



**Kenya Marine Fisheries Socioeconomic
Development Project (KEMFSED)
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**MINISTRY OF MINING, BLUE ECONOMY AND MARITIME
AFFAIRS**

Request for Bids

**CONSTRUCTION RENOVATION OF MALINDI FISHERIES
OFFICE**

Employer: State Department for Blue Economy & Fisheries
Project: Kenya Marine Fisheries Socio-Economic Development
Project (KEMFSED)
Contract Title: **CONSTRUCTION RENOVATION OF MALINDI
FISHERIES OFFICE**
Country: Republic of Kenya
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VOLUME 3 OF 4

SPECIFICATIONS, PREAMBLES AND PRICING NOTES

THE PROPOSED KEMFSED PROJECTS - CONSTRUCTION OF MALINDI OFFICE BLOCK

AT

MALINDI, KILIFI COUNTY

FOR

KEMSFED

TENDER DOCUMENT

SPECIFICATIONS AND BILLS OF QUANTITIES

Specification

VOLUME 3

SPECIFICATIONS, PREAMBLES AND PRICING NOTES

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1 SECTION 1- SPECIFICATIONS FOR BUILDERS’ WORKS

SPECIFICATIONS, PREAMBLES AND PRICING NOTES

CONTRACTOR'S OBLIGATIONS

PRICING ITEMS OF PRELIMINARIES

Prices SHALL BE INSTERTED against Items of "Preliminaries" in the tenderer's priced Bills of Quantities. Where no price is inserted the Contractor shall be deemed to have included in his prices or rates for the various items in the Bills of Quantities or Specification for all such costs involved in complying with all the requirements for the proper execution of the whole of the works in the Contract. The contractor is advised to read and understand all preliminary items.

CONTRACTOR'S SUPERINTENDENCE /SITE AGENT

The Contractor shall constantly keep on the works a literate English fluent speaking Agent or Representative, competent and experienced in the kind of work involved, who shall give his whole time to the superintendence of the works. Such Agent or Representative shall receive on behalf of the Contractor, directions and instructions from the Engineer Contractor, directions and instructions from the Engineer and such directions and instructions shall be deemed to be given to the Contractor in accordance with conditions of Contract. The Agent shall not be replaced without the specific approval of the Engineer.

SUFFICIENCY OF TENDER

The Contractor shall be deemed to have satisfied himself before tendering as to the correctness and sufficiency of his tender for the Works and the rates and the prices stated in the Bills of Quantities. Rates and prices quoted shall cover all his obligations under the Contract and all matters and things necessary for the proper completion and maintenance of the Works.

COMPLIANCE TO COVID-19 PROTOCOLS

Pursuant to the guidelines issued by the Ministry of Health the Contractor shall ensure that all necessary measures with regards to prevention, detection and containment of

the Covid-19 virus are in place on site throughout the entire construction period. These include, but not limited to, provision of hand washing points with soap and water or approved anti-bacterial hand sanitizers, requirement for the use of masks, social distancing as far as is possible, signages, warnings, inspections and periodical fumigation.

TEMPORARY DISPOSAL OF RAIN WATER

The Contractor shall provide and maintain all necessary temporary gutters, downpipes, chutes, drains etc. for conveying rainwater from the buildings. The Contractor shall allow for temporary drainage plumbing and piping for keeping the premises and site free from accumulation of water. The Contractor shall allow for draining flood water out of the site

SITE TELEPHONE

The contractor shall provide telephone facilities (fixed or mobile) on site throughout the duration of the contract for use by the project consultants. He shall also maintain the phone in permanent working condition and pay all charges for the duration of the Contract.

WATCHING, LIGHTING AND CCTV

The Contractor shall provide at his own risk and cost all watching as necessary to safeguard the works, plants and materials against damage and theft.

STAMP DUTY CHARGES

The Contractor shall allow for the payment of all stamp duty charges in connection with the Performance Bond and Contract Agreement.

SITE LEVELS

Before commencing work the Contractor must arrange for and agree with the Engineer the existing site levels and similarly establish and the existing site levels

SETTING OUT

The contractor shall set out works in accordance with the dimensions and levels shown on the drawings and shall be responsible of the correctness of all dimensions and levels set out by him and he will be required to amend all errors arising from inaccurate setting out at his own cost and expenses. In the event of any error or discrepancy in the dimensions or levels marked on the drawings being discovered, such errors or discrepancies must be reported by the contractor to the Engineer for his immediate attention. No work shall be commenced by the contractor until he has received written instructions from the Engineer to adjust such discrepancies which may be proved, upon receipt of such instructions and no claim for extra expenses or relief from the provisions of the Conditions of the Contract, any discrepancy or error in the dimensions or levels shown on the drawings may be made thereafter.

Before any work is commenced by Sub-Contractors or specialist firms, dimensions must be checked on the site and/or building and agreed with the Contractor irrespective of the comparable dimensions shown on the drawings. The Contractor shall be responsible for the accuracy of such dimensions.

EXISTING PROPERTY AND ADJACENT PROPERTY

The contractor shall take every precaution to avoid damage to all existing and adjacent property including buildings, roads, cables, drains and other services and he will be held responsible for all damages hereto arising from the execution of his contract and he shall make good all such damages when directed at his own expense to the satisfaction of the Engineer. Special attention must be paid to newly constructed site access road

TRANSPORT TO AND FROM THE SITE

The contractor shall include in his prices for the transport of materials, workmen etc to and from the site of the proposed works at such hours and by such routes as are permitted by the Authorities.

