plaster Work

5.2.1 Lime

The lime for plastering shall comply with BS 890 clause "A" for non-hydraulic lime and shall be as obtainable and too approved.

5.2.2 Composition of Plaster

A mix referred as 1:4 or other mixes as specified on the drawing shall be used.

5.2.3 Surfaces

All surfaces to be paved or plastered must be brushed clean and well wetted before each coat is applied. All cement paving and plaster shall be kept continuously damp in the interval between application of coats and for seven days after the application of the final coat.

5.2.4 Partially or wholly set materials

Partially or wholly set materials will not be allowed to be used or remixed. the plaster mixes etc. must be used within one hour of being combined with water.

5.2.5 Samples

The contractor shall prepare sample areas of the screed, paving and plastering as directed until the quality, texture and finish required is obtained and approved by the Project Manager, after which all work executed, shall conform with the respective approved samples.

5.2.6 Finish Generally

All screed and paving shall be finished smooth, even and truly level unless otherwise specified.

Rendering and plastering shall be finished plumb, square, smooth and even.

All surfaces to be plastered shall be thoroughly wetted before any plastering is commenced.

No plastering will be allowed to take place until all chases for services have been cut; services installed and chased made good.

On no account may finished plaster surface be chased and made good.

All work shall be to the approval of the Project Manager and any work not complying with the above shall be hacked away and replaced at the Contractor's expense.

5.2.7 Arises and Angles

All arises and angles shall be clean and sharp or slightly rounded or thumb-covered as directed including neatly forming mitres.

5.2.8 Making Good

All making good shall be cut out to a rectangular shape, the edges undercut to form dovetail key and finished flush with the face of surrounding paving or plaster. All cracks, blisters and other defects shall be cut out and made good and the whole of the works shall be perfect on completion.

5.2.9 Cement Paving, Screed etc.

Cement screed shall consist of cement and sand mix 1:2 laid in panels and finished with a steel trowel if not otherwise specified.

Where specified as waterproof "pudlo" or similar waterproofing compound shall be added to the cement paving or screed strictly in accordance with the manufacturer's instructions.

Where practicable, screed is to be laid while the concrete is still green. When this is not practicable, the concrete is to be well washed and brushed perfectly clean with a steel wire brush, to remove laitance and to give a roughened face as a key and then kept wet for at least seven days before the screed is laid. On the day of laying the surface is to be only damp with all surplus water removed and has to be painted with cement and sand mix 1:1 grout immediately before commencing laying of the screed. The grout is to be applied

continuously in front of the screed, and not in large areas that will dry out before the screed is applied.

Screed shall be protected during the first stage of hardening from harmful effects of sunshine, drying winds, rain or water. In exposed positions, the screed shall be covered with a well wetted layer of sawdust, hessian or other approved material, and this layer shall be damp for at least seven days, during which period no traffic is to be allowed over the screed.

5.2.10 Cement Rending

Cement rending shall consist of cement and sand mix 1:4 to not less than 15mm finished thickness and be furnished to a true and even surface.

5.3 Carpentry and Joinery

5.3.1 Timber Materials

All timber shall be in accordance with the latest approved grading rules issued by the Government of Kenya or other competent authority (legal notice No. 358).

The quality shall be as first (or prime) grade. All timber works to be carried out in accordance with BS 1186 and CP 112.

Any of the following timber may be used:

Standard Common Name & Botanical Name

Podocarpus	Podocarpus Spp
Cedar	Juniperus Procera
African Mahogany (Munyama)	Khaya anthotheca
Mininga	Pterocarpus Angloensis
Mvule	Chrophora Excelsa

All timber shall be free of live borer beetle or other insect attack when brought upon the site. The contractor shall be responsible up to the end of the maintenance period for executing at his own cost all work necessary to eradicate insect attack of timber which becomes evident-including the replacement of timber attacked or suspected of being attacked, notwithstanding that the timber concerned may have already been inspected and passed as fit for use.

All timber shall be seasoned to a moisture content of not more than 15%.

5.3.2 Boards and Sheets

Fibreboard

Shall be 12mm "Celotex" or other approved fibreboard complying with BS 1142, Part 3

Plywood

Shall be laminated board faced on in both sides with 4mm plywood. Exposed edges shall be lipped with 20mm hardwood and rates shall include for leaping.

Plastic Sheetting

Shall be 45mm thick, and shall be obtained from an approved manufacturer. The doors shall comply with BS 459, Part 2. External doors shall be framed, ledged and braced as shown on the drawings, and they shall comply with BS 459, Part 4.

5.3.3 Workmanship

All timber shall be as long as possible and practicable to eliminate joints. Where joints are unavoidable, surfaces shall be in contact over the whole area of the joint before fastenings are applied.

No nails, screws or bolts are to be fixed in any split end. If splitting is likely, or is encountered in the course of the work, holes for nails must be bent at right angles to the grain.

All exposed surfaces of joinery work shall be wrought and all arises "eased off" by planning and sand papering to an approved finish suitable to the specified treatment.

Where intended to be in contact with stone, concrete blocks, cement or plaster, the backs and other faces of all doors, windows and other frames and linings, posts, architectural skirting, fillets and fascias shall be treated with two coats of wood preservative before fixing.

Bottom edges of doors shall be painted with one coat of approved primer before fixing.

Any fixed joinery which in the opinion of the Project Manager is liable to become bruised or damaged in any way shall be completely cased and protected by the contractor until the completion of the works.

5.3.4 Inspection and Testing

The Project Manager shall be given facilities for inspection of all works in progress whether in workshop or on site. Such tests will be carried out by the Forestry Department.

5.3.5 Clearing Up

The contractor is to clear out and destroy or remove all cut ends, shavings and other wood waste from all parts of the building and the site as the work progresses and at the conclusion of the work.

This is to prevent accidental borer infestation and to discourage termites and decay.

5.4 Roofing**5.4.1 Asbestos Roof Sheetting**

The floor sheetting and fittings shall be "Super-Seven" corrugated asbestos cement roofing, manufactured by the Kenya Asbestos Cement Company Limited laid and fixed in strict accordance with the manufacturers instructions.

Fixing to be of approved type and quality.

5.4.2 Protection

All roof surfaces shall be kept clean and protected and handed over watertight at completion.

5.5 Steelwork

5.5.1 Materials

All materials shall be the best of their respective kinds and free from defects. The materials in all stages of transportation handling and stacking shall be kept clean and injury from breaking, bending and distortion prevented.

All steel and steel sections shall comply with BS 4, BS 4360 and BS 4848.

All steel shall be of approved manufacture and the contractor shall on request deliver to the Project Manager a manufacturer's test certificate for all steel used.

All structural steel shall be of grade 43A according to BS 4360.

Steel for handrails, screens etc. can be of lower grade, but all steel shall be weldable and the grade shall be approved by the Project Manager.

Electrodes shall be of a class appropriate to the steel. Bolts and nuts shall be according to BS 4190.

5.5.2 Workmanship

Workmanship for all steelwork shall generally follow the requirements in BS 449 and BS 5135.

The contractor shall prepare all the necessary workshop drawings, which shall be approved by the Project Manager. The Project Manager's approval shall not in any way relieve the contractor of his responsibility for the workshop drawings being in accordance with the contract drawings and specifications.

All welding of structural steel shall be carried out in the contractor's workshop and the whole structure or parts thereof shall be test assembled in the workshop before delivery to the site.

Should any doubt arise as to the quality of the steel or the welds, the Project Manager may require testing carried out. If the results show insufficient quality of materials or workmanship, the contractor shall cover all expenses related to the tests and shall replace and rectify all materials and welds found unsatisfactory.

5.5.3 Ladders

Ladders and tanks etc shall be galvanized steel pipes in accordance with BS 1387 "Medium clause" and shall be made to the dimensions on the drawing.

5.6 Ironmongery and other Fittings

All ironmongery shall be approved by the Project Manager. The approved samples shall be regarded as the standard for work.

5.6.1 Locks

All locks and ironmongery shall be with screws, etc. to match. Before the door etc. is painted, handles shall be removed, carefully stored and prefixed after completion of painting. Locks shall be oiled and left in perfect working order.

25mm diameter rubber door stops shall be provided at all doors and securely plugged and screwed to floors or walls.

All external doors shall be provided with locks of cylinder type. All internal doors to be provided with approved latch locks and handles. All locks shall have two keys with attached labels with door references before being handed over to the Project Manager.

5.6.2 Sanitary Fittings

All sanitary fittings shall be of approved manufacture and installed in accordance with the manufacturer's recommendation.

5.7 Glazing

5.7.1 Glass

All glass shall comply with BS 952 and be free from flaws, bubbles, specks and other imperfections.

Glass panes shall be cut to sizes to fit the opening with not more than 2mm play all round and where puttied shall be clipped to the frames.

Clear sheet glass shall be of ordinary glazing quality

5.7.2 Cleaning Etc

On completion, remove all broken, scratched or cracked panes and replace with new to the satisfaction of the Project Manager. Clean inside and out with approved liquid cleaner. On no account shall windows be cleaned by scrapping with glass.

5.8 Painting, Decorating and other surface Treatment

5.8.1 Approved Specialist

An approved specialist must execute all work under this trade unless the Project Manager agrees otherwise. The paint shall be of approved manufacture.

5.8.2 General

The contractor shall so arrange his programme of work that all other trades are completed and the workmen are away from the area to be painted, when painting begins. Before painting, the contractor must remove all concrete and mortar dropping and the like from all work to be decorated and remove all stains as to obtain uniform colour to work to be oiled and polished.

All plaster, metal, wood and other surfaces which are to receive finishes of paint, stain, and distemper or paint work of any description are to be carefully inspected by the contractor before he allows any of his painters to commence work.

5.8.3 Painting Generally

All materials to be applied externally shall be of exterior quality and/or recommended by the manufacturers for external use, all in accordance with BS 4800 or similar.

All materials shall be delivered on site intact in the original sealed drums of tins and shall be mixed and applied strictly in accordance with the manufacturer's instruction and to the approval of the Project Manager.

Unless specially instructed or approved by the Project Manager, no paints are to be thinned or otherwise adulterated, but are to be used as supplied by the manufacturers and direct from the tins.

The priming, undercoats and finishing coats shall each be of differing tints and the priming and undercoats shall be the correct brands and tints to suit the respective finishing coats in accordance with the manufacturer's instruction.

No painting is to be done in wet weather or on surfaces which are not thoroughly dry.

Each coat shall be properly dry and in the case of oil or enamel paints shall be well rubbed down with fine glass paper before the next coat is applied. The paint work shall be finished smooth and free from brush marks.

5.8.4 Preparation and priming of plaster etc. surfaces

Surfaces shall be perfectly smooth, free from defects and ready for decoration. All such surfaces shall be allowed to dry for a minimum period of six weeks, stopped with approved plaster compound stopping and rubbed down flush, as necessary, and then be thoroughly brushed down and left free from all efflorescence, dirt and dust immediately prior to decorating.

Plaster surfaces, which are to be finished with emulsion, oil or enamel paint, shall be primed with an alkali resisting primer complying with the particular paint manufacturer's specification and applied in accordance with their instructions.

Fibreboard or similar surfaces shall be lightly brushed down to remove all dirt, dust and loose particles and have all nail holes or other defects stopped with an approved plaster compound stopping rubbed down flush and left with a texture to match surrounding material.

5.8.5 Preparation and Priming of Metalwork

All surfaces shall be thoroughly brushed down with wire brushes and scraped where necessary to remove all scale, rust, etc. immediately prior to decorating. Where severe rust exists and if approved by the Project Manager, a proprietary de-rusting solution may be used in accordance with the manufacturer's instructions.

Shop primed and unprimed surfaces shall be given one coat of metal chromate primer or lead oxide primer.

Galvanized surfaces shall be treated before priming with an approved proprietary mordant or de-greasing solution. The surfaces shall be thoroughly washed down with water, allowed to dry and primed at last.

Coated surfaces already treated with bituminous solution, shall be scraped to remove soft parts and then receive two isolating coats of aluminium primer or other approved ant-tar primer.

5.8.6 Preparation and Priming Woodwork

All woodwork shall be rubbed down, all knots, covered with a thick coat of good shellac or aluminium knotting; primed with one coat of approved ready-mixed proprietary wood primer and all cracks, nail holes, defects and uneven surfaces, etc. , stopped and faced up with hard stopping rubbed down flush.

5.8.7 Wood Preservative

All woodwork in contact with walling or plaster shall be treated after cutting and preparation but before assembly or fixing with one coat of approved wood preservative. The solution is to be brushed on all faces of all timbers, unless exposed to view and painted.

5.8.8 Cement Paint

Shall be super snowed or equal and approved. Two coats shall be applied after preparation as specified above.

5.8.9 Emulsion Paint

After preparation as specified above, a minimum of three coats shall be applied using a thinning medium or water only if and recommended by the manufacturer.

An approved plaster primer tinted to match may be substituted for the first coat.

5.8.10 Enamel Paint

Apply two undercoats and one finishing coat, after preparation and priming as specified above.

5.8.11 Lining of Chemical Tanks

The lining of chemical tanks with "EPOBOND" and "EPOFLOOR" shall be carried out by specialists approved for such work by the manufacturer or his agent

5.8.12 Cover Up

Cover all floors, fittings, etc. with dust sheets when executing all painting and decoration work.

5.8.13 Clean and Touch Up

Paint splashes, spots and stains shall be removed from floors, woodwork, etc., and any damaged surfaces touched up and the whole of the work left clean and perfect upon completion and during the maintenance period.

5.9 Staff House

Staff house to include:

1. Plumbing fittings and pipework to deliver water to taps, toilet and shower,
2. Shower head and supporting fittings, shower tap, toilet bowl, toilet cistern, wash basin, kitchen sink, tap, kitchen work top 900mm x 1000mm.
3. Wastewater pipework and manholes to deliver wastewater to the septic tank as shown in drawing. Septic tank to acceptable standards approved by the Engineer.
4. 150 litre tank supported on beam within roof truss and all supply pipework from a suitable connection point, discharge from the tank to connect into fittings mentioned in 1 and 2 above.
5. Electrical fittings and wiring to enable connection of at least 1 No. 60 watt bulb per room and 2 No sockets in kitchen and living room and 1 No. socket in bedroom.
6. All windows to have 4mm glass and support requirements. Provide for burglar proofing.
7. Provide for roof brandering and PVC ceiling.
8. Provide for plastering and painting of wall and floor finishes including all surface preparation works

6 PIPE WORKS

6.1 Materials

6.1.1 Concrete Pipes

A General

Pre-cast concrete pipes and fittings shall comply with BS 5911: Part 100.

Minimum crushing test loads shall be as specified in Table 7 of the said standard.

Where plot chambers are connected directly to the main sewer, the connection shall be done by oblique-angled junctions with an angle of 45°

Concrete pipes with flexible joints

The joints of pipes and junction shall be of a type which is able to maintain a maximum angular and straight movement as shown in the following table, without loss of water tightness under the pressure stated in clause 7.7 Testing.

Internal Diameter	150	225	300	375	450	525
Angular movement	1.67°	1.19°	0.89°	0.72°	0.6°	0.50.4

Concrete pipes with rigid joints

The joints of pipes and junctions shall be sealed with mortar mix 1:3.

6.1.2 Unplasticised Polyvinyl chloride (UPVC) Pipes

All UPVC pipes and fittings shall comply with KS 06-149: Part 2: 1981 (Metric Series).

The uPVC pipe shall be designated by its nominal outside diameter.

6.1.3 Ductile Iron Pipes

Ductile iron pipes and fittings shall comply with BS 4772 or ISO 2531. The pressure rating of the pipe shall be for a minimum working pressure of 2.5N/mm².

Joints in pipe bridges are flanged, spigot-socket or Viking Johnson Couplings.

Pipes and fittings shall be coated inside and outside with a hot pipes material complying with the requirements of BS 4164 "Coal Tar based hot applied coating materials for protecting iron and steel" or with a cold applied material complying with BS 3416 " Black bitumen coating solutions for cold application", Type 1 material.

6.1.4 Sluice Valves

Sluice valves shall comply with BS 5163, PN 16. They shall be flanged in accordance with BS 4772, PN 16.

6.1.5 Pre-cast Concrete Covers

Concrete covers to be manufactured according to the detailed drawings.

6.1.6 Cast Manhole Covers

Covers in traffic areas: - Standard Triangular Heavy Duty Frame and cover according to BS 497. Ref. A2-19 1/2.

Covers for plot chambers:- Grade C(Light Duty) single seal recessed type inspection cover and frame according to BS 497 ref. C8-24/18.

6.1.7 Manhole Step Iron

To be manufactured according to the detailed drawing.

6.1.8 Steel Work

All steel to be hot dip galvanized according to BS 729. All steel surfaces exposed to sewage shall be coated with black bitumen coating to BS 3416, TYPE 1 material.

6.2 Handling and Storing Materials

6.2.1 General

The method of transportation, handling and storing of pipes and fittings shall be in accordance with the manufacturer's recommendations.

Pipes, valves, specials and other materials shall be handled, moved, lifted or lowered with the least possible impact. Handling equipment shall be of approved type. In slinging pipes, only flat slings shall be used and the use of chain slings, hooks or other devices working on scissors or grab principles shall not be permitted. Pipes shall be slung from two or more points as the Project Manager may direct and the slinging, lifting and lowering shall be in

the hands of a competent and experienced man. Care shall be taken to keep pipes and fittings clean and free from soil, mud, dirty water, solvents chemicals etc.

Subject to the requirements of inspection before acceptance, protective bolsters, caps or discs on the ends of flanges of pipes or specials shall not be removed until the pipes or specials are about to be lowered into the trench. Every precaution shall be taken to prevent damage to internal linings of external coatings.

Pipes in storage shall be supported clear of the ground on approved supports and adequately braced to prevent rolling. They shall not be stacked more than four tiers high without the approval of the Project Manager.

Materials of different classification shall be stored separately.

All pipes and associated material shall at all times be protected from sun and weather to the satisfaction of the Project Manager.

No valves shall be lifted by the spindle.

No valves, fittings or specials shall be stacked more than one tier high without the permission of the Project Manager, and they shall not be stored in a dirty place or condition and shall not be allowed to become embedded in earth, sand, stone, aggregate, water, fuel, or any other deleterious matter.

Valves and their ancillary equipment shall be protected before and after erection against collapse of earthworks, falls of materials, concrete and cement droppings, wood and other matter.

Shortly before the laying or fixing any valve, pipe or fitting the contractor shall in the presence of the Project Manager or his representative carefully examine each valve, pipe and fittings during loading, unloading, handling, storage and transportation. All damage and all defects revealed by this examination shall be repaired and remedied by the contractor.

6.2.2 Transport of PVC pipes

The full length of the pipe shaft shall rest on the loading area of the lorry. Overhanging of pipes, to prevent sagging and deformation shall be avoided. Rough handling and dragging of pipes and fittings shall be avoided.

6.2.3 Storing of PVC pipes

PVC pipes shall not be stored on each other to a height exceeding 1.5m. Pipes shall be staggered to prevent the sockets to rest on the shaft of the pipes. The first tier shall be placed on a well drained layer of sand. All pipes and fittings shall be protected from sunlight by use of tarpaulins. Grass cover will not be accepted.

6.3 Excavation of Trenches

6.3.1 Trench Width

The minimum trench width shall be according to the detailed drawings, corresponding to the minimum width indicated below:-

Concrete Pipes	150	225	300	375	450	525
Width of Trench	805	890	970	1060	1140	1220
PVC Pipes	160	200	250	315	-	-
Width of Trench	460	500	550	615	-	-

6.4 Laying and Jointing

6.4.1 General

All laying and jointing of pipes except jointing of PVC and Polythene pipes shall be in conformity with CP 301 and CP 2010.

The bottom of the trench or surface of the bed shall be finished to a smooth even surface at the correct level to permit the barrel of the pipe to rest on the surface throughout its whole length between joint and sling holes. If considered necessary by the Project Manager, fine screened material shall be placed and consolidated in the trench bottom to provide such a bed. The bottom of the trench and pipe bed shall be inspected by the Project Manager, and only when passed as satisfactory shall pipe laying commence.

Each pipe shall be laid accurately to line, level and gradient so that, except where otherwise directed, the finished pipe line shall be in a straight line both in horizontal and vertical plans.

The levels and gradients shown on the drawing shall be rigidly adhered to unless otherwise ordered by the Project Manager.