SECURITY OF WORKS

The contractor shall be entirely responsible and shall pay security of all works, stores, materials, plant, personnel etc both his own and sub-contractors and shall also provide all necessary watching, lighting, and other precautions as necessary to ensure the security, the safety and protection of the public.

PROGRESS SCHEDULE

The Contractor shall furnish to the Engineer within 14 days of the possession of site a Time progress Chart for approval and display in the site offices showing the time and order in which he proposes to carry out the works within the total construction time stated in the contract. The chart will show in detail the construction time and order in which each section of the work is to be carried out and be sub-divided into trades and tasks. If the contractor proposes sectional completion of the project he must plan this in detail including access roads, and services and this shall be reflected on the chart

EXCAVATION

Prices are to include for excavating in all materials met with except Rock as specified. Prices are also to include planking and strutting and for destroying all white ants in the vicinity of the buildings.

Shall be to the widths and depths indicated on the drawings or to such lesser or greater depth as the Project Engineer may deem necessary and so instruct the contractor in order to obtain satisfactory foundations.

STARTING LEVEL

Unless otherwise described the starting level of all excavations has been measured from the level remaining after completion of reduced level excavation, generally taken as the underside of 200 surface strip.

CLASSIFICATION OF EXCAVATED MATERIAL CLASS I ROCK OR HARD MATERIAL

This class shall consist of all materials which cannot be removed except by blasting, by the use of metal wedges and sledge hammers or by ripper with heavy tractor and rear mounted hydraulic single type heavy –duty ripper.

Boulders greater than 0.5 CM; when their nature and size is such that they cannot be removed without recourse to one or more of the methods described above shall also be categorized under class one.

Where the boulders constitute 50% or more of a particular part of the excavation, such part shall be considered as class 1 material throughout.

CLASS 2 NORMAL OR SOFT MATERIAL

This class shall constitute all materials, which can be removed without recourse to the methods described for class 1 above, and/or class 3 below.

CLASS 3-COMPACTED GRAVEL OR DECOMPOSED ROCK

This class shall constitute of all materials such as consolidated murram gravel decomposed or stratified rock, stone and boulders less than 0.5CM, harder than class 2, but which can be excavated by ripping or which in confined spaces, requires excavation by hand using compressor tools.

EXCAVATION WORK

Excavation work is measured net as before digging and the Contractor must allow for increases in bulk after digging.

FILLING

Filling is measured net after consolidation. Filling obtained from surplus excavated materials is to be free from all weeds, roots, vegetable soil or other unsuitable materials and is to be filled in layers each of not more than 225mm finished thickness. Each layer shall be well wetted and consolidated as described hereafter.

NO BORROW PITS

No borrow will be allowed to be opened on the site.

REMOVAL OF SURPLUS MATERIALS

All surplus excavated material, where so directed, and all rubbish, is to be carried away from the site and the Contractor shall find his own dump and pay all charges.

FOUNDATIONS NOT TO BE COVERED

No excavations or foundations work shall be filled in or covered up until all measurements necessary for the adjustment of variations have been made by the Quantity Surveyor.

HARDCORE FILLING

Hardcore for filling under floors, etc, shall be hard broken quarry waste to the approval of the Project Engineer broken to pass not greater than a 150mm ring or to be 75% of the finished thickness of the layers being compacted whichever is the lesser and graded so that it can be easily and thoroughly compacted by rolling. The filling is to be laid in layers each of a consolidated thickness not exceeding 225mm and well-watered and rolled with a vibrating roller where rolling is impossible, compaction shall be by hand or mechanical tampers.

The top surface of the hardcore shall be leveled or graded to falls as required and blinded with similar material broken to 25mm gauge and surfaced with 50mm layer of stone dust or murram, well-watered and rolled to receive concrete or paving.

NOTES CONCERNING MEASUREMENT AND PRICING

The Contractor must allow for all costs incurred during progress of the contract for complying with the provisions concerning the preparation and use of graded mixes.

Prices for concrete shall include for mixing and depositing as described or indicated and for hoisting and depositing at the various levels required throughout the building, and shall also include for forming or hacking a satisfactory key for all faces receiving asphalt and plaster work. Prices for slabs shall also include for leveling off the surface as described under "Compaction" and all temporary formwork to form construction joints at bay edges.

Prices for reinforced concrete shall, in addition, include for filling into, between or on formwork, and thoroughly compacting between and around rods or fabric reinforcement and for forming all additional construction joints between varying mixes. Where described as 'vibrated', prices must include for fully vibrating as described.

Prices for formwork shall include for extra material at joints, extra labour and waste for narrow widths, small quantities, overlaps, passing at angles straight cutting and waste, splayed edges, notchings, etc and for fixing at the various levels including battens, struts, and supports for bolting, wedging, easing, striking and removal. Prices for linear items such as boxings shall include for angles and ends.

Prices for steel rod reinforcement shall include for cutting to lengths and all labour in bending and cranking, forming hooked ends, handling, hoisting and fixing in

position and for providing all necessary tying wire and supports. Prices for fabric reinforcement shall include for all straight cutting and waste, handling, hoisting and fixing in position, producing all necessary tying wire supports and all extra material laps.

Prices of all precast concrete shall include for all moulds, finishing as described, handling reinforcement, hoisting and fixing at the required levels, bedding, jointing and pointing in cement and sand (1:5) mortar also for casting or cutting to the exact lengths required and any waste resulting from such cutting.

CODE OF PRACTICE

All workmanship, materials, tests and performance in connection with the reinforced concrete work are to be in conformity with the latest edition of the British Standard Code of Practice (C.P. 8110 of 1985 "The Structural Use of Reinforced Concrete in Buildings") where not inconsistent with these Preambles.

SUPERVISION

The Contractor whose duty will be to supervise all stages in the preparation and placing of the concrete shall employ a competent person approved by the Engineer. All cubes shall be made and site tests carried out under his direct supervision, in consultation with the Engineer.

CONTRACTOR'S PLANT, EQUIPMENT AND CONSTRUCTION PROCEDURES

Not less than 30 days prior to the installation of the Contractor's plant and equipment for processing, handling, transporting, storing and proportioning ingredients, and for mixing, transporting and placing concrete, the Contractor shall submit drawings for approval by the Engineer, showing proposed general plant arrangement, together with a general description of the equipment he proposes to use.

After completion of installation, the operation of the plant and equipment shall be subject to the approval of the Engineer.

Where these Preambles, the Bills of Quantities or the Drawings require specific procedures to be followed, such requirements are not to be construed as prohibiting

the use by the Contractor of alternative procedures if it can be demonstrated to the satisfaction of the Engineer that equal results will be obtained by the use of such alternatives.

Approval of plant and equipment or their operation, or of any construction procedure, shall not operate to waive or modify any provision or requirements contained in these Preambles governing the quality of the materials of the finished work.

LEVELS AND FOUNDATIONS

The foundations of the works shall be carried down to depths as directed by the Engineer and they must be cut as nearly to the size of the concrete as possible and the vacant spaces between the concrete and the solid ground, except where otherwise shown, must be carefully filled in as directed by the Engineer.

All temporary timbering shall be removed but should any timber be left in or should any other work be done beyond that specified; it will be at the Contractor's own cost.

B. TOLERANCE

All insitu concrete work shall be dimensionally accurate to within the following tolerances: -

.01 between the centerline of principal members columns or beams

+/- 5mm up to 15 metres c/c

+/- 10mm over 15 metres c/c

Note the +/- 10mm tolerance shall not be accumulative.

.02 In storey height

+/- 5mm floor to floor

.03 In plumpness of columns and walls

+/- 10mm on any storey or overall the structure

.04 In level of floors

+ 5mm /- 3mm of the true prescribed horizontal surface level

.05 In cross sectional dimensions of column beams and walls

+ 5mm/- 3mm in any dimensions up to 2 metres overall

+10mm/- 3mm in any dimension over 2 metres.

.06 Cover to reinforcement

+5mm/5 of the stated covers

The Contractor shall be responsible for the cost of all corrective measures required by the Engineer to rectify work, which is not construed within the tolerances set out above.

MATERIALS GENERALLY

All materials which have been damaged, contaminated or have deteriorated or do not comply in any way with the requirements of these Preambles shall be rejected and shall be removed immediately from the Site at the Contractor's own expense. No materials shall be stored or stacked on suspended floors without the Engineer's prior approval.

SAMPLES AND TESTING

Every facility shall be provided to enable the Engineer to obtain samples and carry out tests on the materials and construction. If these tests show that any of the materials and construction does not comply with the requirements of these Preambles, the Contractor will be responsible for the costs of the tests and the replacement of defective materials and/or construction.

CEMENT

Cement unless otherwise specified shall be ordinary Portland Cement of a brand approved by the Engineer and shall comply with the requirements of B.S. 12, with the exceptions that it may contain reactive volcanic ash of not more than 10 per cent of the total weight and the quality of insoluble residue permitted in B.S. 12 may be exceeded on this account only. A manufacturer's Certificate of Test in accordance with B.S. 12 shall be supplied for each consignment delivered to the site.

Cement may be delivered to the site either in bags or in bulk. If delivered in bags, each bag shall be properly sealed and marked with the manufacturer's name and on the site, it is to be stored in a weather proof shed of adequate dimensions with a

raised floor. Each consignment shall be kept separate and marked so that it may be used in the sequence in which it is received. Any bag found to contain cement, which has set or partly set shall be completely discarded and not used in the works. Bags shall not be stored more than 1.5m in height.

AGGREGATES

Aggregates shall conform to the requirements of B.S. 882 and the sources and types of all aggregate are to be approved in all respects by the Engineer before work commences.

The grading of aggregates shall be one within the limits set out in B.S.882 and as later specified and the grading, once approved, shall be adhered to throughout the works and not varied without the approval of the Engineer. Fine aggregate shall be clean, coarse, siliceous sand of good, sharp, hard quality and shall be free from lumps of stone, earth, loam, dust, salt, organic matter and any other deleterious substances. It shall be graded within the limits of Zone 1 or 2 of Table 2 of B.S. 882.

Coarse aggregate shall be good, hard, clean, approved black trap or similar stone, free from dust, decomposed stone, clay, earth matter, and foreign substances of friable thin elongated or laminated pieces. It shall be graded within the limits of Table 1 of B.S. 882 for its respective nominal size.