Where lines of pipe are to be constructed, the contractor shall provide and fix, at such points as may be directed, properly painted and securely positioned sight rails, the levels and positions of which shall be examined and checked by the Project Manager before the rails are used and as often thereafter as may be necessary.

There shall at no time be less than three sight rails in position on each length of pipeline under construction to any one gradient, and the sight rails shall be situated vertically above the line of pipes or immediately adjacent thereto.

Pipes shall be lowered singly into the trench, brought to the correct alignment and inclination bedded throughout their length, and properly jointed strictly in accordance with the manufacturer's instructions. Unless otherwise approved by the Project Manager, pipes shall be laid in an upstream direction and the socket of the pipes shall face upstream and every pipe shall be concentric with the previous.

Notwithstanding any flexibility provided in pipe joints, pipes must be securely positioned to prevent movement during and after the making of a joint. On screw and socket joints threads shall be coated with an approved tape to ensure water tightness.

Long radius curves in the pipeline shall be negotiated by deflections taken up in the joints or pipes of one or more lengths of pipes. The deflection at each of the various types of joint of pipes used in the works shall not exceed the manufacturer's specifications.

The contractor shall take care that all pipes and couplings are clean and free of foreign matter before subsequent sections are jointed.

The contractor shall obtain from the manufacturer or other approved supplier the necessary tackle required for the proper jointing of the pipes.

The contractor shall make himself and his employees acquainted with and comply with the instructions issued by the manufacturers of the various types of proprietary joints and couplings for incorporation in the works. The contractor shall be responsible for obtaining copies of such instructions.

Pipes shall not be cut without the permission of the Project Manager. The cut shall be made with an approved mechanical pipe cutter and the edges of the cut shall be clean, true and square. Threading of steel pipes shall be done with an approved device.

Subject to the permission of the Project Manager, pipes shall be covered over with approved fill material upon successful completion of laying and joining. Joints shall be left exposed until completion of the pressure test.

Fill for surrounding and cushioning shall consist of uniformly readily compatible material free from tree roots, vegetable matter, building rubbish and excluding clay lumps retained on a 75mm sieve and stone retained on a 25mm sieve.

Adequate precautions shall be taken by way of back-filling or other means to anchor each pipe securely to prevent flotation of the pipeline in the event of the trench being flooded or during concreting.

Upon successful completion of the pressure test, the pipeline shall be back-filled as specified.

6.4.2 Concrete Pipes

(a) General

Each concrete pipe or joint, immediately before being laid, shall be carefully brushed out and tested for soundness by striking with a hammer, and any pipe or joint which does not ring true or which shows in any way other way any sign of being defective, shall be rejected.

Concrete pipes will be laid either in sand, gravel or concrete bedding.

In cases of a sand or gravel bedding, the contractor shall ensure that each pipe is supported throughout its length by the barrel according to the bedding factor. The pipe is to be supported at least by the quarter of the barrel for bedding factor 1.9.

The pipes have to be bedded on a firm foundation of sand gravel which does not contain any hard lumps.

Joint holes are to be formed in the sand to enable joints to be made and inspected but they are to be as short as practicable.

In cases of concrete bedding the contractor shall lay the pipes on pre-cast concrete stools of the same quality of concrete used for bedding, and the stools should have the same curvature as the pipes barrel. The pipes should be adjusted to the required levels and after checking jointing and testing them, concrete for bedding will be poured and compacted well at the underside of the barrel and socket of the pipes.

(b) Concrete pipes with flexible joints

Concrete pipes with flexible joints will be laid in sand gravel or concrete bedding.

(c) Concrete pipes with rigid joints

Concrete pipes with rigid joints will always be laid in concrete bedding with the appropriate bedding factor.

The rigid joints for concrete spigot and socket pipes shall be made as follows:-

- (1) Before commencing the jointing operation, the socket of the previously placed pipe and the spigot of the new pipe shall be cleaned and thoroughly soaked with water.
- (2) The spigot shall be wrapped one complete lap with tarred hempen spun yarn and the new pipe shall be carefully drawn towards the previously laid pipe so that the spigot enters the full depth into the socket of the previously laid pipe. The new pipe shall then be adjusted and fixed in its correct position in line, level and gradient and the tarred yarn shall be caulked tightly home into the socket.

On completion of this operation, the yarn shall not fill more than one quarter of the total depth of the socket.

- (3) The remainder of the socket shall be completely filled with cement mortar consisting of one part of cement to three parts of sand. The mortar filling shall terminate flush with the socket and shall be neatly trowelled to a smooth finish around the pipe.
- (4) To assist the curing of the mortar, the contractor shall cover the joints immediately after they are made with a layer of hessian which shall be kept continuously wet during daylight hours and he shall further adopt such other measures as the Project Manager may direct.

Provided the contractor has the Project Manager's written consent other means of jointing may be adopted.

(d) PVC Pipes

The pipes shall be laid on smooth soil and must never be surrounded with concrete. The soil must not contain hard lumps.

In road reserves, all PVC pipes should be protected by concrete slabs, when the distance from road surface to top of pipe is less than 1200mm.

(e) Steel Pipes

Steel pipes and fittings shall conform to the relevant BS or KBS standards.

6.5 Concrete Manholes and Plot Chambers

Manholes shall be constructed on sewer lines in the positions indicated on the plan drawings or wherever ordered by the Project Manager.

Manholes on pipe sewers shall be constructed with an in-situ base as detailed on the drawings which shall be raised to form the benching and channels shall be carefully formed to shape according to the number, diameter and positions of the incoming and outgoing pipes. The channels in the manhole bases shall have circular inverts. The benching shall be sloped towards the channels at a gradient of 1 in 5.

Benching shall be carried out in concrete mix 1:3:6 and rendered with 10mm 1:3 cement mortar. The ends of all pipes entering and leaving the manholes are to be carefully cut to shape to suit the internal dimensions of the manholes.

Pre-cast concrete chamber rings shall have a wall thickness of at least 150mm. The lowest chamber ring shall be bedded in 1:2 cement mortars.

Adjacent chamber rings shall have ogee joints; chamber rings bearing on manhole bases shall have the appropriate edge square. This edge shall contain a shallow u-chase to assist the bedding of the rings or slabs.

Plot chambers of block work shall be carried out as specified on the drawings and reinforced with hoop irons in every shift. The block work shall be rendered internally with 10mm cement mortar, 1:3. Step irons as detailed on the drawings shall be provided in manholes deeper than 1.20m.

6.6 Testing

A water test shall be applied for concrete pipes as specified in B.S., C.P. 301 after laying and jointing the pipeline and before backfilling or placing concrete surround or bedding concrete, to reveal cracked or porous pipes and faulty joints. Any leakages including excessive sweating which causes a drop in the test water level, will be visible, and the defective part of the work shall be rectified.

Should the Project Manager so direct, manholes shall be tested by completely filling with water, and there shall be no appreciable loss over a period of 2 hours.

On completion of works, or at suitable intervals during construction, infiltration tests shall be carried out. The permissible amount of infiltration shall be 2 litres of water per minute per kilometre of sewer line of any diameter.

The test should be carried out by inserting suitable strutted plugs in the low end of the pipelines and in the connections, if necessary, and by filling the system with water. For small pipes, a knuckle bend may be temporarily jointed in at the top and a sufficient length of vertical pipe jointed to it in order to provide the required test head. Alternatively, the required test head may be applied by means of a small bore pipe leading from a suitable container and connected to a plug.

Precautions should be taken by strutting or otherwise to prevent any movement of the pipeline during the test.

A test pressure of 1.2m head of water above the soffit of the drain should be applied at the high end but not more than 2.4m. at the low end. Steeply graded drains should be tested in stages where the above maximum head would be exceeded if the whole section were tested at once.

The loss of water over a period of 30 minutes should be measured by adding water from a measuring vessel at regular intervals of 10 minutes and noting the Quantity required to maintain the original water level in the standpipe. The average Quantity of water added for drains up to 300mm nominal bore should not exceed 0.06 litre per hour per 100 linear metres per millimetre of nominal bore of the drain.

A water test shall be applied for P.V.C pipes as specified in DIN 4033 paragraph 7.2 after laying and jointing the pipeline and before backfilling to reveal faulty joints. No backfilling of the trench will be allowed before the water test has been carried out successfully.

The water test for P.V.C. pipe shall be carried out as follows:

The pipeline shall be filled with water and air pockets shall be removed. The pipeline shall for at least 1 hour be exposed for an internal pressure of 5m water column. Eventually water losses occurring during that time shall be restored. Testing is to be carried out for a period of 15 minutes where the pipes are exposed under internal pressure of 5m water column. During that time there must be no loss of water.

6.7 Refilling of Trenches

6.7.1 Refilling in common Excavation

The back filling of trenches shall be carried out expeditiously so as to reduce lengths of trenches open at any one time. The back filling to a depth of 250mm above the top of the construction shall be placed immediately the work is ready to receive it, in order to protect the construction from the sun.

Backfill to a depth of min. 300mm above the top of the pipe shall be suitable fine material with max. particle size 20mm, placed in layers of 50mm kept at the same level on each side of the pipe and rammed to a density of 90% modified AASHO.

Further back filling shall be executed with selected materials in 150mm layers (300mm layers if a mechanical rammer is used) each layer being well rammed and watered to obtain the maximum compaction. Care shall be taken to ensure that no stone or other material which could damage pipes or other work is placed within 500mm of such work.

If the original soil is not water bearing, the cohesion less material used for refilling should at intervals be interrupted by barriers of impermeable material in order to prevent a flow along the trench.

6.7.2 Refilling in Rock

The fill material in rock excavation shall consist of soil of friable nature not exceeding 20mm and approved by the Project Manager. Rock fill must only be used when a layer of minimum 500mm sand, gravel or soil of friable nature has been carefully compacted by hand over the top of the pipe and then only when approved by the Project Manager.

7 PLUMBING AND DRAINAGE

7.1 General

Testing, cleansing and sterilization are to be carried out as specified in section 6- Pipeworks.

All work shall comply with CP 310, CP 301 or CP 308.

7.2 Plumbing

The entire works must be carried out in strict accordance with the local Authorities. By-Laws and to the satisfaction of the Project Manager.

7.2.1 Tubing

Galvanized mild steel tubing shall comply with BS 1387 'Medium' with screwed and socketed joints made in approved jointing compound.

Fittings for the same shall be galvanized malleable iron to BS 143. Pipes shall be cut by hacksaw or other method which does not reduce the diameter of the pipe or form a bead or feather, which might restrict the flow of water.

Copper tubing shall be light gauge, to conform to BS 2871, and the fittings shall be capillary or compression fittings of approved manufacture complying with BS 864: Part 2.

All brass work and fittings shall be in accordance with BS 1010 for draw of taps and stop valves and BS 1212 for ball valves.

All tubing described as chased into walls shall have the wall face neatly cut and chased, the tubing wedged and fixed and plastered over.

All formed bends shall be made so as to retain the full diameter of the pipe.

Bends shall be formed with approved tools to an internal radius of not less than eight times the outside diameter of the pipe.

Bending of tubes shall only take place when suitable fittings are not available, and unions shall be incorporated in the system in order to facilitate easy repair or augmentation to the system.

7.2.2 Cold Water Storage Tank

Cold water storage tanks shall be of galvanised steel or of approved quality. The tank if galvanized should be supplied with a galvanized sheet iron or fibre glass removable dust covers with edges turned down 25mm to suit the exact size of tank.

7.2.3 Sanitary Fittings

Connections to sanitary fittings shall be made with 450mm copper tubing bent to shape as required with copper to iron couplings at each end.

All waste fittings shall be provided with copper "S" or "P" traps, complying with BS 1184, minimum size 40mm. They shall be properly connected to tails of waste fittings with screwed or other approved joints, and be complete with openings for cleaning. Traps to sinks shall be unpolished, and those to lavatory basins shall have a chromium plated finish.

7.2.4 Cast Iron Soil and Ventilation Pipes

The soil, waste and vent pipes shall be coated cast iron spigot and socket pipes to BS 416 medium grade.

Pipes described as fixed to walls are to be secured at least 25mm clear of finished wall surface with strong cast iron holder bat clamps in two sections bolted together, one section to have lewised end for building into walls, fixed not more than 2 apart.

Pipes shall be jointed with asbestos yarn and caulked with molten lead or jointed with an approved special jointing compound.

Ventilation pipes shall normally be brought up above the roofs and shall be fitted with an approved galvanized wire grating.

Where a ventilating pipe passes through a roof, the contractor shall provide a 24 gauge galvanized sheet metal flashing of approved size to suit the roof dressed tightly against pipe and over and under roof finish-and sealed to the Project Manager's approval.

7.2.5 Manholes

Manholes shall be constructed on sewer lines in the positions indicated, or wherever ordered by the Project Manager.

The manholes shall be constructed in accordance with drawings of typical and special manholes.

Manholes on pipe sewers shall be constructed with an in situ base in concrete grade 20, which shall be raised to form the benching and invert of the manhole.

The benching and channels shall be carefully formed to shape according to the number, diameter and positions of the incoming and out going pipes. The channels shall have circular inverts. The benching shall be sloped towards the channels at a gradient of 1 in 6, or as otherwise detailed on the drawing.

Benching shall be carried out in concrete Grade 15 and rendered with 1:3 cement mortar. The ends of all pipes entering and leaving the manholes are to be carefully cut to shape to suit the internal dimensions of the manholes. All pipes entering and leaving manholes are to be as short as possible.

Manholes of pre-cast concrete rings to be carried out as per BS 556.

Chambers of block work shall be carried out as specified on the drawings. The block work shall be rendered internally with cement mortar 1:3.

Ladders or steps irons as detailed on the drawings shall be provided in manholes deeper than 1.20m.

7.3 Drainage

7.3.1 Cast Iron Drain Pipes

Shall be coated cast iron spigot and socket pipes conforming with BS 437 in all respects, and with fittings to BS 1130. Pipes shall be jointed with asbestos yarn and caulked with molten lead or jointed with an approved special jointing compound.

7.3.2 Open Drains or Channels

Sight rails shall be fixed at intervals not exceeding 50m.

The excavation for the drains shall be neatly taken out to the required levels and gradients so as to avoid any unnecessary under-filling. Where under filling is required, it shall be laid in 100mm layers of approved granular material, each layer being well rammed. The earth sides above the drains shall be neatly dressed off to such slope as the Project Manager may direct.

The invert and sides of the drains shall, where specified, consist of pre-cast concrete elements as specified in section 5 and on the drawings, jointed with cement mortar, the joints being neatly struck as the work proceeds.

8 ROAD WORKS, FOOTPATHS AND FENCING

8.1 General

All materials and workmanship not described in this section are deemed to comply to the relevant specifications of the work in hand contained in other sections of these specifications.

8.2 Roads and Paved Areas

For earthworks see section 3.

8.2.1 Subgrade

The subgrade shall be shaped to the correct cambers, gradients and levels as shown on the drawing for the full width of the crown.

All fill and top 150mm subgrade shall be compacted to at least 100% B.S. standard Compaction.

The subgrade shall be constructed in such a manner and to such levels that no single point deviates more than 30mm from the stipulated levels.

Subgrade should be kept continuously drained and any damage caused by water accumulating on or running off the surface shall be made good at the Contractor's expense.

Before any material is laid on subgrade, the subgrade shall be cleaned off all foreign matter, any pot holes, loose material, ruts corrugation, depressions and any other defects due to improper drainage, traffic or any other cause and shall be corrected to the satisfaction of the Project Manager. Any discrepancies shall be made good to the Project Manager's approval before any work on the base may start.

The Project Manager's approval of the subgrade shall in no way relieve the contractor of any obligations under the contract.

8.2.2 Base Course

(a) Graded Stone base Course

Where this type of base course is specified, stone used for this comply with the following requirements:

(i) Grading

BS Sieve	Percentage Passing
75mm	100
65mm	95-100
40mm	0-5

- (ii) The stones should not contain deleterious matter in them and should be free from dust, and admixtures of softer stones.
- (iii) The rock from which the stones are produced should comply with the following:-

A.C.V.(Aggregate Crushing Value)	Not greater than 35%
L.A.A. (Los Angeles Abrasion)	Not greater than 50%
S.S.S. (Sodium Sulphide Soundness)	Loss on 5 cycles not more than 12%.
- (iv) Binder material used shall be crusher fines of P.I. not greater than 8%.

Before commencing delivery of the bulk stones, the contractor must submit to the Project Manager samples of stone he proposes to use and these when approved shall form standard for the work.

The hardcore stones shall be transported and spread on the approved subgrade in even thickness.

The fines for choking shall be "crusher fines", non-plastic with 95-100% passing BS sieve 200 and well graded.

The stone layer shall be compacted with roller not less than 12/16 tons. Rolling should be longitudinal and shall commence from the outer edges of the road. Rolling shall continue until there is virtually no movement under or ahead of roller.

After a few passes of roller the evenness of the surface will be checked and depressions shall be made good by adding additional material or otherwise as case may be and rolling continued.

When the required firmness of the layer has been obtained the voids in the layer shall be filled with the crusher fines. The fines shall be spread in thin layer and should be brushed and rolled down into the voids. Water shall be sprayed evenly over the surface during this process to ensure complete filling of all the void.

The finished level of the surface should be true to shape and level specified so that no point on the finished surface deviates by 20mm of the specified levels.

(b) Gravel Base

Gravel for base, where specified, shall confirm with the following requirements:

(i) California Bearing Ratio (CBR)

Minimum CBR after 4 days soak shall be 18%.

(ii) Grading

The gravel shall have a grading as per grading envelop shown in the attached curve.

(iii) Plasticity

P.I: 30 maximum.
 PM. 200 min, 1200 max.

(iv) Nodule Hardness

Nodule hardness shall be good.

Compaction top base course gravel shall be carried out to 98% BS compaction.

8.2.3 Wearing Course(a) Gravel Wearing Course (Murrum Finish)

Gravel shall be from approved source and quarried so as to exclude vegetable matter, loam, top soil or clay. The gravel shall comply with the requirements of clause 8.2.29 (b) and compaction carried out to 100% BS compaction.

The Contractor shall set out the lines and levels of the edges of the carriage way by means of wooden pegs or steel pins to the width and levels shown on the drawings or as directed by the Project Manager. The distance between pegs shall not be greater than 20m where road is straight and gradient uniform and not more than 10m where the road is on horizontal curves or vertical curve.

Gravel wearing course material shall be spread in a uniform layer across the full width required and scarified so that the maximum size of any particle not greater than one half of the compacted thickness of the layer is excluded. It shall then be mixed, watered if directed by the Project Manager, graded and compacted to at least 100% B.S. Compaction and graded to final level. Waterlogged gravel should be allowed to dry to its OMC before it is processed and compacted.

The compacted thickness of any layer shall not exceed 150mm and where a greater compacted thickness is required and material shall be laid and processed in two layers. Any oversize material, which cannot be broken down to the required size, shall be removed to a soil dump.

The tolerances on levels permitted shall be as follows:

Thickness	25mm
Variation 3m straight edge	25mm
Camber	25mm

(b) Premix (Asphaltic Concrete) Finish

The premix surfacing shall consist of a prime coat and a 40mm thick wearing course.

Prime Coat

The primer used shall be MCI applied between the temperature 45⁰C-85⁰c at the rate of 1 litre/m².

8.2.4 Paving Slabs and Kerbstones

Precast concrete paving slabs and kerbstones shall be made to the sides indicated in the Bills of Quantities and the drawings. The casting shall be carried out as specified in section 4 and the laying as specified in clause 7.3.2-open drains.

8.3 Fencing

All fencing shall be erected in exact vertical position and to straight lines as shown on the drawings. The materials and workmanship shall comply with the recommendations in BS 1722.

8.3.1 Concrete Posts

Pre-cast concrete posts shall be cast of concrete grade 20 as specified in section 4, to the sizes shown on the drawings.

The posts shall be securely placed in preformed holes and cast in concrete to depths as shown on the drawings.

Bracing shall be provided at all corners, and at intervals of not more than 50metres on straight lines of fencing. Maximum distance between posts is 2.5m.

8.3.2 Chain Link

The chain link fencing shall be supplied in rolls of 2130mm (7feet) width and shall be with 65mm mesh of 12½ gauge, fitted to 4 rows of line wires with binding wire at 130mm centres.