If in the opinion of the Engineer, the aggregate meets with the above requirements but is dirty or adulterated in any manner it shall be screened and/or washed with clean water at the Contractor's expenses.

Aggregates shall be delivered to the site in their prescribed sizes or grading and shall be stocked-piled on paved areas or boarded platforms in separate units to avoid intermixing. **On no account shall aggregates be stockpiled on the ground.**

The Engineer shall be entitled to require a Certificate from an approved testing laboratory in connection with each source of fine and coarse aggregate showing that materials comply with the Specification. All such testing be carried but at the Contractor's expense.

WATER

The water used for mixing concrete shall be from an approved source, clean, fresh and free from impurities and comply with the requirements of B.S.3148.

CONCRETE STRENGTHS

Grade “35”, “30”, “25” and “20” concrete shall have minimum strengths as given by Works Cube Tests shown on Page 2/9

	MINIMUM CRUSHING STRENGTHS	(i) DITTO	(ii) DITTO	(iii) DITTO
	Grade 35	Grade 30	Grade 25	Grade 20
7 days	23.5 N/mm ²	20.00 N/mm ²	16.5N/mm ²	13.5 N/mm ²
28 days	35.0 N/mm ²	30.0 N/mm ²	25.0 N/mm ²	20.0 N/mm ²

The average strength obtained from cube tests shall be 10 percent higher than the minimum strength shown above.

Grades lower than those given shall be of nominal mixes and may be measured by volume or weight. Unless the Engineer directs so, no cube tests will be required for these grades.

Nominal mix by column	-	1:3:6	1:4:8
Cube metres of Fine Aggregate			
Per 50Kgs bag of cement	-	0.12	0.16
Cubic metres of Fine Aggregate			
Per 50Kgs bag of cement	-	0.24	0.32
Max size of Coarse Aggregate	-	20mm	20mm

CEMENT

The quantity of cement shall be measured by weight or volume. Where delivered in bags, each batch of concrete is to use one or more whole bags of cement.

AGGREGATE

- (i) For grades “35”, “30”, “25” concrete aggregates shall be measured by weight in a weight batching machine as described hereafter.
- (ii) For lower grade concrete, aggregates may be measured by weight or by volume, where approved gauge boxes of such a size as will give the correct proportions shall be used.

WEIGHT BATCHING MACHINES

Weight batching machines shall be of an approved type and shall be properly maintained and checked for accuracy at regular intervals.

CONCRETE MIXES

The weights of fine and coarse aggregate to be used in concrete mixes “35”, “30” and “20” shall be limited in accordance with the table below. The Engineer shall first approve the proportions of fine to coarse aggregate and cement, which the contractor proposes to use for each of the mixes specified. The contractor will then be required to prepare Preliminary Test Cubes and have these cubes tested as described for Work Cube Tests.

The test results should be submitted to the Engineer in sufficient time for further tests to be carried out should they prove unsatisfactory. Cube strengths in the preliminary tests must show crushing strengths at least 25 per cent higher than the strengths specified for work cube test. If contractor is unable to produce specified cube strengths he will be required at his own cost to increase the cement contents of the mix until satisfactory results are produced.

The Engineer may require at any time during the Contract the proportions of fine to coarse aggregate to be altered in order to produce a mix of greater strengths or improved workability and providing that the total proportions of aggregate to cement remain unchanged, no claim for additional cost will be considered.

MIX	Grade 35	Grade 30	Grade 25	Grade 20
Minimum cement				
Content by weight to				
Combined total				
Weight of aggregate	1 to 5	1 to 6	1 to 7	1 to 7

Work cubes are to be made at intervals as required by the Engineer and the contractor shall provide a continuous record of the concrete work. The cubes shall be made in approved 150mm moulds in strict accordance with the Code of Practice. Six cubes shall be made on each occasion, from different batches, the concrete being taken from the point of deposit.

Each cube shall be marked with a distinguishing number (number to run consecutively) and the date, and a record shall be kept on site, giving the following particulars: -

- (a) Cube No.
- (b) Date made
- (c) Location in work
- (d) 7-day Test

Date.....

Strength:.....

- (e) 28-day Test

Date:.....

Strength:.....

Cubes shall be forwarded, carriage paid to an approved Testing Authority in time to be tested three at 7-days and three at 28-days. No cube shall be dispatched within three (3) days of casting.

Copies of all Work Cube Test results shall be forwarded to the Engineer and one shall be retained on the site.

If the strengths required above are not attained and maintained throughout the carrying out of the Contract, the Contractor will be required to increase the proportion of cement and/or substitute letter aggregate so as to find concrete which does comply with the requirement of the Contract. The Contractor may be required to remove and replace at his own cost any concrete, which fails to attain the required strength as, ascertained by Work Cube Tests.

CONCRETE WORK

TRADE PREAMBLES

The Contractor must allow in his rates for concrete test cubes for all expenses in connection with the preparation and conveyance to the Testing Laboratory and testing of test cubes and no claim in respect of his failure to do so will be entertained.

A. MAKING AND PLACING OF CONCRETE

The concrete shall be mixed only in approved power-driven mixers of a type and capacity suitable for the work and in any event not smaller than 0.5/0 33-cu.m capacity.