The cranked top of the posts shall be fitted with 3 strands of 12 1/2 gauge barbed wire with four point barbs at 150mm centres. All members of the fencing shall be hot dip galvanized. The engines shall be of diesel type with a maximum speed of 3000 RPM designed for continuous running

9 SECTION ELEVEN TESTING, TRAINING & COMMISSIONING

9.1 Testing & Commissioning

The Contractor shall be responsible to commission all equipment and put into readiness for use. Commissioning tests are required including operational tests to demonstrate that the Works or relevant section operate safely, as specified and under all operating conditions, and following this testing, Trial operation to demonstrate that the Works or section perform reliably and in accordance with the Contract. The commissioning plan needs to be developed, to the satisfaction of the supervising engineer, before the commissioning period. The minimum tests to be completed on completion of works, to enable the Engineer gauge the performance of the system are as follows:

Each structure will be filled to the Top water level and left to stand for 24 hours. Once The Concrete had absorbed water after 24 hours, the structures will be topped to the Top water level and allowed to sit for a period of 48 hours to establish if the and leakages are noted. Units should be isolated and each unit's TWL should be studied in accordance to the TWL shown on the drawings and this will be used as a basis to determine if any structure has any leakage to address. A water loss of greater than 10% volume will be investigated thoroughly and it will be the contractor's responsibility to deliver each structure leak free to the satisfaction of the Engineer and in accordance to this specification

After the leakage test described above, the plant will be run for a period of 7 days as a normal working condition operation inclusive of lab investigation and testing and the following will be measured and recorded:

- The daily discharge out put
- The daily operation time
- The daily power consumption
- The daily Chemical usage
- The outputs of the lab tests

Should any of the above not conform to the designed out puts, the Engineer will expect the Contractor to carry out investigation as per the Engineer's instructions and make good any defects or adjustments necessary to have the treatment works operate as designed

- The contractor shall develop all record templates necessary for the operation of the Treatment works and lab testing that require to be done during operations and the Contractor will be responsible to develop and O&M Manual specific to the treatment works

- The contractor will test the performance of the treatment works under special conditions, mimicking unit closure of units for servicing and inclusive of emergency shut down and restart procedures. The contractor will make salient points relating to each which will be included in the O&M Manual

- Where after, the equipment shall be run by the Contractor as directed by the Engineer for a further Trial period of not less than 30 days during which thorough and systematic inspection, testing, etc. of all equipment - including valves, filters, meters, submersible pump

from the clear water tank, etc. - will be completed to the satisfaction of the Engineer. During this period regular water quality checks should be made and compared to National drinking water standards. In the trial operation period, the bidder's operator will be required to carry out regular plant and monitoring activities, namely dosing, cleaning of tanks, backwashing, water quality tests, record keeping and trouble shooting. The Contractor shall schedule this period such as to allow himself enough time to remedy, replace, etc. unsatisfactory work, equipment, etc. and still meet the final completion date.

The contractor will plan to officially handover and commission the works once (i) the tests above have been satisfactorily completed, and the plant subsequently performs to requirements, and (ii) as and when the training as described in 11.2 is deemed complete in line with the specification. The contractor at this time shall supply the operational manuals and As-built & commissioned drawings, will prepare the site, make good all landscape and touch up painting as well as other specific activities the Engineer deems fit to enable a neat and aesthetic handover of the works to the Client. The cost of the same will be deemed to be included in the rates for testing, training and commissioning. Thereupon a certificate of commissioning will be issued and the guarantee period then commences.

The Contractor shall maintain the facility for the Defects Liability Period or manufacturer's warranty (whichever is longer) post commissioning.

9.2 Training

The contractor will train a maximum of six (6) personnel, seconded to him by the Employer, on the operation and maintenance procedures. As the contractor actions the above trial operation described in 8.1, the training of relevant staff will commence. The training will be practical and hands on, with theory also provided where necessary for improved understanding. Operators, Lab Technicians and Administrators who will responsible for the works will be attached to the contractor for the training period and they will assist to develop the O&M manual. This notwithstanding, the delivery of the manual will remain the responsibility of the contractor.

The contractor will train the staff on all the above procedures and continue to train and maintain the works for a period of 2 weeks, after which the contractor will handover operations to the trainees for a period of 14 days. If during this period it is in the Engineer's opinion that knowledge of the O&M of the system has not been fully disseminated during the training, the contractor will be advised on the short comings of the operations observed and he/she will be expected to carry out a further 7 days on training on the noted weaknesses and handover fully the works. If after the 14 days grace the staff are found competent, the contractor will be invited to handover the complete works pending any works to be carried out over the defect liability period. Training reports will be issued weekly by the contractor to the employer.

9.3 As Built and as Commissioned Drawings

Prior to commissioning, the contractor will be expected to handover as built drawings to the Engineer complete with all details of the setting out, structural works, dimensioning and details of each structure. Handover and commissioning will not be accepted till this requirement is fulfilled.

In addition As-Commissioned drawings should be produced by the contractor to reflect any changes made during the commissioning period.

TABLE OF CONTENTS

PART 2: SPECIFICATIONS RELATED TO ELECTRO-MECHANICAL WORK

201 Electrical and Mechanical Clauses

- 201.1 Technical Specifications
- 201.2 Scope of Works
- 201.3 General for Materials
- 201.4 Metric Standardization
- 201.5 Work Programme
- 201.6 Schedules of Particulars
- 201.7 Schedules of Spare Parts
- 201.8 Drawings and Data to be Supplied
- 201.9 Protection and Packing for Dispatch
- 201.10 Unloading, Erection and Running of Plant
- 201.11 Storage and Safe Keeping
- 201.12 Foundations, Builders Work and Setting out of Machinery
- 201.13 Built-in Items
- 201.14 Location and Alignment
- 201.15 Operation and Maintenance Instructions
- 201.16 Technical Records
- 201.17 Labels
- 201.18 Fire Extinguisher
- 201.19 First Aid Cabinet

202 Electrical Equipment And Cabling

- 202.1 Applicability
- 202.2 Installation Standards
- 202.3 LV Creepage Distance and Clearances
- 202.4 Main Electricity Supply
- 202.5 Materials
- 202.6 Polarity
- 202.7 Workmanship
- 202.8 Switchboards and Multi-Motor Control Boards
- 202.9 Small Wiring and Terminal Blocks
- 202.10 Indicating Lamps
- 202.11 Cable Connection
- 202.12 Instruments
- 202.13 Current Transforms
- 202.14 Voltage Transformers
- 202.15 Safety Notice and Equipment
- 202.16 General for Fuse Switches
- 202.17 Motor Starters

203 Electric Motors

- 203.1 Reactive Power Compensation
- 203.2 Automatic Power Factor Control
- 203.3 Distribution Boards
- 203.4 Remote Control Push Button

204 Cables And Electrical Fittings

204.1	Plastic Insulated Wire-armoured Cable (PVC SWA PVC)
204.2	PVC Insulated Cables
204.3	Building Services Wiring
204.4	Cabling Methods
204.5	Cable Trench Work
204.6	Cable Ducts
204.7	Cable Tray Work
204.8	Conduit Systems
204.9	Flexible Conduit
204.10	Cable Trunking
204.11	Socket Outlets
204.12	Lighting Switches
204.13	Lighting Fittings
204.14	HPL Light Fittings
204.15	Emergency Lighting
205	Earthing
205.1	General for Earthing
205.2	Earthing Systems
205.3	Earthing Nests
205.4	Location of Nests
205.5	Battery units
206	Pumping, Lifting And Mechanical Equipment
206.1	Applicability
206.2	Installation Standards
206.3	Pump Construction
206.4	Motors
206.5	Mechanical Seal
206.6	Oil
206.7	Protection Against Surge
206.8	Pump control
206.9	Characteristic Curves
206.10	Piping
206.11	Pressure Gauges
206.12	Air Valves
206.13	Non-Return Valves
206.14	Sluice Valves
206.15	Butterfly Valves
206.16	Dismantling Pieces
206.17	Compressor Station for Filter Backwashing
206.18	Lifting Equipment
207	Transformer and Switchgear
207.1	General
207.2	Transformer Requirements
207.3	Tests
207.4	Finish
208	Test Instructions and Commissioning
208.1	Works Testing and Inspection Costs
208.2	Test Instruments

208.3	Test Certificates
208.4	Hydraulic Works Test
208.5	Works Inspection Tests and Guarantees
208.6	Pumps
208.7	Motors
208.8	Alternator
208.9	Diesel engine
208.10	Diesel Alternative Set
208.11	Control Panels
208.12	Circuit Breakers
208.13	Transformers
208.14	Lifting Equipment
208.15	Fuel Tanks
208.16	Cables
208.17	Pressure Switches and Gauges
209	Site Testing
209.1	Co-ordination of Site Testing Programme
209.2	Cable Tests during Installation
209.3	Final Painting
209.4	Failure to Achieve the Specified duty
210	Operation and Maintenance
210.1	Manuals
210.2	Spare Parts
210.3	Training

201 ELECTRICAL AND MECHANICAL CLAUSES

201.20 Technical Specifications

The Technical Specifications for the Electrical and Mechanical Works are to be read in conjunction with Part I of the Technical Specifications. Both documents are to be regarded as mutually explanatory. Any discrepancy shall be reported by the Contractor to the Engineer immediately, who shall clarify and inform the Contractor of his decision.

The Technical Specifications for the Electrical and Mechanical Works detailed in this Part II, generally refers to all machinery components, mechanical and electrical equipment, pump sets, control systems, etc. These Technical Specifications shall serve to specify all electrical and mechanical works wherever applicable within the scope of this Contract.

201.21 Scope of Works

These Specifications include the design, selection, supply, erection, installation, site testing, painting, commissioning of the following electrical and mechanical equipment:

- Power supply, transfer, switchgears, distribution and control panels to all parts of the pumping station;
- Sewage pumps and associated equipment for the pumping station;
- E/M equipment to be used within the pumping station, including details for all controls units as necessary;
- Cabling and wiring connecting up each plant provided under this Contract;
- General electrical services within the buildings and compounds;
- Spares, tools and other ancillary equipment;
- Internal pipe works, valves and fittings of pumping station;
- General electrical services within the buildings and compounds;

201.3 General for Materials

All materials shall comply with the relevant IEC, BS, ISO, DIN and ASTM Standards and the standards form part of these Specifications.

Goods and materials delivered to site shall comply with the requirements of the latest issue (with the up to date amendments) of the relevant Standard.

Goods and materials not manufactured to above Specification shall be of a quality not inferior to that described in the relevant Standards. The substitution of any such Specification shall only be made with the approval of the Engineer.

If any design of the works is necessitated by the adoption of such alternatives the costs incurred shall be borne by the Contractor.

Unless otherwise specified and subject to the approval of the Engineer the use, installation, application or fixing of materials and components shall be in accordance with all applicable recommendation of the manufacturers. Where appropriate, the Contractor shall make use of any technical advisory services offered by manufacturers.

201.4 Metric Standardisation

The entire project shall be completed in accordance with the metric system and metric units. Drawing components, dimensions and calibrations shall be in metric units and generally in accordance with the SI unit standard.

201.5 Work Programme

The programme of work to be executed and payments shall be divided into two periods viz:

Part (I): Design, Manufacture and Delivery Period – Design and manufacture of all equipment to be supplied under the Contract. Inspection and Works Testing of individual items and complete units and secure packing for transportation. Transportation, loading and off-loading at all points and delivery to site.

Part (II): Installation, Testing and Commissioning Period – Erection / installation of all items, site testing, safe keeping, commissioning and Defects Liability Period.

201.6 Schedules of Particulars

Particulars given in the schedules (Volume 1) shall be binding for the Contractor and may not be varied, except with the Engineers written approval. The Engineer's approval shall not in any way relieve the Contractor of any of his obligations under the Contract.

201.7 Schedules of Spare Parts

The Employer shall in no way be deemed to be placed under any obligation to purchase all or any of the spare parts listed or recommended in the schedules of spare parts (Volume 1).

The Contractor shall obtain and provide detailed schedules in duplicate of all the spare parts supplied. During commissioning on site, all spare parts shall be checked against the schedule and the Contractor shall obtain a certificate of 'Take Over' from the Engineer.

201.8 Drawings and Data to be Supplied

To be Supplied After Award

The following drawings and data shall be supplied by the Contractor upon Award of the Contract:

- a) Drawings showing the general arrangement, typical details and dimensions of the installation of the plant and associated pipe works and lifting equipment, power supply,

switchgears, control panels, distribution panels, transformers, etc. and general electrical installations;

- b) Detailed specification of the various items proposed by the Contractor;
- c) Preliminary curves for all pumping units, indicating Net Head/efficiency/kW absorbed, plotted against delivery;
- d) Preliminary performance curves of compressors for filter backwashing;

The drawings and data shall be accompanied by:

- System descriptions with principles of scheme;
- Motor list/connected loads/power demand;
- Functional description of power supply and distribution;
- Construction proposals for switchgears;
- Proposals for cabling (interior/exterior), high/low voltage indicating cable types;
- Cable lists, which served as basis for cost calculations of Tender

Subject to the requirements and limitations of this Specification, the Contractor shall be responsible for the general and detailed design of all plants, associated pipe works and lifting equipment, power supply, control panels and wiring details, etc.

Enclosed with this document, shall be drawings showing the proposed arrangement of the various installations. The Contractor is required to maintain the arrangements shown in the Tender Drawings as far as possible, subject to the differences in the physical dimensions of the equipment offered.

The Contractor may submit alternative arrangements and proposals, etc. but these shall be quoted as alternatives to the design detailed in this document. Any alternative design proposed must be fully described to facilitate a detailed comparison.

In case where the Contractor has proposed his own design, he shall be responsible for preparing any necessary modifications to the design and drawings.

All drawings shall be dimensioned and detailed in SI (metric) units.

Working Drawings

Within a period of eight weeks following the Letter of Acceptance the Contractor shall submit to the Engineer, in triplicate, the following drawings for approval:

- General arrangement drawings and sectional views, which shall be fully dimensioned showing in detail plants and ancillary equipment supplied under the Contract;
- Electrical Drawings: On the basis of the simplified documents described in Particular Specifications and the drawings, the Contractor shall prepare the following supplementary details:

- Wiring diagrams, calculations and construction plans and drawings, installation plans, complete cable lists, clamping plans, etc., as well as lists of parts, clearly indicating material and type of proposed equipment;
 - This also applies to the control and signal circuits as well as interlocking the interrelated control of other technical sectors;
 - A clear illustration according to pertinent standards is imperative;
 - A complete documentation (lists of parts, descriptions, operation and maintenance instructions, test reports and certificates, PTB-certificates with type approval of explosion protected equipment, etc.) shall be submitted prior to be commencement of installation.
- Copies of proposed panel layouts

One copy of the drawings will be retained for record purposes whilst one copy will be returned to the Contractor, stamped 'APPROVED' and/or marked up with any necessary modifications or revisions. Where any modifications or revisions are marked on a drawing, the Contractor shall make the necessary corrections and resubmit the drawing for approval.

Manufacture of the equipment shall not commence until such time as the Contractor is in receipt of approved drawings. Approval of the Contractor's drawings or documents shall not release the Contractor of any of his obligations under the Contract.

After the Engineer's approval of a drawing no changes shall be made to that drawing except as provided in Clause 51 (Variations) of the Conditions of Contract.

201.9 Protection and Packing for Dispatch

The Contractor shall ensure before dispatch, from the manufacturer's works that all plant is adequately protected by painting or by other approved means for the whole period of transit, storage and erection, against corrosion and accidental damage. The Contractor shall be held responsible for the plant being so parked and/or protected for overseas shipment, as to ensure that it reaches the Site intact and undamaged. The plant shall be packed to withstand rough handling in transit and, all packages shall be suitable for storage including possible delays in delivery.

The flanges of pipes, valves and fittings, shall be protected by wooden discs attached by means of services bolts (which shall not be used on the site) or by other approved means. The sleeves and flanges of flexible couplings shall be packed in cases. Cases containing rubber rings, bolts and other small items shall normally not weigh more than 500 kg gross.

No package or bundle shall contain items of Plant intended for incorporation in more than one section of the Works. All items of Plant shall be clearly marked, in English, for identification against the packing list. Every crate or package shall contain, in English, a packing list in a water-proof envelope.

All crates, packages, etc. shall be clearly marked, in English, with a water-proof material to show the weight, where the weight is bearing, and where slings should be attached and shall also, have an indelible identification mark relating them to the packing lists.

Cases shall bear the Contractors name and the name of the particular Site as well as full directions. These shall be painted in a strong contrasting colour in large legible characters, Steel work, pipes, valves and all uncased fittings and metal work, shall be similarly marked with the dispatch marks, in suitable paint or other approved medium. When the dispatch marks can not be applied satisfactorily direct to the body of any item, they shall be stamped on a metal label, attached to the item or part, by means of wire passing through holes at either end of the label and secured so that it lies flat with the item.

201.10 Unloading, Erection and Running of Plant

The Contractor shall make due allowance for the following commitments:

- Making his own arrangements for all appropriate skilled and unskilled labour necessary to unload, move into position or storage all items of equipment and plant supplied. The Contractor shall be responsible for any damage occasioned.
- Supplying all steps, trestles, ladders, scaffolding etc. that may be required during the course of the installation.
- Providing the necessary qualified, skilled and unskilled labour, for the erection of each and every part of the Plant equipment and apparatus, so that it can be all installed complete, and left in good working order.
- Providing the necessary technical personnel, either from the manufacturers or his own staff, for the installing, testing and setting to work of specialized equipment.
- Providing adequate protection for the plant and plant finish from the time it is delivered to Site during storage and erection periods until the Take-over Certificate is issued. (In particular, the Contractor shall provide and fix adequate sheeting, etc. to prevent the ingress of dust and dirt, both during erection period and whilst building finishes are carried out after erection.
- Inspecting related structures and obtaining the Engineer's agreement to the proposed programme, prior to erection of any item of equipment.

201.11 Storage and Safe Keeping

The Contractor is to provide site storage, the arrangements of which, shall be approved by the Engineer and which shall comply with the following minimum requirements:

Category A	Electrical Equipment	Covered, dust proof and vermin-proof
Category B	Rotating mechanical machinery, valves	Covered
Category C	Pipes, Steelworks, etc.	Shaded

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The Contractor shall, on commencement of the Contract, confirm the space he requires under each category.

201.12 Foundations, Builders Work and Setting out of Machinery

The Contractor, in accordance with the Civil Engineering Specification, shall be responsible for providing and preparing all the necessary foundations and bases for the various items of plant, including the form of holes for pipe works, steelwork, cabling rag bolts and, where necessary, the building in of foundation bolts and sundry items of plant equipment and other apparatus, strictly in accordance with the foundation drawings, which shall be supplied by the Contractor and spaces will be left between the concrete and bedplates etc., for grouting and building in, later by the Contractor. The Contractor shall be responsible for the accuracy of the particulars given on the Drawings.

When the Foundations are completed and the structure is in a suitable condition as agreed by the Engineer, the Contractor shall install the plant.

The Contractor shall observe the following requirements during erection:

- All machinery shall be mounted on steel packing ground flat on both sides. The packing shall be selected in thickness to take up variations in the level of the concrete foundation. Only one, steel packing, of selected thickness shall be used on each location, which shall be adjacent to each holding-down bolt. The number of shims shall not exceed two at each location; and the thickness of each shim shall not exceed 3 millimetres.
- All machinery shall be aligned, leveled and pulled down by the nuts of the holding-down bolts, with a spanner of normal length and no grout shall be applied until the machinery has been run and checked by the Engineer for stability and vibration.

The Contractor will clean the concrete and prepare for grouting up after the equipment pumps, motors, girders etc. have been finally fixed, jacked up and run.

The Contractor will be responsible for the grouting and final building in, of the equipment. The Contractor shall take all responsibility for the satisfactory nature of this work and shall have a representative present while the concrete is being put in.

If it is necessary to build in any item before the erection of the main machinery, the Contractor shall be responsible for these to be on Site to meet the erection programme.

201.13 Built-in Items

The Contractor shall inform the E&M supplier, if any, at the time of placing an order, of the period during which items of equipment to be built in shall be delivered to the Site.

201.14 Location and Alignment

Where separate items of interconnected plant, such as motors, couplings, pedestals, pumps and similar items, depend upon correct alignment for satisfactory operation, then each and

every item shall be positively located in its correct operational position by means of dowels. Locating correct re-alignment can be easily achieved when re-assembling the items after removal for overhauls.

201.15 Operation and Maintenance Instructions

The Contractor shall submit to the Engineer not later than 1 (one) month before Commissioning, draft copies of the Operation and Maintenance Instructions in English for the whole of the plant.

The instructions shall be correct and fully descriptive and prepared in such a way as to provide a step by step description of the preparation, and setting to work of the whole of the plant and its shutting down.

Draft copies shall be produced and submitted by the Contractor during the Contract Period, early enough to allow for possible alternation and re-submission, in addition to a language translation check. Taking over of the plant shall not take place until the approval copies are produced and submitted. Draft manuals shall be submitted in their entirety. Submission of sections in isolation will not be accepted.

Before the works are taken over, the Contractor shall provide four copies of instruction manuals in English for the approval of the Engineer, to cover all details of normal operation of the plant and requirements, regarding maintenance, both of the plant as a whole and of all the individual items.

Manuals prepared by the Contractor and manuals relating to plant supplied by any sub-contractors shall be printed (not duplicated), and shall all be bound into suitable A4 size loose-leaf ring binders, with tough waterproof and greaseproof covers.

Alterations or deletions which may be required by the Engineer, following the experience gained during the periods of running and further maintenance, shall be incorporated in these six copies in the form of additional or complete replacement pages, and the cost of these amendments shall be deemed to be included in the price inserted in the Bill of Quantities.

The operation and maintenance manuals shall be prepared in such a way as to provide a step by step description of the erection, commissioning, testing, operation (setting to work and shutting down), maintenance, dismantling and repair and shall include:

- Schedule of equipment supplied, giving manufacturers name and address and appropriate make/model No./Catalogue No;
- Schedule of routine maintenance of all equipment supplied, specifying the hourly, daily, weekly, monthly, yearly inspection, testing, and other actions to be taken for proper maintenance including supply of an appropriate number of printed carton record sheets for each individual plant component;
- Schedule of spares supplied, with manufacturers reference number, cross referenced with the sectional arrangement drawings;
- Schedule of tools supplied, with manufacturers reference;

- Sectional arrangement drawings of all major items of the Plant, with dismantling/assembling instructions;
- Plant layout drawings (as-built) in a suitable scale, showing the installation as erected;
- “As wired” diagrams of all electrical and control circuits, and connections between control panels and installed loads together with internal Wiring diagrams for all equipment;
- Comprehensive cable schedules showing all cable and core allocations including spares;
- Full and comprehensive operation, maintenance, and trouble-shooting instructions for all items of equipment and systems supplied;
- Field and factory test records/certificates for motors, pumps, compressors, pressure vessels, lifting equipment, all mechanical electrical installations and other works where appropriate for both works and site tests;
- Actual pump performance curves as tested;
- System performance curves;
- Schedule of recommended lubricants and their equivalents, which must be readily available;
- Comprehensive technical data and detailed drawings for each item of equipment;
- Fault finding chart with a step by step description of action;
- Detailed procedures for ordering spares

The issue of the Provisional Acceptance Certificate (PAC) shall be subject to receipt and approval of the Operation and Maintenance Manuals by the Employer.

At the location of each type of equipment, shall be supplied and mounted on the wall, in a conspicuous position:

1 No	Board mounted, Schedule of Routine Maintenance, to be carried out on Plant
1 No	Board mounted, set of Instructions for Operation of the Plant

The prints on each board to be of large type in English. Boards shall be of neatly finished plywood and suitably protected by clear varnish or other approved material.

201.16 Technical Records

The Contractor shall submit to the Engineer not later than one month before commissioning, copies, in English, of technical data as the following:

- Information on suppliers (address, fax, telephone, e-mail), for the whole of the plant mechanical and electrical installations;

- Full technical documentation for the above items;
- Step-by-step description of the preparation and setting to work of the whole of the above items, describing their operational interrelations with the operational system of the plant;
- Not later than the time at which the works are taken over, the Contractor shall provide four copies of instruction manuals in English to the approval of the Engineer to cover all details of normal operation of each item and requirements regarding the functional relation with the plant as a whole and of all the individual items, together with routine maintenance instructions.

201.17 Labels

The Contractor shall ensure the supply and fitting of engraved labels, to all items of plant and all valves throughout the plant. The reference numbers of all valves shall be indicated on the schematic diagram to be supplied and mounted for handing in the Pumping Stations. All labels shall be of the type specified for the control panels and electrical specifications and shall be in English language.

201.18 Fire Extinguisher

A light alloy CO₂ fire extinguisher, (for dealing with electrical fires), of not less than 5.0kg. Capacity shall be supplied, fitted with a squeeze grip, valve and swivel horn, for each building.

The jet length shall not be less than 2 meters and the extinguisher shall be suitable for operation in an ambient temperature of 50°C and be subject to a test pressure of not less than 87 kg/cm².

The base of each extinguisher shall be flat to enable the unit to be rested on the floor.

Each extinguisher shall be complete with a wall-mounted bracket and a sign in English, giving operating instructions, which shall be fixed in positions designated by the Engineer.

201.19 First Aid Cabinet

A first aid cabinet shall be supplied and installed in the office/control room. The first aid outfit shall be housed in a strongly made wall flying, wooden cabinet and the contents shall be according to Mozambican safety standards.

202 ELECTRICAL EQUIPMENT AND CABLING

210.4 Applicability

The following clauses specify general requirements and standards of workmanship for the equipment and all installations. General specification clauses shall apply where appropriate except where particularly redefined in the individual specification clauses.

210.5 Installation Standards

The work shall be executed in a neat and workmanlike manner. All work shall be carried out in accordance with the requirements of:

- Regulations in force in Kenya where applicable;
- Relevant BS/ISO/DIN specifications;
- Recommendations issued by the International Electro-Technical Commission IEC:

No. 298	High voltage enclosed switchgear
No. 694	Basic installation level, for 3 and 11 KV
No. 56	High voltage circuit breakers
No. 60	High voltage test requirements
No. 185/186	Current transformer
No. 694	Common clause
No. 76	Power transformers
No. 129/265/429	Load breaker fuse combination and isolators
No. 502/540	MV cables laying

210.6 LV Creepage Distance and Clearances

No. 157	LV circuit breakers
No. 158	LV contractors
No. 185	LC current transformers
No. 337	LV auxiliary circuits
No. 439	LV general part
No. 408	LV air breaks switch disconnectors and fuse
No. 144/529	Degree of protection
No. 34-1:14	Rotating Electrical Machines

Where VDE Standards are quoted in these Technical Specifications, equivalent International Standards may be applied, provided the requirements of Clause 201.3 are fully complied with.

210.7 Main Electricity Supply

The electricity supply will be provided by Kenya Power and Lighting Co. (KPLC). The exact characteristics of the incoming power feeding shall be obtained from KPLC and suitably

rated equipment shall be provided. For Tendering purposes the characteristics of power supply shall be taken as follows:

- Medium Voltage

3 and 11 KV, 3 phase, 3 wires, 50 Hz, plus earth protection. Fault level up to 63 kA for busbar rating 400 A and subjected to the short circuit calculation for each plant, which shall be submitted by the contractor, based on the rating of the power transformers and pump motors.

Voltage \pm 5%

Frequency \pm 1%

What about 380/400 Voltage power supply? This should be included

210.8 Materials

All materials incorporated in the Works shall be the most suitable for the duty concerned. All materials shall be new and of first classification commercial quality, free from imperfections and selected for long life and minimum maintenance.

The use of dissimilar metals in contact shall be avoided, but where unavoidable these materials shall be selected so that the natural potential between them does not exceed 250 mV. Electroplating or other treatment of contacting surfaces shall be employed as necessary to reduce the potential difference to the desired limit.

All materials and materials finishes shall be selected for long life under the specified Site conditions, and shall be derated by the approved factors, given in the latest issue of the IEC standards and the relevant VDE system or equivalent. Tropical grade materials and panel components shall be used.

All electrical components shall be of robust construction and derated to ensure long life and trouble-free operation under the extreme site environmental conditions, selected for minimum maintenance, capable of withstanding and operating under voltage surge and fluctuation conditions. The minimum derating for all electrical equipment including cables shall be in accordance with the relevant approved national electrical standards, appertaining to the Site climatic and environmental conditions.

210.9 Polarity

The polarity of all apparatus used for the Works specified shall be arranged as follows:

- For two poles apparatus, the “phase” or “live” pole to the top (or left hand side) and the “neutral” or “earthed” pole at the bottom (or right hand side). On plus and socket outlets the polarity shall conform to IEC standards and DIN/VDE.
- For three or four poles apparatus the phases in order, black, brown, grey and neutral, reading from top to bottom or left to right, in the case of vertical or horizontal layout respectively.

Layouts are viewed facing the front of the apparatus.

All cables shall be so connected between main switchboards, distribution boards, plant and accessories so that the correct sequence of phase colours is preserved throughout the system.

All cable cores shall be identified with phase colours. Where more than one phase is incorporated on a common system in one room, then the live cores shall be black, brown, grey, as appropriate and, fittings and switch accessories shall be permanently labeled and segregated in accordance with IEC standards No. 502 and 540.

210.10 Workmanship

Particular attention shall be paid to the appearance of all cable runs, the arrangements of which shall be agreed by the Engineer before the commencement of installation. The installation shall be completed to the highest standard of neatness, with respect to the visible cable runs, the arrangement and alignment of apparatus and fittings. Conduit shall be surface run.

The positions of all equipment are shown diagrammatically on the Contract Drawings, but the exact locations shall be agreed with the Engineer before the commencement of installation.

There shall be included for the fixing of all switches, fuse boards, switchgears, cables, fittings, cable trays, accessories and all other items comprising the electrical installation.

All holes for fixing shall be made by means of a rotary drill, not of the percussion type; screws shall be secured with rawl plugs or similar approved devices. A single shot cartridge tool may be used only at the discretion of the Engineer's Representative.

Should the installer propose to use junction boxes in auxiliary control cable circuit for the purpose of marshalling a number of cables feeding to a common item of equipment, full details shall be given to the Engineer. The installer shall only proceed after receipt of the written approval of the Engineer. Any such junction box shall be of the wall-mounting pattern with double terminals. All cores shall be ferruled and identified in accordance with the system schematic and cable diagrams.

All electrical installations, other than lighting and socket outlets, mounted externally to buildings, shall be provided with a permanent sub-shade canopy.

210.11 Switchboards and Multi-Motor Control Boards

Switchboards and multi-motor control boards shall comply with the following requirements:

202.8.1 Construction

Distribution switchboards and motor control boards shall consist of a number of cubicles of equal height and depth mounted side by side to form a composite board of uniform and pleasing appearance.

The maximum height of any operating control shall not exceed 1,800mm.

All cubicles shall be constructed from a minimum thickness of 2.0mm thick sheet steel, of totally enclosed welded construction, arranged for wall mounting or floor fixing, with removable back covers and hinged front doors interlocked that the doors can not be opened when the breaker or starter is in the 'ON' position and where specified. All cubicle doors shall be fitted with chromium plated car type door handles and not screws. The size and weight of any removable cover shall be such that one person can handle it easily. The metal base of the cubicles shall be dust and corrosion ad dam protected and be fully vermin proofed. The method of vermin proofing shall be such that additional cables can be added or removed after the initial installation has been completed. All steel parts shall receive corrosion protection treatment before painting, except moving parts, which shall be greased. The outside of the cubicles and the interior of the compartments shall be stove-enameled to IEC standard, enclosure protection to IP 54.

Compartments shall be easily accessible for maintenance purposes. Barriers shall be included, between each compartment, to contain an internal fault, as defined in IEC standards, to ensure safe maintenance on any outgoing circuit when the remainder of the board is live. Each compartment shall be provided with a separately fixed compartment heater.

Cubicles shall not rely on any removable portion for their rigidity. Boards shall be arranged for ready extension at each end.

The Contractor shall provide a detailed list about all instrumentation, equipment and details proposed to be contained in the LV and MV switchboards, as shown on the single line diagram's for the pumps stations. These lists shall be confirmed by the pump manufacturer, the supplier of the electrical equipment, the contractor proposes to supply, deliver and install.

202.8.2 Busbars

Busbars and connections shall be identified by phase colour marking, and adequately supported by suitable insulators the whole, to be mechanically and electrically designed to withstand the full fault capacity as specified herein.

All busbars and connections shall be rated for continuous operations. The mechanical and dielectric strength of busbars and support shall be capable of withstanding the worst conditions of electrical surge, which can occur in the installation.

Busbars and primary connections shall comply with DIN 40705, as appropriate, and shall be housed in SF6 enclosures, with a time rating compatible with the switchgear.

Busbars shall be of high conductivity finned copper with a PVC sleeving and moulded PVC shrouds shall be provided over joints.

Bolted copper busbars links, shall be provided where specified and shall be used for maintenance purpose only. The link section shall be easily accessible from the front or top

of the board and shall have a lockable cover. Provision for storing the links, nuts and bolts shall be made in the switchboards.

202.8.3 Fuses

All fuses shall be H.R.C. according to IEC 129, 265 and 420 and one spare fuse for each fuse fitted in the panel shall be supplied clipped adjacent to the position in which it would be in service.

A complete schedule of all fuses in the panel shall be affixed in convenient position in the panel.

Neutral links shall not be arranged in fuse holders but shall be separately bolted copper links with one link for each fuse.

202.8.4 Terminals

All terminals for outgoing connections shall be located at a low level in the compartment adjacent to the cable gland trays.

Provision for accommodation of rising armoured cables shall be made with adequate cable supports and a form of cable entry seal either of hardwood or similar approved material shall be provided.

Space shall be provided to accommodate cable glands of appropriate size for incoming and outgoing circuits and non-ferrous gland plates shall be supplied where single core cables are terminated. All glands and trays shall be adequately earthed.

Cable disconnecting links shall be provided where specified and shall be used for maintenance purposes only. The links shall be fitted to the busbars users, immediately before the cable terminations and shall be easily accessible. The links shall be labeled 'ISOLATING LINK' and the circuit or cable reference shall be quoted.

202.8.5 Auxiliary Switches

Auxiliary switches for indication, protection, interlocking and supervisory purposes shall be readily accessible and enclosed in a transport dust-proof cover.

Adequate secondary disconnection shall be included between the fixed portion of a circuit breaker and the moving portion.

Spare auxiliary contacts two normally open and two normally closed, shall be provided on each unit and wired to suitable accessible spare terminals.

202.8.6 Labels

The Contractor shall supply and fit engraved labels to all items of plant, valves etc. throughout all installations. Plant reference numbers shall correspond to those used in the operating and maintenance manuals. The size of labels should not be less than 100mm x 50mm and lettering shall be in English. Labels shall be black laminated plastic with

engraved white letters and shall have chamfered edges using either chrome plated nuts and bolts or permanent adhesive.

For electrical panels, switch gear etc. labeling shall be as follows:

- All external labels shall be black laminated plastics with engraved white letters in English. Edges shall be chamfered. The labels shall be affixed with chrome-plated nuts and bolts
- All internal labels shall be engraved multi-layered plastic (Traffoloyte or similar affixed with chrome plated nuts and bolts).
- Each compartment door shall have a title label and each door mounted component or control, shall have a function label.
- Every internal component shall be identified and each fuse shall be labeled with identification of fuse type or fuse current capacity.
- Compartments with doors or covers not interlocked at an isolator shall have an external label affixed thereto as follows:
- **DANGER – UNDER VOLTAGE** with flash and voltage in red letters, on white background in English.

In addition to the above plant identification labels, the Contractor shall ensure each item of machinery shall have manufacturers identification / rating plate detailing in English the following:

- a) Manufacturers name and address; Model/type identification;
- b) Serial number;
- c) Year of manufacture;
- d) Appropriate rating details;
- e) Other relevant details, limitations etc.

202.8.7 Panel Earthing

A continuous copper earth bar shall run the length of the switchboards, with terminal for connection to the station earthing system; the cross-sectional area shall be in compliance with and meet the requirements of IEC publication 364-5-54.

202.9 Small Wiring and Terminal Blocks

All switchboards and instrument panels wiring, shall be carried out in PVC insulated cable, in a neat and systematic way and securely fixed and arranged so that access to the apparatus is not impeded. The minimum wire size shall be of 1.5mm² cross-sectional area.

All terminal blocks for the connection of small wiring shall comprise shrouded anti-tracking mouldings of melamine-phenol or comparable material with provision for securing conductors either by high tensile screws and clamps or alternatively in the case of small telephone type conductor by solder tag connection. All terminals at voltages above 110 V shall be fitted with transparent protective covers.

Terminal blocks shall be arranged to facilitate easy access to both terminals and wiring ends. Connections for outgoing circuits to auxiliary pilot cables shall be provided with test links.

Identification ferrules or reference numbers shall be fitted on the wires at both ends, and letter and number shall correspond to the appropriate wiring diagram and colour codes to IEC 45.

Terminations shall be of the latest practice and restricted to one wire per terminal.

202.10 Indicating Lamps

All indicating lamps shall be low voltage with self-contained transformer or low voltage DC Bulbs shall be voltage rated higher than the transformer secondary to ensure long life. Lamp shall be well ventilated and the design shall permit removal of lamp glass and bulbs from the front of the unit. Indicating lamps shall be supplied by an individually fused circuit.

202.11 Cable Connection

A cable and sealing box with wiping gland at least 150mm above floor level and pointing downwards shall be provided for each circuit, except where otherwise indicated.

Where single core cables are to be accommodated a non-magnetic gland plate shall be provided. For cables size 400mm² and above, insulated glands shall be fitted.

The individual terminals shall be provided with pressure type cable lugs of ample size and connected to the current carrying elements by means of corrosion resistant bolts nuts and washers.

Where cables are metal sheathed or armoured, the sheathing and/or armouring shall also be earthed at the end box.

Undrilled gland plates shall be provided, approximately 300mm above floor level, for the reception of conduits and threaded glands. Boxes and glands shall be within the cubicles except where otherwise approved.

Prior to manufacture, the Contractor shall conform cabling termination requirements to the Engineer.

202.12 Instruments

All indicating instruments shall be of 90° scale type, flush mounted and generally of the same appearance throughout. They shall comply with IEC recommendation and be of industrial grade accuracy. Instruments shall be hermetically sealed or tropicalised. Instruments shall have external zero adjustment and have black bezels. They shall be positioned such that they can be easily read and the dial centres shall be not less than 400mm and not more than 2000mm above finished floor level. Meters shall be fitted with an adjustable pointer or shall be inscribed on the scales to indicate the normal circuit rating for the associated plant.

Instruments shall have a square front appearance with width dimensions as follows:

60 mm	Ammeters upto 20A , voltmeters up to 600V
100 mm	All other instruments

Ammeters fitted in a motor circuit shall have a suppressed scale to indicate the maximum starting current. Kilowatt hours meters shall be arranged to register 3 phase, 4 wire unbalanced loads except as otherwise indicated.

All instruments shall be mounted adjacent to the relevant circuit breaker switch or starter, unless separate panel suites are specified herein.

At points of connection of potential circuits to LV busbars etc., HRC fuses shall be provided to protect the auxiliary wiring. For cubical gear these fuses shall be housed inside and readily accessible. Additional fuses to clear individual instrument faults shall be provided and accessible from the front of the cubical where otherwise specified.

202.13 Current Transformers

Current transformers shall comply with IEC 185 and should be suitably rated and designed to carry out appropriate function – viz metering and protection as indicated in the attached schedule. The short time current rating should not be less than 3 seconds.

Identification labels giving type, ratios, accuracy limit factor, rating output and serial numbers shall be fitted.

Duplicate rating labels are to be fitted on the exterior of the mounting chambers suitably located to enable reading without removal of any cover. Labels shall be supplied for multi-ratio current transformers indicating the connection required for alternative ratios.

Bar type current transformers shall be supplied in preference to those with wound primaries. Short time current factors shall relate to the full fault level for three seconds. For over-current protection, the product of VA rated burden and rated accuracy limit factor shall be less than 150 unless otherwise agreed with the Engineer.

One secondary terminal of each current transformer shall be earthed through a removable link at the switchgear.

202.14 Voltage Transformers

Voltage transformers shall be of the isolatable type with a secondary three phase voltage of 110 Volts and shall comply with IEC 186. Epoxy resin insulated shall be acceptable.

The primary shall be protected by HRC fuses which, together with the connection between the fuses and the primary conductors, shall be adequately rated to withstand the short circuit rating of the switchgear.

Fuses shall be included to protect the secondary windings and, they shall have safe access for renewal.

Safety shutters shall be provided to automatically cover the fixed contacts when the transformer is isolated. Shutters shall be coloured yellow when isolating contacts are connected to the feeder side of the circuit and inscribed **CIRCUIT** in English Language

202.15 Safety Notice and Equipment

For each switchboard the Contractor shall supply the following equipment, which shall comply with IEC standards No. 694 and 349:

1No	Electrical grade rubber mat 1000m, wide extending the full length of the switchgears and switchboards
1No	Pair of electrical grade rubber gloves
1No	Notice in English advising treatment for a person suffering from electric shock.