The mixer shall be equipped with an accurate water-measuring device. All materials shall be thoroughly mixed dry before the water is added and the mixing of each batch shall continue for a period of not less than three minutes after the water has been added and until there is a uniform distribution of the materials and the mass is uniform in colour.

The entire contents of the mixed drum shall be discharged before recharging. The volume of mixed materials shall not exceed the rated capacity of the mixer. Whenever the mixer is started, 10 per cent extra cement shall be added to the first batch and no extra payment will be made on this account.

As a check on concrete consistency, slump tests may be carried out and shall be in accordance with BS. 1881. The Contractor shall provide the necessary apparatus and allow for the costs of such tests. The slump of the concrete made with the specified water content, using dry materials shall be determined and the water to be added under wet conditions shall be so reduced as to give approximately the same slump.

The concrete shall be mixed as near to the place where it is required as is practicable, and only as much as is required for a specified section of the work shall be mixed at one time, such section being commenced and finished in one operation without delay.

MAKING AND PLACING OF CONCRETE (CONT'D)

All concrete must be efficiently handled and used in the works within twenty (20) minutes of mixing. It shall be discharged from the mixer direct either into receptacles or barrows and shall be distributed by approved means, which do not cause separation or otherwise impair the quality of the concrete. Approved mechanical means of handling will be encouraged, but the use of chutes for placing concrete is subject to the prior approval of the Engineer.

Concrete shall be placed from a height not exceeding 1.500m. directly into its permanent position and shall not be worked along the shutters to that position. Unless otherwise approved, concrete shall be placed in a single operation to the full thickness of slabs, beams and similar members, and shall be placed in horizontal layers not exceeding 1.500m. deep in walls and similar members.

Concrete in columns may be placed to a height of 4.000m. with careful placing and vibration and satisfactory results. Where the height of the column exceeds 4M suitable openings must be left in the shutters so that this maximum lift is not exceeded.

Concrete shall be placed continuously until completion of the part work between construction joints as specified hereinafter or of a part of approved extent. At the completion of a specified or approved part, a construction joint of the form and in the position hereinafter specified shall be made. If stopping of concreting be unavoidable elsewhere, a construction joint shall be made where the work is stopped. **The Contractor must make a record of all such joints and a copy supplied to the Engineer.**

Any accumulation of set concrete on the reinforcement shall be removed by wire brushing before further concrete is placed.

The Contractor shall provide runways for concreting to the satisfaction of the Engineer. Under no circumstances will the runway be allowed to rest on the reinforcement.

Care shall be taken that the concrete is not disturbed or subjected to vibrations and shocks during the setting period.

MAKING AND PLACING OF CONCRETE (CONT'D)

Mixing machines, platforms and barrows shall be clean before commencing mixing and be cleaned on every session of work.

Where concrete is laid on hardcore or other absorbent materials, the base shall be suitable and sufficiently wetted before the concrete is deposited.

A. COMPACTION

At all times during which concrete is being placed, the Contractor shall provide adequately trained and experienced labour to ensure that the concrete is compacted in the forms to the satisfaction of the Engineer.

Concrete shall not be placed at a rate greater than will permit satisfactory compaction or to a depth greater than 450mm before it is compacted.

During and immediately after placing the concrete shall be thoroughly compacted by means of continuous tamping, spacing, slicing and vibration. **Vibration is required for concrete of Grades "35", "25" and "20".**

Care shall be taken to fill every part of the forms, to work the concrete under and around reinforcement without displacing it and to avoid disturbing recently placed

concrete which has begun to set. Any water accumulating on the surface of newly placed concrete shall be removed and no further concrete shall be placed thereon until such water is removed.

Internal vibrations shall be of a frequency of not less than 7,000 cycles per minute and shall have a rotating eccentric weight of at least 0.75Kg with an eccentricity of not more than 15mm. Such vibrators shall visibly affect the concrete within a radius of 250mm from the vibrator.

Internal vibrators shall not be inserted between layers of reinforcement less than one half times the diameter of the vibrators apart. Contact between vibrators and reinforcement and vibrators and formwork shall be avoided.

Internal vibrators shall be inserted vertically into the concrete wherever possible at not more than 500mm centres and shall constantly be moved from place to place.

COMPACTION (CONT'D)

No internal vibrator shall be permitted to remain in any one position for more than ten seconds and it shall be withdrawn very slowly from the concrete.

In consolidating each layer of concrete the vibrating head shall be allowed to penetrate and re-vibrate the concrete in the upper portion of the underlying layer. In the area where newly placed concrete in each layer joins previously placed concrete more than usual, vibration shall be performed, the vibrator penetrating deeply at close intervals along these contacts. Layers of concrete shall be placed until layers previously placed have been vibrated thoroughly as specified.

Vibrators shall not be used to move concrete from place to place in the formwork.

At least one internal vibrator shall be operated for every two cubic metres of concrete placed per hour and at least one spare vibrator shall be maintained on site in case of breakdown during concreting operations.

External formwork vibrators shall be of the high frequency low amplitude type applied with the principal direction of vibration in the horizontal plane. They shall be attached directly to the forms at not more than 1.200mm centres.

In addition to internal and external vibration, the upper surface of suspended floor slabs shall be leveled with a tamping or vibrating screed prior to finishing. Vibrating

elements shall be of the low frequency high amplitude type operating at a speed of not less than 3.000 r.p.m.