202.16 Circuit Breakers

202.16.1 SF6 Circuit Breakers

The SF6 circuit breakers shall comply with the following and be suitable for controlling loads, the site climatic conditions, and comply with IEC 157 for 11KV, 3 – phase, 50Hz wire operation, for use on the breaking capacity of the fault current in accordance to the short circuit calculation for the fault level for each plant. ASTA or KEMA test certificates shall be forwarded with the Tender. Air Circuit Breakers (ACB) will not be accepted for use where SF6 Circuit Breakers are specified. Tenderers shall include with their offer a schedule showing circuit breakers and their respective loads.

The circuit breakers should be horizontally isolated, enclosed pattern SF6 break type, complete with operating mechanism manual operated, and the circuit breaker operation, when in the isolated position, shall be provided.

Locking by means of padlock or removable key in the open position shall be possible.

The operating mechanism shall have a mechanical 'ON/OFF' indicator and a manual trip device fitted with means for locking test terminal blocks, healthy trip lamp (coloured white) and associated pushbuttons set of auxiliary switches, '**SUPPLY AVAILABLE**' lamps (blue) (on incoming units only), cable boxes complete with glands of suitable size for the accommodation of the incoming and outgoing cables entering from below.

Each circuit breaker shall be provided with an operation counter. Auxiliary contacts for the indication of breaker state for use at 220V AC shall be provided.

All circuit breakers shall be provided with inter locks to ensure that:-

- Circuit breakers cannot be isolated when it is closed.
- The Circuit breaker cannot be closed in the service position without completing the auxiliary circuit between the fixed and moving positions.
- With the circuit breaker earthing device in position, tripping may only be effected by a manual device in the operating mechanism.

- The following flush mounting equipment shall be fitted to the front of each of incoming circuit breaker panel:

1 No	Under voltage relay
1 No	Phase sequence relay
1 No	Triple poles, flush mounted overcurrent relay arranged for two poles overcurrent and one pole earth protection with auxiliary relay for instantaneous remote trip and indication.
1 No	Voltmeter with selector switch for phase/phase, phase/neutral and off positions, fitted to line side of incomer
1 No	Kilowatt hour integrating meter
1 No	Kilovar integrating meter
1 No	Kilowatt meter
1 No	Pilot lamp for "SUPPLY AVAILABLE"
1 No	Pilot lamp for "Trip Circuit Healthy"

NOTE:

Interlocks are required between mains, incomers and standby incomers, such that it shall be impossible to have both closed at the same time (except in the with-drawn position). These shall be arranged such that all permissive and all prohibitive signals are present before a circuit breaker may be closed.

Any other interlocking shall be provided as necessary to ensure the safe operation and maintenance of all electrical equipment provided under the Contract.

All low voltage circuit breakers shall be housed in control boards which comply with the requirements of this specification.

The height of any controls shall not exceed 1,800 mm.

There shall be a purpose designed, separate attachment earthing device. The device shall be arranged to earth either the cable box or busbar side of the circuit breaker, and shall be stored in a suitable robust container, which shall include details of assembly and use.

206.16.2 Moulded Case Circuit Breakers

Unless otherwise indicated, circuit breakers shall be manually operated and shall provide thermal-magnetic, inverse-time-limit overload, and instantaneous, short circuit protection.

Breakers shall be moulded case type, rated 380 Volts, 3 pole and have 100A or larger frames. The minimum interrupting rating shall be 30 kA symmetrical at 380 Volts.

The breakers shall be supplied with an overload and short circuit rating as follows:

- 100 A frame: Fixed long time and instantaneous ampere setting
- 225 A frame: Interchangeable long-time and adjustable instantaneous ampere setting
- 400 A frame: Interchangeable long time adjustable instantaneous fault ampere setting
- 600 / 800 A frame: Interchangeable adjustable solid state trip

- a. Long time ampere
 - b. Long time delay
 - c. Instantaneous ampere
 - d. Ground fault ampere
- 1,500 A frame and above: Interchangeable adjustable solid state trip
- a. Long time ampere
 - b. Long time delay
 - c. Instantaneous ampere
 - d. Ground fault ampere
 - e. Ground fault ampere

The solid state trip circuit breakers shall be supplied with a portable testing unit to allow for periodic trip setting testing.

Time current characteristic curves and other necessary information and data for each size of breaker furnished shall be provided. Where M.C.C.B. are used for feeding, shall be equipped with the same instruments as described in item 2.8.1. for SF6 circuit breaker.

202.17 General for Fuse Switches

Fuse switches shall comprise enclosed heavy duty composite SF6 break switches and fuse units, complying with IEC 439 and shall be rated and equipped as detailed. Composite units shall be contained within an SF6 enclosure of metal and shall be fitted with an earthing terminal irrespective of any means or connections such as is provided for attaching armouring or other metallic covering of the cable supplying the composite unit.

202.17.1 Enclosure

The enclosure shall be so constructed that the cover cannot be never opened and the construction shall be such that when the cover is opened a competent examiner can override the interlock and operate the switch. After such operation, the cover shall be prevented from closing with the switch position indicator in a false position.

Switch shall be provided with mechanical 'ON/OFF' indicators and operating handles. Means shall be provided for locking the switch in the 'OFF' position only.

202.17.2 Fuses

The fuse shall either include a suitable fuse carrier or it shall be capable of isolation. IF the fuse carrier is included it shall be such that when it is being withdrawn normally or when it is completely withdrawn, the operator is completely protected form accidental contact with any live metal of its fuse link, fuse contacts and fixed contacts.

If the fuse is capable of isolation, it shall be so interlocked with the switch that isolation is complete before the fuse enclosure can be opened, further the switch shall be prevented from closing while the fuse-cover is open.

202.17.3 Isolating Switches

The compartment-isolating switch shall interrupt all supplies into the compartment to enable safe maintenance to be undertaken. Isolators shall have metal handles and a facility shall be provided to enable the isolator to be padlocked in the 'OFF' position only. One padlock with 4 keys shall be supplied for each isolator on the board.

202.17.4 Fuses and Links

All fuses shall be of the HR cartridge pattern to IEC 439 and suitable for site climatic conditions.

Fuse holders and fittings shall be made of moulded plastic insulating material of an approved make. Ceramic materials will not be accepted. Fuse fittings shall be fully shrouded and it shall be possible to change the fuses without danger of contact with live metal. For every fuse in service a spare shall be provided, clipped local to the duty unit.

When incorporated in distribution boards fuse fittings shall have basic sizes 16, 32, 63, 100 and 200 A, and the fuse holders shall be able to accept fuse links of that rating or any BS rating down to the next basic size.

HRC fuse cartridges, where used in distribution boards, shall be manufactured in accordance with IEC 129, 265, 420 and 439.

Fuses and links in the same circuit shall be mounted above each other in separate rows and shall not alternate in the same row.

202.18 Motor Starters

202.18.1 General

The starter cubicles as required are to form part of a Motor Control Centre and as such circuit connections protection devices and the like shall comply with the installation standard specified in item 2.2. The cubicles shall be easily accessible for maintenance purposes and shall be damp, dust and corrosion-proof. The motor starter shall be of rating to carry the full load current of its rated duty at its most severe load conditions. All starters shall be capable of at least 40 starts per hour at 100 percent full load torque. Motors up to and including 7kW shall be started directly on line. Motors above 7kW shall be started in accordance with Clause 202.18.2 HV motors shall be started directly on line.

202.18.2 LV Starters

Each starter shall be housed in a separate compartment containing the following:

For Direct Online LV Motor Starter

- 1 No. Triple poles 380 Volt-50Hz, externally manual operated MCCB equipped and instantaneous, short circuit protection. The MCCB is interlocked with the compartment door with the provision for using a padlock to lock in the off provision and provided with suitable number of auxiliary contacts.
- 1No. Triple poles contactor for switching direct-on line in accordance with

IEC 158 and standards feeted with auxiliary contact.

- 1No. Triple poles thermal over current protection.

For Start Delta Starter

- 1No. Triple 380 V 50Hz externally manual operated MCCB equipped with thermal magnetic, inverse time limit over load and instantaneous, short circuit protection. The MCCB is interlocked with the compartment door with the provision for using a padlock to lock in the off provision and provided with suitable number of auxiliary contacts.
- 1No. TP thermal overload relay with fully adjustable, to set the actual current setting required to trip the motor with in the max time that the motor characteristic permit this condition to exist.

The adjustable setting range shall cover the required power output. Documentary evidence must be produced showing the current time characteristic of each overload and the motor manufacturers thermal stability time/current characteristic comparison.

Consideration must be given at to the requested method of star delta starting system.

- 1No. Set of main control terminal and auxiliary terminals for remote controls and indications.
- 1 No. Set terminals for remote lock-off stop push button
- 1No. 380/2-20 V 50 Hz double wound single phase transformer with earth screen and suitable capacity to supply all control circuit and pilot lamp requirements. The transformer primary shall incorporate suitably rated fuse and neutral link, with the control and lamp circuit having separate fuse protection on each side.
- 1No. Anti-condensation heater (off when starter is closed). The heater shall be separately fused.

The following equipment shall be mounted on the front f control panel:

- 1No. Ammeter fitted with suppressed scale, to read motor running at starting current.
- 2No. Pilot lamp , to indicate “SUPPLY ON” (green), and ‘MOTOR RUNNING” (red).
- 1No. Pilot lamp to indicate “MOTOR FAILED” (amber)
- 1No. ‘MANUAL/OFF/AUTO” selector switch
- 1 Set “START/STOP” push button
- 1No. Externally operated overload reset push button

- 1No Motor and cubicle heater 'OFF/AUTO'.

In view of the fact that overload indication of all drivers may be required, each starter should be designed for this purpose.

The signal for this remote indication will be taken via auxiliary contact fitted to the isolators and contactors or relay of the individual starters.

The motors, in some, groups will be required to operate in a predetermined sequence and, starters should include suitable auxiliary relays and contacts.

All starters shall contain a totally enclosed dustproof time or the operation will be controlled by a timer in the automatic section which shall have multiple contacts and also be totally enclosed dustproof which shall prevent pump(s) starting after a power failure until after a prudent time has elapsed. The time(s) or contact shall be adjustable in the range 50 percent to 200 percent of the anticipated maximum delay, which shall be taken as twice the total time required for all pumps to start and run steadily having been started consecutively. The time(s) or contacts shall be set to give individual sequential start after a power failure with no drive starting until its predecessor has reached full steady running.

The moving contact shall be suitably rated to operate an auxiliary relay of the attracted armature type. The auxiliary relay shall be suitable rated to work at 220 V AC and have contacts suitable for operating the tripping mechanism of the associated circuit breaker and initiating an alarm and indication system.

When the auxiliary relay operates, it shall automatically operate a mechanical flag to give visual indication that the relay element has operated. The auxiliary relay and mechanical flag shall be reset by a hand-operated button mounted on the front of the removable cover.

202.18.3 Interlocking

Mechanical interlocking shall be provided where possible. All electrical interlocking shall be of the double type having separate permissive and prohibitive interlocks. Thus to allow a device to operate there must be an absence of prohibitive signals and a presence of permissive signals from the remaining devices in the interlocked system.

Suitable equipment shall be provided mechanically to prevent a device being manually operated when a prohibitive signal from another part of the interlocked system is present.

202.19 Protection

All protective relays shall conform to the latest edition of IEC Standard 157-1 and be suitable for the climatic site conditions, fully sealed against ingress of moisture or dirt, and tropicalized.

The relay shall have automatic thermal compensation for variation in the temperature between 0 to 55°C. All protective relays shall be supplied in flush mounted metal cases with glass windows. Relays shall be mounted on a withdrawable chassis with plug-in facilities.

Each individual element of the relay shall initiate a flag to indicate that the element has operated. The element and flag shall be reset by operating an external reset button mounted on the front of the relay case.

202.19.1 Motor Protection

For all motors up to 75 KW, three single pole, wound magnetic adjustable overloads high set for starting and stalling protection, and three single pole thermal overloads for overload and single phasing prevention shall be provided.

202.19.2 Protection Relays

Protection relays shall alternatively be accommodated in the housing of the circuit breakers for protection of their downstream line sections against various kinds of fault.

The Contractor shall in any case provide suitable back-up protection for short-circuit relays and earth-fault relays by proper time setting of successively arranged relays and their mutually interconnected controls so that in case of a fault in any section of the 400 V grid only the faulty section will be disconnected, whereas all health parts of the grid will remain in operation. Subsequently, relay setting schemes shall be furnished by the Contractor for approval by the Engineer.

The following relays and associated current transformers shall be applied for all 400 V circuit breakers to be installed according to the attached single line diagram.

- Overload or overcurrent relays with either, an inverse time delay overcurrent release or a definite time delay-overcurrent release whichever type is more suitable and interconnected to it.
- Short –circuit relay with instantaneous overcurrent release.
- Earth-fault relay or earth leakage relay with a three phase sum current transformer acting on a response current from 0.2 to 0.7 times the rated current which can be set in several steps. The delay time of the release shall also be variable in several steps between 100 and 500 milliseconds in order to attain the above-mentioned back-up protection.

Under voltage relays shall be installed only in circuit breakers used for feeders of large motors in order to avoid automatic restarting of motors, after voltage recovery following a power failure.

All relays shall be equipped with respective fault communicators and indicators for audible and visible fault indication in the control room. A fault panel shall be part of the supply. Connection works shall be included.

Auxiliary switches to be actuated by the operating mechanism shall be available in sufficient quantities to cover all control, indication, operation and protection requirements.

The Contractor shall submit circuit diagrams of all main, control and protection circuits of the circuit breakers to be used.

203 ELECTRIC MOTORS

Motors shall be selected from the following, to satisfy the Contractor's requirement and comply with the KPLC power current restrictions.

Motor frames for indoor use shall be provided with openings for ventilation but protected so as to exclude the ingress of falling dirt or moisture conforming to a degree of protection not less than IP 54.

All outdoor motors shall be provided with suitable covers to protect them from direct sunlight.

Motors up to 7kW shall be squirrel cage, suitable for DOL starting, having a starting current not greater than 6 x full load current (FLC).

Motors between 7kW and 37.5kW shall have their starting current restricted to 4 x FLC and shall use one of the following starting methods:

- Solid State Reduced Voltage (Soft) Start
- Komdorffer Auto Transformer

Motors over 37.5 kW shall have their starting current restricted to 2.5 FLC and shall use one of the following starting methods:

- Solid State Reduced Voltage (Soft) Start
- Komdorffer Auto Transformer
- Rotor Resistance

Motors over 100 kW shall be high-voltage operated, squirrel cage rotor suitable for DOL starting, having a starting current not greater than 6 x full load current (FLC).

Submersible pump motors, because of inherent design are to generally comply with the foregoing. However, the starting method is to be restricted to solid-state reduced voltage starting only.

LV motors shall be suitable for operation on a 380 V, 50 Hz, 3-phase supply.

MV motors shall be suitable for operation on a 3,000 V, 50 Hz, 3-phase supply.

All motor enclosures shall satisfy, and be selected from:

- IP54, for general purpose drives
- IP55, for outdoor or machines subject to splashing or washing down
- IP68 to submersible machines.

The motors shall run in ball and/or roller bearings, and the weight of the motor shall be carried by thrust bearings incorporated in the motor body.

The efficiency and power factor of the motors shall be high over a wide range of load conditions, and the motors shall be designed, manufactured and tested in accordance with IEC 34 for continuously rated industrial electric motors with Class F insulation, but limited to Class B

temperature rise. The maximum continuous rating (MCR) of each motor shall be as set out below and shall be rated and designed for operation in ambient temperatures up to 50 °C and capable of prolonged operation in sand laden atmospheres.

MCR RATINGS

Application	Up to 75 kW drive	Above 75 kW drive
All pump motors (excluding positive displacement type)	10% above that required under all conditions of operation	5% above that required under all conditions of operation

NOTE:

- The reserve power requirements shall be added to the calculated power prior to any other adjustments, e.g. high ambient temperatures at site.
- All motors shall have Classification ‘F’ insulation but Classification ‘B’ temperature rise limitations shall apply. It should be noted, however, that this requirement is in addition to any adjustments necessary for high ambient temperatures at site.

All motors shall be capable of starting 10 times per hour. The starting motor current shall not exceed 6 times full load current.

Motor shafts shall run in ball and/or roller bearing and the weight of the rotating units shall be carried by all thrust bearing incorporated in the motor body.

The motors shall be commercially silent in operation and run free from vibration and the rotors shall be perfectly balanced both statistically and dynamically and shall be tested and adjusted for dynamic balance in an approved manner.

Terminal boxes shall be provided with glands suitable for XLPE or PVC armoured cable. The motor stool base where appropriate shall be drilled at works vertically below the terminal box gland for the passage of the cables and the edges of the hole slightly countersunk or the hole bushed.

Terminal boxes shall be labeled with “Traffolyte” type labels white letters on red background, to read in English:

WARNING!
TERMINALS UNDER VOLTAGE
SWITCH-OFF BEFORE REMOVING THE COVER

All motor drive shall be labeled to correspond with their respective starters.

All submersible pump motors shall be provided with slot temperature detection (resistance thermometers) embedded in each phase of the stator Winding, the leads of which shall be brought to the terminal box.

Out of these measurements, at least one maximum temperature contact shall be derived either thermostatically or electronically and, this thermal contact shall give alarm and or trip its

associated motor starter circuit breaker when the motor winding temperature reaches its maximum allowable value.

Motors with sleeve bearings shall be fitted with one dial type thermometer on each bearing for local control and either thermocouple or resistance thermometer for remote indication, with oil level indicators marked for running and stand-still, oil flow indicators.

Arrangements shall be made with the manufacturer so that the Engineer may witness tests.

203.1 Reactive Power Compensation

A “capacitor bank” for central reactive power compensation according to IEC publication No. 70, shall consist of a definite number of parallel operated 400 V capacitors, and their associated feeders of individual contractor-fuse combinations, as well as an automatic power control relay.

All this equipment shall be readily mounted inside suitable 400 V panels and shall be connected ready for operation as shown in the single line diagram.

The control relay shall alternatively connect or disconnect capacitor units in order to keep the power factor around 0.95 under fluctuating load conditions.

When dimensioning the total capacitance, as well as the number of parallel operated capacitors, a design analysis shall be carried out based on the actual power factors of motors as given by the manufacturer.

Over compensation, i.e. self-excitation of the circuits shall be avoided in all cases. The control relay which is operating in principle like wattmeter must be connected according to the manufacturer's instructions in order to provide proper service.

203.2 Automatic Power Factor Control

Automatic power factor correction control devices shall be used for control of central compensation of the reactive power in three phase supply systems without harmonics. Equipments modules shall be made of steel sheet enclosed boxes for MCC mounting.

Units up to 180KVar shall consist of a built-in module, completely mounted and connected, with power factor control relay and low-voltage fuses, capacitor control relays, discharge resistors, low-loss MKP power capacitors and terminal blocks for connection of the control and current transformer lines. The module is built into a prefabricated steel sheet box.

Units of higher rating than 180 KVar shall contain:

- Group of low-voltage fuses, containing of 18 fuses with low-voltage fusible-links, and busbars for central connection to the main;
- Capacitor sub-assemblies, each consisting of capacitor control relays, low loss MKP capacitors and discharge choke for quick discharge;
- Power factor relay, multi-step, with LED, hand switch and manual/automatic reversing switch in an instrument box, with lines and terminals for connection of the control lines and current transformer lines as well as for the control lines to an extension module;
- Steel sheet standard panel;
- Terminal for PE- and N-conductor;

- Sight glass in panel door for the control of power factor relays
- The cable entry for each unit shall be provided from below. Power supply is necessary for each unit and extension module. A three-pole low voltage fuse shall be used for the short-circuit protection of each unit.

203.3 Distribution Boards

All distribution boards shall be of the totally enclosed metal clad pattern manufactured in accordance with IEC standard publication No. 28A5, 157, 185, 337, 439, 144 and 529.

Fuses, MCB and MCCB as incorporated in distribution boards shall comply with the relevant IEC standard and be fitted with thermal overload and instantaneous magnetic short circuit protection and, earth leakage protection when specified shall be current operated.

The enclosure shall be made from zinc coated mild sheet steel formed to a clean line and complete with a lockable hinged cover with gasket. Removable plates with conduit knockouts shall be provided at top and bottom.