A. CONSTRUCTION JOINTS

Construction joints shall be permitted only at the positions predetermined on the Drawings or as instructed on the sites by the Engineer. In general, they shall be perpendicular to the lines of principal stresses and shall be located at points of minimum shear, viz. vertically at, or near mid-spans of slabs, ribs and beams.

Suspended concrete slabs are generally to be cast using alternate bay construction in bays not exceeding 15.00m in length. No two adjacent bays are to be cast within a minimum period of 48 hours of each other.

The joints between adjacent bays are to be in positions agreed with the Engineer.

Under no circumstances shall concrete be allowed to tail-off, but it shall be deposited against stopping-off boards.

Before placing new concrete against already hardened, the face of the old concrete shall be thoroughly hacked, roughened and cleaned and laitance and loose material removed there from, and immediately before placing the new concrete the surface shall be saturated with water and covered with a coat of mortar at least 25mm in thickness composed of cement and fine aggregate in the proportions used in the concrete.

A. CURING AND PROTECTION

Care must be taken no concrete is allowed to become prematurely dry and the fresh concrete must be carefully protected within two hours of placing from rain, sun and wind by means of Hessian sacking, polythene sheeting, or other approved means. This protective layer and the concrete itself must be kept continuously wet for at least seven days after the concrete has been placed. The Contractor must allow for the complete coverage of all fresh concrete for a period of 7 days. Hessian or polythene sheeting shall be in the maximum widths obtainable and shall be secured

against wind. **The Contractor will not be permitted to use bags, Hessian or other material in small places.**

Concrete in foundations and other underground work shall be protected from admixture with falling earth during and after placing.

Traffic or loading must not be allowed on the concrete until the concrete is sufficiently matured and in no case shall traffic or loading be of such magnitude as to cause deflection or other movement in the formwork or damage to the concrete members. Where directed by the Engineer, props may be required to be left in position under slabs and other members for greater periods than that specified hereafter.

A. FAULTY CONCRETE

Any concrete which fails to comply with these Preambles or which shows signs of setting before it is placed shall be taken out and removed from the site. Where concrete is found to be defective after it has set, the concrete shall be cut out and replaced in accordance with the Engineer's instructions. **On no account shall any faulty, honeycombed, or otherwise defective concrete be repaired or patched until the Engineer has inspected and issued instructions for the repair.** The whole of the cost whatever, which may be occasioned by the need to remove faulty concrete, shall be borne by the Contractor.

B. ROD REINFORCEMENT

The steel reinforcement shall comply with the latest requirements of the following British Standards: -

4449:	1988	Specification for bars for the reinforcement of Concrete.
4466:	1989	Bending dimensions and scheduling of bats for The reinforcement of concrete
4483:	1985	Steel fabric for the reinforcement of concrete

The Contractor shall submit a test certificate of the rollings. Reinforcement shall be stored on racks above ground level. All reinforcement shall be free from loose mill scales or rust, grease, paint or other substances likely to reduce the bond between the steel and concrete.

C. FABRIC REINFORCEMENT

Fabric reinforcement shall be electrically cross-welded steel wire mesh reinforcement to B.S. 4483 and of the size and weight specified.

A. FIXING ROD REINFORCEMENT

Reinforcement shall be accurately bent to the shapes and dimensions shown on the Drawings and Schedules and in accordance with B.S. 4466. Reinforcement must cut and bent cold and no welded joints will be permitted unless so detailed.

No concreting shall be commenced until the reinforcement in position and until his approval has been obtained. The Contractor shall give two clear days' notice of his intention to concrete to the Engineer.

The Contractor is responsible for maintaining the reinforcement in its correct position, according to the Drawings, before and during concreting. During concreting a competent steel fixer must be in attendance on the concreters to adjust and correct the positions of any reinforcement, which may be displaced. The vibrators are not to come into contact with the reinforcement.

Irrespective of whether any inspection and/or approval of the fixing of the reinforcement has been carried out as above, it shall be the Contractor's sole responsibility to ensure that the reinforcement complies with the details on the drawings or bending schedules and is fixed exactly in the positions shown therein and, in the positions, to give the prescribed cover.

B. COVER TO ROD REINFORCEMENT

The Contractor will be held entirely responsible for any failing or defect in any portion of the reinforced concrete structure and including any consequent delay, claims, third party claims, etc., where it is shown that the reinforcement has been incorrectly positioned or is incorrect in size or quantity with respect to the detailed drawings or bending schedules.

Spacing blocks of approved size and shape of concrete similar to that used in the surrounding construction and fixed to the reinforcement on formwork by No.18 S.W.G. wires set into the spacer blocks or other approved means shall be provided where necessary to ensure that the requisite cover is obtained. The Contractor is to include providing sufficient such spacer blocks in his prices for steel reinforcement.

CONCRETE WORK (CONT'D)

COVER TO ROD REINFORCEMENT (CON'TD)

Unless otherwise directed the concrete cover to rod reinforcement over main bars in any face shall be: -

Foundations against earth face	75mm
Foundations against blinding	50mm
Columns	40mm
Beams	25mm
Slabs	20mm
Walls	25mm

A. FIXING FABRIC REINFORCEMENT

The fabric shall be free from scale, rust, grease or other substance likely to reduce the bond between the steel and the concrete and shall be laid with minimum 300mm laps and bound with No.18 S.W.G. annealed iron wire.

Where reinforcement projects from a concrete section of the structure and this reinforcement are expected to remain exposed for some time, it is to be coated with cement grout to prevent rust staining on the finished concrete. This grout is to be brushed off the reinforcement prior to the continuation of concreting.

B. FIXTURES AND INDENTATIONS IN CONCRETE

No openings, chases, holes or other voids shall be formed in the concrete without the approval of the Engineer. Details of any fixtures to be permanently built into the concrete including the proposed positions of all conduits 25mm and over in diameter shall be submitted to the Engineer for his approval before being placed.

A. CHASES, HOLES ETC IN CONCRETE

The Contractor shall be responsible for the co-ordination with the Electrical and other Sub-Contractors for incorporating electrical conduits, pipes, fixing blocks, chases, holes and the like in concrete members as required and must ensure that adequate notice is given to such Sub-Contractors informing them when concrete members incorporating the above are to be poured. The Contractor shall submit full details of these items to the Engineer for approval before the work is put in hand. All fixing blocks, chases, holes etc. to be left in the concrete shall be accurately set out and cast with the concrete.

Unless otherwise instructed by the Engineer, all electrical conduits to be positioned within the reinforced concrete shall be **fixed inside** the steel cages of beams and columns and **between the top and bottom** steel layers in slabs and similar members.

B. FORMWORK

The Engineer shall approve the method and systems of formwork, which the Contractor proposes to use, before construction commences. Formwork shall be

substantially and rigidly constructed of timber or steel or precast concrete or other approved material.

All timber for formwork shall be of good sound, clean, sawn, well-seasoned timber, free from warps and loose knots and of scantlings sufficiently strong for their purpose.

C. CONSTRUCTION OF FORMWORK

All formwork shall be of sufficient thickness and with joints close enough to prevent undue leakage of liquid from the concrete and fixed to proper alignment, level and plumb and supported on sufficiently strong bearers, shores, braces, plates, etc. properly held together by bolts or other fastenings to prevent displacement, vibration or movement by the weight of materials, men and plant on same and so wedged and clamped as to permit of casing and removal of the formwork without jarring the concrete.

Where formwork is supported on previously constructed portions of the reinforced concrete structural frame, the Contractor shall by consultation with the Engineer ensure that the supporting concrete structure is capable of carrying the load and/or sufficiently propped from lower floors or portions of the frame to permit the load to be temporarily carried during construction.

Soffits shall be erected with an upward camber of 10mm for each 4.000m of horizontal span or as directed by the Engineer.

Great care shall be taken to make and maintain all joints in the formwork as tight as possible, to prevent the leakage of grout during vibration. All faulty joints shall be caulked to the Engineer's approval before concreting.

The formwork shall be sufficiently rigid to ensure that no distortion or bulging occurs under the effects of vibration. If at any time the formwork is insufficiently rigid or in any way defective the Contractor shall strengthen or improve such formwork as the Engineer may direct.

The Contractor's attention is drawn to the various surface textures and applied finishes required and the faces of formwork next to the concrete must be of such material and construction and be sufficiently true to provide a concrete surface which will in each particular case permit the specified surface treatment or applied finish.

All surfaces, which will be in contact with concrete, shall be oiled or greased to prevent adhesion of mortar. Oil or grease shall be of a non-staining mineral type applied as a thin film before the reinforcement is placed. Surplus moisture shall be removed from the forms prior to placing of the concrete.

Temporary openings shall be provided at the base of columns wall and beams and at any other points where necessary to facilitate cleaning and inspection immediately before the pouring of concrete. Before the concrete is placed the shuttering shall be trued-up and any water accumulated therein shall be removed. All sawdust, chips, nails and other debris shall be washed out or otherwise removed from within the formwork.

The reinforcement shall then be inspected for accuracy of fixing. Immediately before placing the concrete, the formwork shall be well wetted and inspection openings shall be closed.

The erection, casing, striking and removing of all formwork must be done under the personal supervision of competent foremen, and any damage occurring through faulty formwork or the Contractor at his own expense shall make its incorrect removal good.

After removal of formwork, all projections, fins etc on the concrete surface shall be chipped off and made good to the requirements of the Engineer at the Contractor's expense. Any voids or honeycombing shall be treated as described under "Faulty concrete".

A. STRIPPING FORMWORK

All formwork shall be removed without undue vibration on shock and without damage to the concrete. No formwork shall be removed without the prior consent of the Engineer and the minimum periods that shall elapse between the placing of the concrete and the striking of the formwork will be as follows: -

Beam sides, wall and columns - 2 days

Removal of formwork and props from slabs and beams - 21 days

If the Contractor wishes to take advantage of the shorter stripping times permitted for beam and slab soffits when props are left in place, he must so design his formwork that sufficient props as agreed with the Engineer can remain in their original position without being moved in any way until expiry of the minimum time for removal of props. Stripping and re-propping will not be permitted.

The above times may be reduced in certain circumstances, at the discretion of the Engineer provided an approved method is adapted at the Contractor's expense to ensure that the required concrete strength is attained before the forms are stripped.

The tops of retaining walls shall be adequately supported with stout raking props at intervals required by the Engineer. These props are not to be removed until after 7 days after casting of the floor slab.