All distribution boards shall be complete with a residual current circuit breaker. The circuit breaker shall be rated and have the same number of phase as the circuit from which it is fed.

Doors shall be fitted with gaskets and shall be easily removable to preserve the finish and simplify installation. Each distribution board shall be arranged for top and bottom cable entry and shall be provided with an ample cable termination plate and chamber to enable cables to be neatly gladded with tails grouped and terminated onto appropriate internal termination.

Distribution boards shall be wall or floor mounted and shall when specified incorporate on-load isolators which shall be front of panel operated with 'ON/OFF' indicator and capable of being padlocked in the 'OFF' position. Distribution boards shall incorporate HRC cartridge fuses or combinations of single pole and neutral and triple pole miniature pole circuit breakers *(MCB) as specified. For DC circuit and 24 volt power outlets double pole shall be used.

Each bank of MCB/fuses shall be clearly identified with its appropriate phase colour code and, the mounting framework for the banks of MCB/fuses shall be easily removable to simplify installation. Adequate phase barriers and shields shall be fitted to ensure that after installation and wiring, all bare terminals and wires are covered, to prevent accidental contact with live conductors during the normal procedure of fuse changing and resetting of MCB.

All distribution board shall be complete with HRC fuse cartridges manufactured in accordance with IEC standards with fusing factor of 1.5, to afford "close" over current protection to circuits as defined in the IEC No. 408.

All neutral bars shall have a separate terminal for each fuse way within the distribution boards.

The termination of circuit cables at distribution boards shall be neat and slack left at each fuse bank or neutral bar to enable the complete assembly to be removed for inspection without disconnection. Neutral conductors shall be connected to the bar in the same order as the phase conductor to the fuse way.

Each distribution board shall be complete with a permanent circuit identification chart, preferably mounted within the front door. This chart shall be permanent and legibly filled in as circuits are completed, the circuit description including the fuse rating. The chart shall be in English.

203.4 Remote Control Push Button

Adjacent to all motors and, in the positions specified, there shall be supplied, installed and mounted on a suitable structure weatherproof, heavy duty push buttons.

Emergency stop, push button actuators, shall be of the auto latch-turn to release type. The actuator head shall be red, mushroom shaped and clearly labeled **STOP** in English.

Two button remote control units, in a single case, shall incorporate an actuator of auto-latch turn, to release type emergency stop push button complete with mushroom shaped head clearly labeled **STOP** in English, and one start push button with plain head and a momentary normally open contact to initiate remote starting. The start push button shall be coloured green and shall be equipped with a half guard to prevent inadvertent operation and shall be clearly labeled **START** in English.

The support structure shall be robust and galvanized by the hot dip method. The structure shall be designed to locate the push button station at a convenient height and position.

It is the responsibility of the Contractor to ensure that the pushbutton stations provided are all from the standard manufacturer.

204 CABLES AND ELECTRICAL FITTINGS

All cables shall comply with the requirements of the relevant DIN/VDE standard for the type of cable supplied.

All cables shall be of a suitable voltage level, stranded copper cored and, manufacturer's test certificates shall be submitted for all armoured cables 600/1000 V and 6/10 (12KV) to the Engineer, before the cables are dispatched.

The contractor shall ensure that each cable is of sufficient rating for its normal and fault conditions. To assess the rating and cross section required for each cable the following factors shall be considered.

- Fault level
- Conditions of ambient temperature, relevant to method of laying
- Voltage drop
- Voltage drop in motor circuits due to starting
- Over current settings of circuit breakers
- Disposition of cabling whether in air, ducts or ground

The Contractor shall state the cable sizes in his tender. The cable sizes are to be approved by the Engineer before ordering. Cable rating shall be calculated in accordance with VDE 0271 and IEC standards 502 and 2289.

The selection of cables shall be based on the following conditions:-

- Ground temperature 35°C
- Air temperature 50°C
- Thermal Resistivity 2.5°Cm/w
- For PVC insulated cables, circuit protection will normally be “Close” with fusing or tripping at .3 times the cables in the schedule.

The contractor shall prepare Technical Schedules showing all principal power and control cables/wires to be supplied. All such cables and wires shall be numbered in the Schedule, the same reference numbers being used in the contract drawings and Specification. The following data shall be included for all cables in the schedule.

- Cable identification number
- Route from/to
- Type of cable
- Derating, factor used
- Cross sectional area (mm²)
- Length *(meters)
- No. of cores (excluding earth conductor)
- Number of spare cores

All cables necessary for the complete operational installation shall be included

The Contractor shall be responsible for measuring from the contract drawings the length of cables required. The cable sizes are to be approved by the Engineer before ordering.

Each cables shall be supplied in a suitable length, and be continuous through its run. Through joints will not be permitted without written permission from the Engineer.

The earthing conductor shall be of adequate cross sectional area and shall, either be one core of a multicore cable or on a separately run single core cable. The use of cable armouring, conduit, water or other service pipes in any part of the earth continuity conductor is strictly prohibited.

The Contractor shall supply and install all necessary cable glands and sealing boxes required to complete the installation. All materials used in the manufacture of the glands etc. shall have no deleterious effect on the cable core or armouring, and shall be non-corrodible.

204.1 Plastic Insulated Wire-armoured Cable (PVC SWA PVC)

Thermoplastic insulated cables shall be, either Polyvinyl Chloride ((PVC) or Cross-linked Polythene *(XLPE)type, and comply with VDE 0271 and IEC 502 and IEC 228 class 1 and 2 respectively. They shall be 600/1000 V and 6/10 (12 KV), and comprise of stranded copper conductor, PVC or XLPE insulation, suitable bedding, steel wire armoured and PVC sheath.

The cables shall be of approved manufacture. Aluminium armour shall be provided on single core cables.

All such cables shall be terminated with mechanical glands in accordance with IEC standards 502 and 540, which shall be of a type to provide adequate mechanical support by locking on the armour and shall at the same time give high earth continuity.

204.2 PVC Insulated Cables

PVC insulated cables shall comply with VDE 027 and IEC 22 class 1 and 2 and IEC 502 and shall be 600/1000 V grade. The cable used shall not be less than 1.5mm² cross sectional area.

204.3 Building Services Wiring

In general wiring for plant machinery shall be carried out in PVC SWA PVC or XLPE SWA PVA while the building services shall be executed in PVC cable enclosed in heavy gauge screwed galvanized conduit. The minimum copper conductor size used shall not be less than 1.5 mm². The use of junction boxes between fittings shall be kept to a minimum and where practicable all connections shall be made at the boxes. When used, junction boxes shall be rectangular pattern. Circuit wiring shall not be connected directly on to the terminals of lighting fittings but shall made off in point boxes consisting of standard BESA box fittings by flexible cables.

The contractor must ensure that the installation is done so that not more than one phase shall occur at switch lighting or power outlets where these outlets are less than 2.5m apart, unless guarded by a wall partition or other barrier. If this is impracticable the Contractor shall obtain the advice of the Engineer before proceeding.

The scheme of wiring shall conform to the colour code requirements of the IEC Regulations. The installation of multi-core and single core cables or bunching of cables in conduit is to be carried out on the assumption that such cables will carry alternating current.

The excessive bunching of small cables in large conduits will not be permitted and, the Contractor shall not exceed the requirements of the regulations.

The Contractor shall include for terminating each cable in excess of 30amp. current carrying capacity, in a pressure operated, mechanically crimped, leg terminal or terminal socket.

204.4 Cabling Methods

Every cable shall be installed in accordance with the relevant IEC Standards Specification. Every cable shall be nearly run vertically, horizontally or parallel to adjacent walls, beams or structural members.

Suitable screens shall be provided to protect the cables, run on the external surface of structures or above ground level, from the effect of the sun's radiation. All screens, used to protect the cable, shall be of an approved design, surely fixed to the structure or ground and be fully ventilated.

Where cables are terminated at a particular item of equipment care should be taken to ensure that the cables finally approach the equipment from a common direction and are individually terminated in an orderly and symmetrical fashion.

All necessary compound for cable joining and junction boxes required to complete the installation, shall be included. Cable ends shall be sealed in suitable chambers bolted to terminals of circuit breaker and other equipment. Every cable shall be supported where necessary by an approved method. All cable glands have a non-corrodible finish and shall be supplied complete with PVC shroud.

PVC or XLPE insulated cables shall be terminated in mechanical glands, in accordance with IEC standards No. 502 and 540, which shall be of a type to provide adequate mechanical support by locking on the armour and give a high earth continuity.

Paper insulated cables with lead or lead alloy sheath shall be terminated in a suitable wiring gland. All cable conductors shall be terminated in a suitable copper lug.

Paper insulated cables shall only be joined or terminated by staff fully qualified to work on this classification of cable. Before proceeding with the joining, the ability of the staff employed on the work shall be demonstrated on site by making trial joints to the satisfaction of the Engineer.

Where cables enter or leave buildings, the ducts shall be sealed at the points of entry into the building. Caulking shall be carried out in fiberglass, followed by not less than 40 mm of bitumen compound or a weak sand/cement mixture as directed by the Engineer. Care must be taken to ensure that the PVC sheathing of cables is not damaged during caulking due to excessive temperature, if heated bituminous compound is employed.

Where it is necessary to remove the PVC sheath of a cable e.g at a joint, the minimum length necessary shall be removed and the exposed copper conductor, sheath or armouring shall be adequately covered by a PVC tape or sleeve or other suitable means.

All cables shall be delivered on robust cable drums with cable ends treated to form an effective seal. When a cable is cut from a drum, the cable end left on the drum shall be immediately sealed in an approved manner to prevent the ingress of moisture. All cables, once they have been cut, shall be either terminated in their final position, immediately or effectively sealed, paper insulated lead sheathed cables by sweating, thermoplastic by taping in an approved manner.

Every cable shall be permanently identified at each end by its cable number. Cable markers shall be securely fixed to the cable.

Cable route marker posts shall also be installed at entry and exit points of buried ducts, exits from buildings (if necessary wall mounted) and in such other position as are necessary, to identify and trace the route of any cable. All power cables shall be connected to the main switchboard and other items of plant, so that the correct phase sequence and phase colour coding are presented throughout the system. All such cables shall be identified with phase colours for 3 and 4 wire systems and blue and brown for single phase. On rotating plant, where to achieve the required direction of appropriately identified terminals, then special core ferrules shall be fitted to identify each core with the terminal to which it is finally connected.

Control and instrument cables shall have individual cores identified by means of suitable permanent ferrules bearing the same numbers or letters at both ends and corresponding with terminals on equipment. Core identification shall be shown on the wiring diagrams of the equipment at which the change is made.

Numbering shall read from the terminals outwards on all cores. At those points of interconnection between wiring, where a change of number can not be avoided, double ferrules shall be provided on each wire. The change of numbering shall be shown on the wiring equipment at which the change is made.

If it is proposed to use junction boxes in auxiliary control cable circuits for the purpose of marshalling a number of cables feeding to a common item of equipment, full details shall be given to the Engineer and he shall only proceed after receipt of the Engineers written approval. Any such junction box shall be the wall-mounting pattern with double terminal with cores ferruled and identified in accordance with the system schematic and cable diagrams.

204.5 Cable Trench Work

The Contractor shall prepare drawings, showing his precise requirements for cable trench work, detailing the width and depth of trenches, utilizing the road crossing cable ducts shown in the Contract Drawings. These drawings shall be prepared in consultation with the Engineer, and be approved before issue, and be based on Contract Drawings, showing proposed cable routes.

The Contractor will carry out the excavation and backfilling of trench work. The Contractor shall be responsible for ensuring that the trench work is adequate for his requirements and in accordance with his trench work drawings.

The Contractor shall apply and lay the sand bedding, supply and lay the cables, supply and lay sand blinding, and supply and lay cable covers, he shall also supply and lay cable routes marker posts, after the backfilling and top soiling has been carried out.

The sanding and laying of cables shall satisfy the following requirements:-

- Cables shall be laid at a depth of 0.75 meter for L.V cables. The depth shall be assessed from finished ground level unless otherwise directed by the Engineer.
- Before laying cables the Contractor shall ensure that the bottom of each trench is firm and have smooth contour and free from broken stones or rock.
- 20cm of sand shall be placed in the trench to form bedding for the cables.
- Cables shall be laid with adequate separation and shall be gently 'snaked' to avoid tension during backfilling and subsequent settlement.
- The Contractor shall provide all necessary plant for the installation including feeding rollers, winches, draw-in stocking, etc and all the necessary labour.
- The Contractor shall deal with, or disport of water to prevent risk to cables and flooding of interconnected buildings.
- To this end, the Contractor shall not unduly delay of cables once a trench has been opened, and temporary sealing of building entries shall be provided by the Contractor if all cables are not laid in one session.

- Before sanding and backfilling, all laid cables shall be inspected by the Engineer.
- The Engineer, before backfilling, shall make a second inspection following sanding and tiling.
- After cables have been laid they shall be covered with a further 20cm of sand, which shall be well tamped around the cables. Mechanical punners shall not be used for this work.
- After sanding, cable covers shall be placed in position to overlap the cables by a minimum of 50mm either side of the cables.
- The Contractor shall carry out backfilling and ensure that tiles are not disturbed and that no large rocks or stones are dropped on tiles or included in the backfill material.
- After backfilling, the Contractor shall reinstate to finish ground level and provide and lay topsoil.
- There may be interval between the backfilling and top soiling. If so the Contractor shall provide temporary wooden route markers and erect these as directed by the Engineer's Representative.

The Contractor shall supply cable cover tiles. These shall be of the pre-cast concrete type, complying with DIN 4124 and engraved **ELECTRICITY** or other suitable symbol.

Cable route marker posts shall be to approve of the Engineer, and fitted with permanently engraved label showing legend.

DANGER ELECTRICITY CABLES

The appropriate voltage and danger symbol of lightning stroke, legend to be in English language.

The general routing of cables is indicated on the Contract Drawings, but the final routes shall be agreed with the Engineer before any work in connection with the cable installation is commenced. All cables shall be installed in strict accordance with the requirements of the Specification.

All single core cables of the same circuit shall be grouped in trefoil and secured.

204.6 Cable Ducts

In road crossings, pump station floors, etc, cables shall be laid protected in cable ducts, which will be PVC ducts. This specification details requirements for PVC ducts and accessories.

The latest issues of the following ASTM (American Society for Testing and Materials) and BS Standards, shall apply and be deemed to be integral parts of this specification.

PVC CABLE DUCTS

ASTM D2564-73A	Solvent
ASTM 792	Density (without filler) appr. 1.4g/cm ³
ISO R174-E	Modulus of viscosity 57-70
ASTM D1708	Modulus of elasticity 27-32000 KP/cm ²
ASTM D2240	Hardness Shore D 80-85
ASTM C2855	Joining Procedure
BS 102-C	Softening Point 81-83 ⁰ C

Tenderer applying any other standards shall include these for approval in his proposal. Tenderers shall specify fully, the PVC being used. The colour shall be grey.

The materials shall, without detriment, maintain their physical characteristics detailed in the specification throughout a temperature range of -20⁰ C to +80⁰ C.

Ducts shall be provided with nominal inside diameters of approximately 150, 100 and 50mm, with a tolerance of ± 0.2 mm.

The wall thickness shall be minimum 4.5mm for the 150mm ducts, 3.2mm for the 100mm ducts and 1.9mm for the 50mm ducts.

Straight ducts shall be provided in lengths of 6m with a socket at one end and the other end beveled on the inside and outside.

Bends shall be provided for 45⁰ and 90⁰ angles. Bends for 150 and 100mm ducts shall be provided with two bending radius, viz. 2500 and 500mm. Bends for 50 and 25mm ducts, shall have a radius of 500mm. All bends shall be provided with a socket.

O-rings of a suitable rubber shall be provided, fitting to the sockets of the different sizes of ducts. The O-ring shall give watertight seal between the two ducts being spliced together.

Plugs shall be provided for fitting in, all sizes of ducts. They shall prevent the entry of water or soil.

The PVC used shall, among others, fulfill following requirements:

- Tensile strength (3 minutes) 50-60 N/mm²
- Tensile strength, extrapolated 50 years min. 25 N/mm²
- Long-term tensile stress min. 10 N/mm²
- Compressive Strength 75 N/mm²
- Maximum total pigment and filler content 5%

Ducts and accessories shall not be stored in direct sunlight for long periods. Ducts shall be stored so that sagging or bending is avoided.

Ducts shall be clearly and indelibly marked with the following information.

- Duct diameter
- Manufacturer's code or trade mark
- Accessories may be code marked. The process of marking shall produce any notching

Tenderers shall provide full documentation, regarding installation practices for installing and splicing ducts, as well as terminating them in hand holes.

204.7 Cable Tray Work

The Contractor shall supply and erect all required cable tray work.

The following points are to be taken into account in selecting routes

- Number of drive power and control cables to be located on each cable tray;
- The avoidance of existing pipe work and pipe work required for future extensions
- The avoidance of maintenance areas of machinery, pipes, etc
- The avoidance of installation areas for the future extension to the plant,
- The avoidance of unnecessary long runs of cable.

The cable trays should be designed to take all cables, including future extension. Cable trays shall be manufactured from not less than 2.0mm thick, perforated galvanized steel, complete with approved type fixings.

Trays shall be supported by purpose made galvanized steel brackets, or channel. Brackets shall be provided at a maximum of 1,200mm centres.

Bends and tees shall be prefabricated and have an inside radius of not less than 300mm, and where large cables are to be accommodated, radius shall be sufficient to fully support correct minimum cable radius.

Cables shall be fixed to trays by means of purpose made fixing clamps. Cable ladder as opposed to tray will be accepted for large cables subject to the Engineer's approval.

All cables shall be saddled or cleated in position, as they are installed along the route.

Single core cables of the same circuit shall be laid and mounted in purpose made trefoil cleats.

Particular care should be taken on vertical rise tray, providing adequate cable fixings to ensure distribution of load and security.

204.8 Conduit Systems

Approved conduit systems shall comply with BS 31 (for rigid steel conduit and fittings), BS 4568 (for rigid steel conduits with metric threads) or BS 731 Part 1 (for flexible steel conduit and adaptors), as appropriate. All conduit and fittings shall be hot dip galvanized. Conduits shall be fixed to the surface of the wall or concealed in the floor screed when they cross the floor.

Non-metallic conduit systems shall not be used without the written permission of the Engineer. Conduit shall be run on the surface or sunk as specified and be neatly arranged and ways shall be provided for additional conduits at all distribution boards. The size of conduits used shall be determined by the number of cables to be drawn in, as scheduled in the IEC regulations or as specified for a particular position, but in no case shall conduits smaller than 20mm diameter be used. Sunk and concealed conduit system shall support fittings independently of any false ceiling.

All conduits shall be installed in an approved manner and arranged with adequate ventilation and drainage where necessary. Where practicable, all bends or sets shall be formed in the conduit itself. Inaccessible junction boxes shall not be used. The radius of bends shall not be less than that given in the latest IEC wiring regulations.

The whole of the conduit system shall be completely swabbed through, to remove any loose matter or dirt, before cables are drawn in. Where conduits connect to switch boxes, draw-in boxes, etc, the conduits must have a machined faced socket screwed onto the end which, when tightened is flush with the outside of the box. The conduit is then to be secured to the apparatus by means of a hexagon smooth bore brass bush screwed from the inside of the apparatus into the conduit socket, in order to make a sound and tight mechanical joint.

Surface run conduits shall be supported at intervals in accordance with the following schedule:-

Size	Interval
20mm	1.2m
25mm	2.0m
32mm	2.5m

Where bends and sets occur in the conduit run, the conduit shall be securely fastened at a distance of 225mm either side of the diversion.

Standard junction or adaptable boxes shall be provided at all junctions and at sharp changes of direction in addition to any special positions where the Engineer calls them for.

Only continuous lengths of buried conduit shall be installed between boxes, no joint boxes being allowed in the floor screeds. Conduit crossing expansion joints shall be fitted with couplings of approved manufacturer with an earthing clip at each side of the coupling connected by the correct size of tinned copper stranded wire.

The ends of conduit laid or set in formwork, prior to concreting shall be temporarily sealed off, with a coupler and a solid brass plug.

No conduit shall be installed on the exterior surface of buildings without the written approval of the Engineer. All exterior fittings shall be suitable for rear access.

Fixing to surfaces of walls shall be by means of spacer bar saddles, securely fixed by screws. Where conduits are concealed or laid in construction floors, they shall be held in position with substantial fixings of make and pattern to be approved by the Engineer.

Conduit shall be of the screwed pattern, galvanized by the hot process. All conduit fittings not carrying accessories shall be supplied with flat covers, fixed in position with round head brass screws. Neoprene gaskets shall be supplied on all fittings.

Adaptable boxes shall be constructed of minimum 3 millimeters sheet steel or best quality cast iron, finished as previously detailed for conduit boxes and sized to prevent the undue packing of cables in them.

Weatherproof boxes and accessories shall be used outdoors and, where indicated in the Specifications or drawings.

Conduit shall be installed such as to permit complete rewiring, without the need to carry out builders works. No single conduit serving single phase socket outlets, lighting points and switches shall contain more than one phase.

Wiring shall be carried out on the looping-in system and no joints other than at looping-in points will be allowed.

204.9 Flexible Conduit

Where the conduit system terminates at any equipment requiring a non-rigid connection a flexible earth conductor shall be run within the conduit, connected to the earth terminates in the equipment and the fixed conduit run. The flexible conduit shall not be used as an earth continuity conductors.

Each flexible connection shall include not less than 400mm length of flexible conduit, and a separate earth conductor shall be unaffected by sunlight or water, connected to the earth terminals in the equipment and the fixed conduit run. The flexible conduit shall not be used as an earth continuity conductor.

204.10 Cable Trunking

The trunking shall be manufactured from heavy duty rigid unplasticised PVC, which shall be self extinguishing and shall be unaffected by sunlight or water. The material shall be suitable for continuous ambient temperatures of 65°C. Each length shall be supplied with the necessary connection sleeves and shall have joggled sides to allow flush fitting.

The length trunking shall be complete, with purpose made angle, and set accessories designed to afford easy installation of and to avoid tight right angle bends in the circuit cables installed in the trunking. All trunking accessories shall be complete with removable covers. No site made mitred joints is allowed.

Where cable trunking is installed in vertical runs, efficient circuit cable clamps are to be installed at not greater than 500mm intervals.

The complete trunking system shall be electrically continuous and each length of trunking shall be bonded to the next or adjacent length and to equipment by an efficient copper bonding strip and brass screws, nut and scraping pattern washer.

All trunking shall be of adequate size to suit the number of cables passing through it but, as a minimum, the size should be 50mm by 50mm. all bends, tees and intersections to be of the gusset type and manufactured by the maker of the trunking and to similar standard. The trunking shall be fixed to the walls and ceilings by means of a secure and permanent fastening to be approved by the Engineer.

204.11 Socket Outlets

Socket outlets for installation throughout the works covered by this Specification, shall all be of the waterproof corrosion resistant type, and shall generally be mounted 1.30m above floor level as follows:-

- 25 Volt, 5A, 2 pin + earth, socket outlets complying with IEC 309-2/81, colour coded and complete, with matching colour coded plugs.
- 250 Volt, 16 A, 2 circular pin + earth, socket outlets. Indoor locations such as store room, bathroom and office shall have non-corrodible metal face. All socket outlets to be wired as part of ring main system and supplied with matching plug all to comply with IEC 309-2/81.
- 380 Volt, 30 A, TP & N and E, not switched nor mechanically interlocked. Each socket outlet shall be supplied via current operated earth leakage circuit breaker mounted within the distribution section of local switchgear/motor control/distribution panel. All socket outlets to be as part of ring main system and supplied with matching plug all to comply with IEC 309-2/81.

204.12 Lighting Switches

Surface switches shall be of the ironclad protected pattern heavily galvanized, type. Where appropriate, they shall be of the “multiple phase” type and where possible be arranged in multi-gang boxes.

Exterior lighting switches shall be metal clad galvanized watertight with rotary switch action. Rear entry shall be provided to allow concealed conduit installations.

Switches employed in the Control room shall be suitable for flush mounting and shall comply with IEC 364-3-1. Moulded, white finish, rocker operated.

Switches in damp areas or for external use shall be heavy-duty surface pattern.

Special care shall be taken to ensure that all switches are securely fixed, truly vertical, and that flush mounted switches are flush with the wall finish so that the overlapping cover plates seat on to the rims of the boxes.

Switches shall be mounted at 1.30 m from floor level and be of heavy-duty type.

Not more than 8 Nos. fluorescent light fittings (16Nos of tubes) shall be connected to any 10 amp lighting switch. Lighting fittings shall be distributed evenly between phases and throughout that loss of any one phase or conductor does not leave any area in total darkness.

Operating switches and contactor energizing coils shall also be distributed between phases.

204.13 Lighting Fittings

Lighting fittings shall be complete with all supports, suspensions, flexible cables, pendants and plugs. They shall be connected to the main circuit wiring with heat resistant flexible cables of a minimum conductor size of 1.5mm², insulated with silicon rubber.

Break joint rings shall be used in conjunction with batten holders ceiling roses or back plates mounted on to a flush installation.

The earthing of all pendant or semi-pendant fittings shall be by a separate core in the connection flex or cable securely bonding the earth terminal on the fittings to the landed joint of interconnecting cables. In no case shall pendant chains or conduit support tube be used as a means of earthing.

Standard fluorescent lighting fittings shall have two suspension or fixing points.

All lamp holders for flexible pendants shall be of the all insulated shirted pattern with cord grips and for batten or wall mounting shall be of similar pattern. All lamp holders shall be the screw cap pattern.

The point box suspensions and other parts of the lighting fittings shall be erected at times to suit the building programme for decoration. The glassware diffusers, shades, lamps and tubes shall not be fitted until all construction work is completed.

All fittings shall be left clean inside and outside, ready for use. All fluorescent fittings shall be suited for instant start irrespective of any catalogue or list numbers quoted.

All fluorescent tubes shall be of an approved manufacture with metal coil filaments gas filled pearl in all standard sizes with standard caps to suit the fittings in which they are installed.

The Contractor shall supply and install all lamps for the entire lighting fittings installation and shall replace all burned out lamps up to the time that the Purchaser takes final acceptance of the Works.

Construction of the fittings shall be suitable for the site climate conditions.

204.14 HPL Light Fittings

The light fittings shall consist of a high-pressure die cast aluminium control gear housing and spun aluminium reflector and designed to operate 2.50 W mercury vapour elliptical lamps. The enclosed reflector shall be of Class protection IP54 and control gear compartment of IP65.

The reflector is mounted onto the control gear housing via two key hole slots and is separated from the control gear housing by means of a 3 mm thick asbestos heat shield that restricts heat transfer from the lamp to the control gear compartment. The reflector neck has five large punched holes to provide an up light component and ensure a cool ambient temperature at the lamp holder. The open version is to be considered.

The lamp holder shall be rated to withstand not less than 240⁰C/5 KV and prevents loosening of the lamp caused by vibrations.

The control holder shall be suitable for operation with the specified rating of the lamp, on a 230 V+3%/-10%, 50Hz, single phase system. All control gear components shall be removable.

All internal wiring shall be specifically coated with protective sleeving to prevent damage by possible abrasion.

Ignition shall be of the superposed pulse type and, the light fitting shall be power factor correction to a minimum of 0.85.

204.15 Emergency Lighting

Emergency light fittings shall be designed to provide a level of illumination under mains failure in compliance with IEC 598-2-22.

Emergency lighting fittings shall be self-contained, incorporating lamp(s), battery charger and mains failure relay.

The fittings shall be fully automatic in operation, providing instant illumination in the event of mains failure. The battery shall be automatically recharged when the main supply is restored.

205 EARTHING

205.1 General for Earthing

The metal framework of all electrical and associated equipment, metal enclosures and associated screenings, supports, any other metalwork that is nor normally used to conduit electricity, shall be effectively earthed at all times. Particular care shall be taken where moving parts are involved that they are earthed in any normal position e.g circuit breaker carriage, cubicle or substation door.

205.2 Earthing Systems

The earthing system shall comply with the requirements of IEC Publication 364-1-54. earth tapes on 11KV plant shall comprise a minimum of 50mmx6mm copper tape and on 380 V equipment 38mmx5mm copper tape.

The non-current carrying metal of electrical equipment provided under the Contract shall be securely bonded to earth. Earthing shall be effected by means of the metal sheath of cables, which shall be securely bonded to the metalwork of the apparatus concerned at each end or a separate each conductor. A separate earth conductor shall be provided for all items of plant rated 20kW or greater.

Armour wires on main cables shall be solidly bonded as additional earth but, cables from the standby generators shall be insulated from the main earth system. Particular care shall be taken on cable termination boxes bonded to the associated item of plant. If continuity is adequate, copper connections shall be made between the apparatus frame and the cable sheath.

Where the cable sheath and armour is used as the earth path return, then it shall be established that the resistance is less than 1.0 . if not, a separate copper earth conductor shall be installed.

Particular care shall be taken to ensure earth continuity across items of equipment situated within a cable run and should the design of such equipment not give adequate and lasting continuity through its structural body, then additional earthing clips and conductors shall be

provided to independently bond the cable sheaths to any piece of apparatus fitted with a special earth terminal, should the earth connection of the termination gland prove inadequate. Any additional earthing clips shall be contained within the apparatus wherever possible.

The earth tapes shall be protected against corrosion and be complete with test links and be run on walls held in position by saddles fixed by rawl plugs and screws.

Connection shall be sweated and riveted and shall be electrically and mechanically continuous. Joints between the main conductor and the earth electrodes shall be readily accessible for periodic inspection and shall be protected against damage and corrosion.

Where rigid or flexible conduit and/or trunking is incorporated into the works, a separate internal earth conductor shall be run which shall be securely bonded to the terminating apparatus by means of a special earth terminal.

The earth electrode system shall consist of two electrode beds or nest independently arranged and, each comprising a system of vertically mounted rods.

On completion of the earth installation the Contractor shall demonstrate to the Engineer that the resistance of the electrodes and the earth network is within the specified limits. The Contractor shall supply test equipment.

205.3 Earthing Nests

Each nest shall comprise of a number of interconnected earth rods, 25mm in diameter by 2.0m long, driven vertically into the ground at intervals of not less than 3.0m apart with heads located at a depth to suit disconnecting chamber position.

Earth rods shall be copper or steel cored with a metallic bonded copper outer surface. Rods shall be provided with special hardened tips and caps, to avoid distortion when connecting the rod to the copper strip.

Leads from each electrode shall be brought to concrete disconnecting lid for test purposes shall be provided over each earth rod. The top of chamber shall be at finished ground level.

The test link shall be of copper and not be less than the connecting cables cross sectional area and have a generous contact area. Disconnecting bolts, nuts, locknuts and washers shall be made from phosphor bronze.

The copper strip connecting the earth rods to the test link shall be exothermically welded at the test link and sweated to the top of the earth rod.

The earth rod interconnections shall be an electrically unbroken ring and interconnections shall be PVC insulated stranded copper conductor earthing cable, sweated to the test links. The cable shall be of sufficient low resistance to carry the maximum fault current for a period equivalent to the clearing time of the protective equipment without undue temperature rise. Joints at the head of the earth rods shall be easily accessible for periodic inspection.

Earth nests shall be connected to their station associated earthing system by 2 Nos. PVC insulated stranded copper conductor earthing cables. The cable shall be sweated to opposite ends of the earth nest and two different spaced points on the station earthing system.

The earthing system shall be protected against damage by corrosion wherever necessary.

205.4 Location of Nests

An earth nest shall be installed at substations where such forms part of this contract. Earth nests shall be located adjacent to the building housing the switchgear as practical. Where two nests are specified, they shall be located at opposite ends of the system.

205.5 Battery units

A battery and charger set shall be housed in a single sheet steel floor mounted ventilated cabinet, with batteries housed in the lower part of the cubicle.

The unit shall be complete with a self-adjusting constant potential, trickle charger suitable for operating from 240 Volt single-phase AC supply. The charger shall be rated to continuously energize relay coils and lamps as applicable. The charger shall be designed to maintain a constant voltage with $\pm 3\%$ irrespective of mains voltage or frequency variation. Booster charge facilities shall be included. The unit shall be fitted with the following.

1 No.	Supply "NO" Indicating Lamp
1 No.	"ON/OFF" Switch
1 No.	Charger Ammeter
1 No.	"OFF/FLOAT/BOOST" Switch
1 No.	Charger Failure Alarm Relay and Lamp
1 Set	Cable Terminals and Fuses

All battery cells shall be Nickel Cadmium structure with a alkaline electrolyte and a metal or plastic case.

Batteries shall be of suitable ampere-hour capacity to operate the closing and tripping coils or motor of the circuit breakers. Dual duty batteries i.e engine starting and tipping for circuit breakers will not be acceptable.

Voltage of battery/charger sets shall be 24 V as appropriate to application. One set shall supply equipment at a single voltage.

206. PUMPING, LIFTING AND MECHANICAL EQUIPMENT

206.1 Applicability

The following clauses specify general requirements and standards of workmanship for the equipment and all installations. General specification clauses shall apply where appropriate except where particularly redefined in the individual specification clauses.

The Contractors rates for mechanical pumping/lifting equipment shall be deemed to include but not necessarily be limited to the complete design, selection, supply, delivery, installation and commissioning of all equipment related to.

206.2 Installation Standards

The work shall be executed in a neat and workmanlike manner. All work shall be carried out in accordance with the requirements of:-

- Regulations in force in Kenya, where applicable;
- Relevant DIN specifications

206.3 Pump Construction

Major pump components shall be of Cast Iron GG 25 DIN 1691 with smooth surface, the shaft being of stainless steel.

All exposed nuts, bolts and washers shall be of AISI type 304 stainless steel or better. All metal surfaces coming in contact with the pumped liquid, other than stainless steel or brass, shall be protected by a factory-applied spray coating of alkyd primer with oxiranesther paint finish on the exteriore of the pump. Pump exterior shall be sprayed with PVC epoxy primer with choleric rubber paint finish.

All mating surfaces where watertight sealing is required shall be machined and fitted with nitrile rubber O-rings. N secondary sealing compounds, rectangular gaskets, elliptical O-dng grease or the like, shall be used.

The impeller shall be of grey cast iron (ASTM A-48 Class 356), hydro-dynamically balanced, double shrouded, non-clogging design, having a long passage without acute turns. The vibration shall be minimized.

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 stationery and made of brass or rubber-clad steel frame drive fitted to the volute inlet.

The pumps shall be capable of continuous vibration, free running when operating over the complete range of flows, and be designed to provide a continuous failing head/quantity characteristic for stable parallel operation. The NPSH (net positive sanction head) required shall

be compatible with that available to enable it to operate without cavitation over the full range of flows at all sump liquid levels.

The pumps shall be capable of working for long periods, without cleaning or, attention and special precaution shall be taken to avoid wear on working surface due to grit and shall be designed such that there is no tendency to unlock any part due to a possible reversal of rotation.

206.4 Motors

The pumps motors shall be in accordance to the IEC requirements for dry installed motors. All motors shall be tropically insulated with class F insulation. The motor shall be designed for continuous duty, capable of sustaining a minimum of ten (10) starts per hour.

The full load output of the motors shall be at least 20% in excess of the maximum power absorbed by the pumps through its working range. The rating shall be in accordance with IEC standards. The limits of temperature rise shall also follow these specifications. The maximum temperature of the surrounding medium is assumed to be 45°C. The speed of the motors shall not exceed 1,500 rpm.

Starting mode up to 7kW direct Online, more than 7kW Star-Delta Starter. Over 100 kWh, high voltage supply and Direct online starting. If high voltage supply is not available, Star Delta Starter shall be used. Each unit shall be provided with an adequately designed cooling system.

Thermal sensors shall be used to monitor stator temperatures. The stator shall be equipped with three (3) thermal switches, embedded in the coils of the stator winding (one switch in each stator phase). These shall be used in conjunction with and supplemental to external motor over current protection and wired to the control panel.

The pump/motor shaft shall rotate on two permanently grease lubricated bearings.

206.5 Mechanical Seal

Each pump shall be provided with a tandem mechanical shaft seal system consisting of two independent seal assemblies. The seal 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 oil chamber, shall contain one stationery and one positively driven rotating corrosion resistant tungsten carbide ring. The upper secondary seal unit, located between the oil chamber and the motor housing shall contain one stationery ceramic seal ring and one positively driven rotating carbon 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 neither be considered acceptable, nor equal to the dual independent seal specified.

The seal cavity for the outer seal shall be equipped with means for wear reduction such as, spiral grooves for particle removal. 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. The motor shall be able to run dry without damage while pumping under load.

206.6 Oil

The oil chamber shall be filled with a medical white oil paraffin type. The oil shall be free from aromatic hydrocarbons, medically clean and be approved according to FDA 172.878. An oil level indicator to control the oil shall be incorporated.

206.7 Protection Against Surge

At the main pumping station, it may be necessary to provide surge suppression to avoid separation of the water column during sudden shut-down when pumps are working to ensure that the maximum pressure and sub-atmospheric pressure are within the working pressure ratings of the pumping main, pumps and stations fittings at all times.

The Contractor shall calculate the water hammer and propose the size of the surge vessel at the main pumping station, if any. The calculation is part of the contract and has to be submitted to the Engineer prior to designing the surge protection equipment.

The surge vessel, if any, shall be out of double hot dip galvanized steel on three stand legs, vertical type, with all necessary safety device.

The water level shall be controlled outside by magnetic contacts, two for max. and min. level and two for max. and min. level alarm.

The air compressor is designed for the volume and pressure of each station. The max. pressure shall be 3 times the operation pressure. The flow capacity shall be vessel volume per hour under operation pressure condition.

The electrical panels are according to the specification and shall include acoustic alarm. All pipes and valves necessary to put the system into operation must be included.

206.8 Pump control

The pumps shall operate sensor controlled, according to the levels indicated in the Drawings. Float control will not be accepted.

206.9 Characteristic Curves

Characteristic and system curves for all pumps shall be supplied to a reasonably large scale which shall show the capacity of the pumps under single and multi pump operation at the duty point and with the sump at maximum and minimum levels.

When tested through their complete range of workable heads at the manufacturer's works all pumps shall give results, which conform to the Curves submitted with the Tender.

206.10 Piping

The contract comprises, supply and installation of all necessary pipes and valves for the station. These shall include delivery pipes for each pump and the manifold complete with branches. The pressure the piping to withstand shall be not less than 10 bars.

The delivery pipe shall be provided with a non-return valve, a sluice valve and a dismantling piece.

The internal wet well piping shall be according to DIN 1629/DIN 2448. The radius of the bends is 1.5N.

All flanges according to BS4504 and pressure class PN16.

The wall-passing piece shall be ductile iron with factory welded puddle flange and shall be installed during the concrete casting. The wall-passing piece has to be vertically and horizontally exactly leveled. The pipes and fittings shall be galvanized as specified after finished welding.

Direct contact with unprotected iron during transportation lifting and installation is not permitted.

The wall passing piece pipe with puddle flange is part of the civil works, but the Contractor for the internal pipe work has to connect the pipes inside the valve chamber. The Contractor for the pipelines to carry out the connection outside the valve chamber.

The pipe work shall be sized such that nowhere in the system the velocity exceeds 2.50 meters per second at the rated output.

206.11 Pressure Gauges

Pressure and compound gauges shall be fitted to delivery branches of each pump. All gauges shall have concentric dials of 150mm diameter, pressure gauges being graduated in meters head and compound gauges graduated in meters. Gauges graduations shall be such that the gauge is not used continuously beyond 70% of the maximum graduation. The gauges shall have two electrical contacts, adjustable to set min./max. alarm.

The face shall have a warning label marked in red in English.

IMPORTANT – TURN OFF WHEN NOT IN USE

Gauge shall be fitted with isolating valves.

Before delivery, each gauge shall be accurately tested, and a test certificate shall be submitted to the English.

206.12 Air Valves

Double acting air release and vent valve, including drain valve, air blow off elbow, cleaning connector, all suitable for installation in raw water pipes. The Contractor shall calculate the air in and out flow capacity. Test pressure to be 1.5PN operation pressure PN 10.

Material

Body-bonnet	Ductile iron
Floats	Synthetic rubber coated steel
Stem	Stainless steel
Bolts and nuts	Stainless steel

Coating	Vinyl paint
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206.13 Non-Return Valves

Ball closing type, special for raw water. Inside without pockets and self cleaning out lining. Test pressure 15PN, operation pressure PN 10, measurement according to DIN 3202.

House cover	Ductile iron
Protection	Epoxy inside and outside
Seal	NBR
Ball	Alumium/GG25
Bolts and nuts	Stainless steel

206.14 Sluice Valves

For water according to DIN 3352 part 4 and DIN 3202 Part 4 for RN 10 including hand wheels, installation material and shaft protection. Factory tests DIN 3230 part 4 with test pressure 1.5PN, operation pressure PN 10.

Materials

Housing and Top	Ductile iron
Protection	Epoxy inside and outside
Spindle	Stainless steel DIN x 20 Cr13
Chamber ring	2 inch free alloy CZ 132
Gate	Ductile iron
Bolts and nuts	Stainless steel, DIN ISO 3502

206.15 Butterfly Valves

Materials

Body and plates	Cast iron
Seal/Seat	E.P.D.M
Internal bolts and shaft	Stainless steel
External bolts	Carbon steel
Bearings	Self lubricated
Connection	Flat face

206.16 Dismantling Pieces

Materials

Body	Galvanized steel
Seal	NBR or Polythene, EPDM acc. BS 2494
Bolts and nuts	Stainless steel
Protection	Rilsan Nylon 11 or Epoxy 250 thickness
Bearings	Self lubricated

206.17 Compressor Station for Filter Backwashing

One set of two identical rotor type blowers for filter backwashing feeding into the discharge main of the backwash water pumps.

Each unit shall be equipped with inlet silencer with integrated filter, easy to clean. The rotor blower shall be driven by a self tensioning V-belt drive. The discharge line shall be equipped with an integrated silencer, unloaded start valve and a pressure relief valve to protect against excessive pressure.

The discharge shall be in accordance with ISO 1217, 1996, Annex C. The compressed air shall be cooled in an after cooler to ambient temperature (+10°C) by an air/air heat exchanger.

The units to be complete, with control switchboard, start/stop button, shall be based on a timer, operation, according to the requirements and recommendation by the filter manufacturer for the combined air/water backwash cycle.

Key information is listed hereunder.

	Input Data	Datum	Unit	Notes
1	Media	-	-	Air
2	Installation	-	-	Dry together with pumps for backwashing filter and internal demand pump station.
3	Operation	-	-	Switch operation
4	Temperature	50	°C	Max. temp. of media in degrees Celsius
5	Qp	60	m ³ /min	Air flow rate.
6	P out	1.0	bar	Delivery pressure

206.18 Lifting Equipment

The Contractor shall design, supply, install and commission for a period as specified the lifting equipment as required under this contract. The span to be considered and the lifting capacity shall be as indicated on the Drawings and bills of quantities.

Design of the crane structure as well as components parts of the crane, shall conform to class 1 duty and shall be as follows:-

Bridge	Standard 1 beams of MS rolled steel sections, bolted to end carriages.
End Carriage	Box type in construction and fabricated from rolled sections
L.T. Wheels	2Nos. straight tread type En8 forged steel, double flanged. Provided in each of the two end carriage.
Pinion/axle	Made from En9, heat treated carbon alloy steel
Gears	Made from En8 and supported on ball bearings
Bearings	Heavy duty sealed ball. Two ball bearings are provided in each wheel for smooth running.
Hook	Made from forged steel-C20, C30 or equivalent. Collar or shank type, with safety latch.
Hoist	Chain pulleyblock with triple spur gear and friction disc brake. Load chain

	wheel made of heavy duty SGI casting with accurately cast chain pockets and mounted on two ball bearings for smooth operation. Bottom block of heavy duty malleable casting.
Load chain	Grade 0 alloy steel
Hand chain	Grade 30 M.S chain

207 TRANSFORMER AND SWITCHGEAR

207.1 General

The transformer shall meet or exceed the requirements of IEC standards 76, 137, 354, 404 and 606 and shall be complete with a first filling of oil, which shall comply with IEC 296.

The windings shall be connected delta-star with group 4 phase displacement primary to secondary vector group reference DY11 (plus 30°) with the star point of the LV winding brought out through the tank and suitably terminated for solid earthing.

The impedance value of low voltage shall be 4% to 6%. The windings shall be rated as specified with a voltage ratio of 11 kV to 3 kV on load. Insulation shall be Class F but, the windings shall be designated for a Class B temperature rise and suitable for operation under the prevailing climatic site conditions.

The high voltage windings shall be provided with tappings at +5%, +2.5%, -2.5%, -5% with constant flux voltage variation as defined in IEC standards.

Tap selection shall be by means of an external operated manual control off-circuit tapping switch. A mechanical tap position indicator shall be provided and the switch shall be padlockable in any position.

The tap changing switch shall be located below the oil level inside the tank and the switch operating rod shall extend outside the tank.

The core shall be constructed from cold rolled steel laminations manufactured to IEC standard. The lamination shall be insulated from each other by means of a suitable temperature resistant oil proof coating.

The windings design and construction shall provide adequately designed and located, coolant flow ducts so that possible hot spots are eliminated. Windings shall be braced to withstand dynamic stresses due to short circuit conditions. The core and winding shall be designed so that the iron loss is at a minimum but the ratio of copper loss to iron loss shall be in accordance with an economic design and the manufacturer shall state the ratio used.

The arrangement of internal connections shall be such that the transformer core and winding may be lifted bodily from the tank shall enable it to be handled whilst filled with oil and shall be pressure tested to 0.1 N/mm²

The windings shall be thoroughly dried out under vacuum at the manufacturer's works and shall be delivered to site filled with oil to the normal level and ready for service.

All necessary protection relays and associated devices shall be provided and all switchboard relays shall be of the withdrawable pattern and complete with dustproof cases.

The transformer shall be provided with external cooling tubes to provide natural cooling under the site temperature and climate conditions.

All terminals shall be brought out through oil tight insulating glands into respective disconnecting terminal chambers to facilitate cable testing.

An MV compound filled cable sealing box, suitable for terminating the incoming 11 kV XLPE/PVC cable shall be provided. The cable sealing box shall comply with the requirements of IEC standards and necessary compound shall be included in the price of the tender.

An MV compound filled cable sealing box, suitable for terminating the incoming 3 kV XLPE/PVC cable shall be provided.

The transformer shall be of non-breathing, hermetically sealed type.

The transformer covers shall be of such construction as will prevent the accumulation of moisture and shall be bolted to a flange on the tank top of form a weatherproof seal. All gaskets shall be of synthetic rubber and cork composition.

The design and construction of the transformer core winding and tank, shall ensure that the noise level at full load is kept to the minimum commensurate with economic design. The tank shall be reinforced or braced where necessary, to reduce the noise levels.

All windings, winding terminals and connections shall be fully immersed in oil under all operating conditions. All joints shall be arranged such that they may be tightened externally. Oil level gauge shall be clearly visible from ground level. Explosion vent with glass or bakelised paper diaphragm shall be fitted.

Thermometer and 'Buchholz' relays shall be provided, each with alarm and tapping contacts including all accessories required for mounting into the relevant switchgear panels.

Rating and diagram plate (to comply with IEC standard) shall be engraved and of a durable and non-corrodible materials.

207.2 Transformer Requirements

The scope of work and supply shall include mounting of the transformers in a package substation cabinet. The transformers shall be furnished, erected and connected ready for operation. The transformer shall conform to the general description and shall be provided with the following additional equipment.

1 No.	MV 12 kV cable XLPE/PVC sealing box to receive the incoming 11 kV power supply from the medium voltage ring main unit.
1 No.	Oil conservation, including air breakers, drain valve and oil level gauge
1 No.	Free thermometer pocket
1 No.	Dial thermometer
1 No.	Drain valve
1 No.	Safety valve
1 No.	Buchholz type relay, double float alarm and tripping
2 Nos.	Earthing terminals
1 No.	Offload tap changer
4 Nos.	Lifting lugs

207.3 Tests

The transformer shall be tested in accordance with the relevant clauses in Section 3 to IEC standards.

207.4 Finish

All transformer tanks, tubes and all steelworks shall be shot blasted internally and externally before painting and a anti-corrosion paint shall e applied to both external and internal surface before applying a final finish. The exterior shall be given an additional coat on site of a durable oil and weather resisting paint in DIN specification to the shade to be specified by the Engineer.

208 TEST INSTRUCTIONS AND COMMISSIONING

This part covers the Test International and Commissioning of the works, material and plants. The Instructions are in accordance with the stated in “**CONDITIONS OF CONTRACT FOR ELECTRICAL AND MECHANICAL WORKS, including ERECTION ON SITE**” – Third Edition 1987, Reprinted 1988 – FIDIC. Particulars are in accordance with the Technical Specifications defined under this Contract.

208.1 Works Testing and Inspection Costs

The Engineer shall be provided with the facility for inspection of all equipment and material and shall be given at least 14 days notice when such equipment or material is ready fro inspection or for works test.

No equipment or material shall be dispatched from the manufacturer works without the written permission of the Engineer.

Full details of the method of testing proposed for each item shall be submitted with the Tender.

The Bill of Quantities shall include for the costs of all works tests, including temporary erection, labour, materials, instrumentation, stores, fuel and power used as may be required during all inspections and tests together with all accommodation and traveling expenses incurred by inspectors for the provision of certified records and curves.

208.2 Test Instruments

The manufacturer shall satisfy the Engineer of the accuracy of all instruments used for the tests and if required shall produce recent calibration tests, or otherwise have them calibrated at his own expense by an independent authority.

KWh meters shall be checked for correct rotation, creep test shall be carried out to ensure that the meter is inoperative with voltage alone, if the secondary of the current transformers is left connected with the primary current interrupted.

208.3 Test Certificates

Test Certificates shall be provided, giving detailed records of all electrical and mechanical tests carried out on the equipment and materials including substations, transformers, switchgears, pump sets, lifting equipment, tanks, pressure vessels, cables and cabling both in the manufacturer's works and at site.

Copies of Certificates of all hydraulic works tests shall be provided.

The Contractor shall obtain and submit to the Engineer and to other parties as may be directed, certificates of test of all items, certifying that they have been satisfactorily tested and describing and giving full particulars of such tests.

Copies of test certificates of major items shall be included in the operating and maintenance instructions.

208.4 Hydraulic Works Test

All equipment subject to water pressure including pumps, pipes, fittings and valves shall be hydraulically tested to the pressure specified or to at least 1.5 times the maximum working pressure.

The testing of diesel fuel bulk storage tanks is covered in Clause 208.15. Certificates of tests re-test and notice of testing dates shall be submitted to the Engineer.

208.5 Works Inspection Tests and Guarantees

All the schedules of particulars shall be completed with the guaranteed particulars and efficiencies of the equipment offered at the duties specified. These will be binding and may not be varied except with the written consent of the Engineer.

All proving tests of electrical equipment shall be in accordance with guaranteed technical data for an ambient temperature of 45°C.

Full witness testing to the relevant standards and to prove guarantees given will be required for the following items:-

- Substations
- Transformers
- Electrical Motors
- Cables
- Switchboards
- Control Panels
- All pumps
- Valves
- Compressors
- Pressure Switches and Gauges
- Lifting Equipment.

In addition, all other items of equipment not subject to witness testing shall be temporarily erected at the Manufacturer's works and tested for satisfactory operation and shall be offered

for inspection. Copies of manufacturer's test readings shall be submitted to the Engineer, all prior to packing for shipment.

Such inspection, examination, or testing shall not release the Contractor, manufacturer or supplier of any item any obligation.

Certified copies of manufacturer's test readings of all items shall be submitted to the Engineer.

Whilst the Engineer shall be provided with facilities for witness testing and/or inspection of all items of equipment at the manufacturer's works he may at his discretion advise that the tests shall proceed, in his absence. The tests shall be made as if in his presence and duly certified copies of test readings shall be submitted.

Where items of equipment are of identical size and duty, it may be required at the Engineers discretion that a reduced number of the items be subject to witness tests. However, this shall not relieve the manufacturer from the requirement of carrying out the performance tests on all items prior to offering for witness testing.

If during inspecting, examining or testing any material or equipment, such items or any parts thereof are defective or not in accordance with the specifications of performance requirements, he may reject the said items or part thereof, giving the manufacturer within a reasonable time notice in writing of such rejection, stating therein the grounds upon which the said decision is based. All retesting shall be at manufacturer's expenses.

208.6 Pumps

The witnessed test shall obtain the guarantees of pump delivery, head, kW input, overall efficiency and other figures in accordance with the guarantees given in the schedule of particulars and shall satisfy the inspector as to the mechanical reliability of the plant and its capability of fulfilling the whole of the conditions. The guarantee duty is subject to a tolerance of +9.5%.

It is preferable that the pumps be tested with their own motors, but if this is not attainable, the pumps shall be tested in conjunction with the pump manufacturer's standard or calibrated motor but, the manufacturer shall satisfy the Engineer as to the performance of the test motor, so that the kW absorbed by the pumps may be accurately determined. It shall be stated in the Tender the type of apparatus available for testing at the works of the pump manufacturer and shall give particulars as to the method of measuring the pump discharge.

208.7 Motors

Pump motors shall be subject to full performance tests, which shall be witnessed by the Engineer at the motor manufacturer works. 5.5 kW to 22 kW site rating shall be subject to performance test unwitnessed. Motors under 5.5 kW site rating shall be subject to type test standards.

Motor tests will be carried out in accordance with the requirements of BS 4999 as applicable. The test shall obtain the overall efficiency and other figures in accordance with the guarantees given in the schedule of particulars. Test Certificates, as Clause 208.3 shall be provided for all sized motors.

208.8 Alternator

All alternators shall be separately tested in conformity with BS 4999 to verify the details given in the schedule of particulars to ascertain efficiency and characteristics by means of an input/output test, the alternator being driven by an AC or DC prime move and the input current shall be measured and monitored against the output of the alternator.

In establishing the efficiency of the alternator, the Engineer shall be satisfied as to the performance of the test motor and recent test performance figures shall be produced. Test Certificates as clause 2089.3 shall be provided.

208.9 Diesel engine

All engines shall be separately witness tested to BS 649 at the manufacturers works and the fuel oil, gas and lubricating oil consumption shall conform to and verify the figures given in the schedule of particulars. Test certificates as Clause 208.3 shall be provided.

208.10 Diesel Alternative Set

After individual testing and mounting on bedplate, aligning and completing with all fittings and accessories, complete diesel alternator sets shall be offered for inspection and equipment operation tests run and, shall not be packed or dispatch without permission of the Engineer.

208.11 Control Panels

The whole of the switch and control gear shall be witness tested as integral units for a complete sequence of operation and as laid down in BS 587 and based on the on the completeness of the circuits in the final manufactured font, within the manufacturers works. The following tests shall be carried out.

208.12 Circuit Breakers

All circuit breakers shall be subject to the following tests.

- Routine tests including HV pressure test, mV drop tests and mechanical tests
- To ensure the operation of the DC closing coil ad satisfaction, closing of the circuit breaker with the voltage on the coil down to 80% of its rated voltage and that maloperation does not occur with a voltage on the coil of 12% of its rated voltage.
- To ensure that satisfactory trip operation of the circuit breaker occurs at no load conditions with the trip coil energized at 50% of its rated voltage.
- Interchangeability of withdrawable identically equipped circuit breakers, checking of all mechanical and electrical interlocks.

- Type test figures for heat test runs performed on identical panel types shall be made available.

208.13 Transformers

The transformers shall be witness works routine tested including the following:-

- Measurement of winding resistance
- Polarity and phase relationship
- Impedance Voltage
- Load losses
- No load losses and no-load current
- Insulation resistance
- Induced over voltage withstand
- Separate source voltage withstand
- Type Test Certificates shall be provided for the following
- Impulse voltage withstand
- Temperature rise

208.14 Lifting Equipment

All lifting equipment shall be witness tested at the manufacturers works to 25% above the rated load and test certificates shall be provided.

208.15 Fuel Tanks

Prior to the dispatch of the tank from the manufacturers works, the diesel fuel bulk storage tank shall be tested hydraulically to a sustained pressure of 0.7 N/mm^2 to ensure that the tank is sound and shows no leaks or distortions. Test certificates shall be provided.

Engine day tanks shall be hydraulically tested to a sustained pressure of 0.4 M/mm^2 and test certificates shall be provided.

208.16 Cables

All HV cables and armoured cables shall be subject to routine tests in accordance with the relevant British Standard Specification. Test certificates shall be provided against each drum and/or cable length. The test carried out on every cable length and/or drum at manufacturer premises shall include.

- High voltage DC insulation pressure test between cores each core to earth metallic sheath or armour as applicable
- Insulation resistance test
- Core continuity and identification
- Conductor resistance test

208.17 Pressure Switches and Gauges

All pressure switches, vacuum and pressure gauges shall be subject to routine tests in accordance with the relevant British Standard Specification. Test certificates shall be provided against each item of equipment.

209 SITE TESTING

After erection is completed, the Contractor shall test fully all items of equipment and shall include provision of:-

- a) All skilled and qualified operating and test staff for the testing of all equipment.
- b) Provision and disposal of all services, lubricants and fuels other than electricity.
- c) All measuring and testing instruments to demonstrate equipment operation to the fulfillment of the works tests.
- d) All loading weights for the load testing of all lifting equipment installations.
- e) All necessary equipment for testing of all diesel fuel bulk storage tanks and fittings.

All tests shall be carried out by the Contractor but shall be supervised by the Engineer and the Engineer shall be satisfied with all tests.

Commissioning shall not be undertaken without the operating instructions and the Employer will not accept any plant without full copies of the operating and maintenance instructions.

All spares, tools and other loose items of equipment shall be checked.

The contractor shall maintain on site all necessary engineering and technical supervision for a period of seven calendar days after the successful commissioning to perform any adjustments that may be necessary or fourteen calendar days after commencement of staff instruction whichever shall be the longest.

209.1 Co-ordination of Site Testing Programme

The contractor shall be responsible for coordinating the programme of site testing of all items and to ensure that all parties concerned are present during any tests to oblige their responsibility.

209.2 Cable Tests during Installation

During the period of site installation, the Engineer will carry out inspections of the works to ensure that the standards of workmanship meet the specifications and are to his satisfaction. In the event of any part of the cabling installation failing to meet these requirements the installer's supervisor or foreman will immediately be informed and shall remedy the deficiency to the satisfaction of the Engineer.

The Contractor shall:-

- a) Provide DC test equipment and apply (after isolation), in the presence of the engineer, the following DC test voltages on all 11 KV grade PVC SWA cable between cores and between cores and sheath.
- | | | |
|---|------------------------------|-----|
| - | Between cores | 34M |
| - | Between all cores and sheath | 25M |
- b) Demonstration correct phasing out of cores in all cables throughout the works and test the insulation of all cables both, between cores and between cores and earth, during installation with a “Megger”, 500 Volt, hand generator.
- c) Conduct soil resistivity tests in the presence of the Engineer to obtain the most suitable location for the earth electrode system.
- d) Demonstrate to the Engineer that the resistance of earth, electrode to earth conductor continuity and earth installation is in accordance with this Specification.

Tests shall be performed from each major item of plant by using an “Earth Megger” and auxiliary return conductor. If any portion of the works fails to pass the tests, test of the said portion shall be repeated within a reasonable time upon the same terms and conditions. Certificates of all tests describing and giving full particulars of such tests shall be provided.

209.3 Final Painting

All equipment and items, after installation and either prior to or after commissioning as necessary or as may be directed by the Engineer, shall be final painted to comply strictly with the specifications.

209.4 Failure to Achieve the Specified duty

If at the site test the performance of the plant does not meet the specified duty, the Contractor shall at his own expenses take such steps as may be necessary to modify the plant in order to achieve the specified duty performance and shall bear the entire cost of conducting all future sites as necessary to confirm satisfactory performance.

In the event of the guaranteed performance not being met on the first or any subsequent of such modifications the Employer reserves the right to reject the plant.

210 OPERATION AND MAINTENANCE

210.1 Manuals

The operation and maintenance data and instructions shall give all relevant instructions for the function, operation and maintenance of all related equipment and installation.

The Operation and Maintenance Instructions shall be written in English. Operation and Maintenance Instructions shall be written to be read in conjunction with the as-built drawings. Copies of manufacturer data may be written in English.

The Contractor shall provide the following documents.

1. Description of function
2. Maintenance instructions, maintenance schedules, mounting and operating instructions.
3. List of labels
4. Data sheets and brochures
5. Spare parts lists.

210.2 Spare Parts

The spare parts required and recommended for at least five years continuous operation of all the equipment shall be supplied under this contract. The extent and unit price of spare parts shall be given in the Tender.

210.3 Training

The contractor shall arrange training for the maintenance staff in relevant and related O&M subjects. The Contractor shall pay all costs for the courses outside Kenya, including traveling, accommodation and maintenance.