A. FAIR FACE FINISHED

Where fair face finish is specified the concrete shall be brought to a perfectly true smooth and even surface by rubbing with carborundum stone dipped in cement grout. Such work must be commenced within one hour of removing the formwork and actively and rapidly pursued until completed, the objective being to complete the finish as soon as possible after removal of shuttering. On no account may such work be postponed to a later stage in the contract. Fair face surfaces shall be clean, smooth, even true, to form and free from all board marks, joints marks, honeycombing, pitting. Etc. The Contractor is permitted at his own expense to provide smooth lining to the forms, which will achieve the required finish without rubbing down. All rubbed down work must be lightly washed with plain cold water

at the completion of the contract, and not before the cement grout used in the finish is at least four weeks old after initial mixing.

B. PRECAST CONCRETE

Unless otherwise approved by the Engineer, all precast concrete construction shall be carried out on the site and shall conform to requirements given elsewhere in these Preambles.

The minimum size of coarse aggregate in precast concrete shall not exceed 20mm and for thicknesses less than 75mm it shall not exceed 15mm.

The compacting of precast concrete shall conform to requirements given elsewhere in these preambles except for thin slabs where use of immersion type vibrators is not practicable. The concrete in these slabs may be consolidated on a vibrating table or by any other methods approved by the Engineer.

The precast work shall be made under cover and shall remain under the same for seven days. During this period and for a further seven days the concrete shall be shielded by sacking or other approved material kept constantly wet. It shall then be stacked in the open for at least a further seven days to season before being set into position.

Precast concrete units shall be constructed in individual forms. The method of handling the precast concrete units after casting, during curing and during transport and erection shall be subject to the approval of the Engineer, providing that such approval shall not relieve the Contractor of responsibility for damage to precast concrete units resulting from careless handling.

Repair of damage to the precast concrete units, except for minor abrasions of the edges which will not impair the installation and/or appearance of the units will not be permitted and the damaged unit shall be replaced by the Contractor at his own expense.

Except where precast work is described as “fair face” or as having an “exposed aggregate” or terrazzo finish, the moulds shall be made of suitable strong sawn

timber true in form to the shapes required. Unless otherwise described, faces are to be left rough from the moulds.

Where precast concrete work is described as “fair face” the moulds are to be made of metal or are to have metal or plywood linings or are to be other approved moulds which will produce a smooth dense fair face to the finished concrete suitable to receive a painted finish direct and free from all shutter marks, holes, pittances etc. In his prices for such precast work the Contractor shall include for all rubbing down to produce the finish required, to the satisfaction and approval of the Engineer.

Where precast work is to have an “exposed aggregate” or terrazzo finish the moulds shall be constructed to the requirements given for moulds for “finished fair” work. The method of achieving the exposed aggregate finish shall be the “aggregate transfer” or other approved methods.

The precast units shall be installed to the lines, grades and dimensions shown on the Drawings or as directed by the Engineer.

A. CONCRETE SURFACE BEDS

Concrete for surface beds shall be Grade 20.

Before placing concrete and where specified or shown on the drawings a layer of 500-gauge polythene or diothene sheeting shall be laid on the base course. Minimum 300mm laps shall be provided at all joints.

The concrete shall be placed as soon as possible after being mixed. In transporting the concrete, adequate precautions shall be taken to avoid damage to the prepared base. The concrete shall be spread to such a thickness that when compacted it shall be spread to such a thickness that when compacted it shall have the finished thickness as specified or shown on the drawings. A layer of concrete 50mm less than the finished thickness shall first be spread and struck off at the correct level to receive the top fabric reinforcement. The top layer shall then be added. Not more than 30

minutes shall elapse between spreading the bottom layer and the start of compaction of the top layer.

The Contractor shall be responsible for maintaining the reinforcement in its correct position during the placing and compaction of the concrete.

The compaction and finishing of the concrete shall be effected by immersion vibrators and hand or mechanical tamper weighing not less than 10 Kgs per metre run and having a tamping edge shod with a steel strip 75mm wide fixed to the tamper by countersunk screws. Immersion vibrator with “spade” attachment will be permitted. Compaction shall be continued until a dense, scaled surface finish is achieved. Over compaction causing an excessive amount of lines to be brought to the surface shall be avoided.

The surface of the concrete shall be finished to the surface texture specified to the levels, falls and cross-falls, as directed or shown on the drawings and shall be subject to the following tolerances: -

The level be within + to – 6mm of the levels specified

The falls shall be within 10% of the falls specified

The smoothness shall be such that departures from a 3.000m straight edge laid in any direction shall not exceed 3mm.

Minor irregularities shall be made good by the use of a steel float but in no circumstances shall mortar be used to make good the surface.

As soon as the surface has been finished, it shall be protected against too rapid drying by means of polythene sheeting or other approved means placed carefully on the surface and kept damp and in position for 7 days and the concrete shall be kept wet for a further 21 days. The most critical period is the first 24 hours after placing or curing during that time shall be very thorough. The Contractor is to obtain the

Engineer's approval to the material and method he proposes to use for curing and no concreting will be permitted until sufficient such material is on site.

Forms shall not be removed from freshly placed concrete until it is at least 24 hours old. Care shall be taken that in their removal no damage is done to the concrete, but should any damage occur the Contractor should be responsible for making it good.

MASONRY AND BLOCKWORK

A. GENERALLY

- (i) Prices for all walling shall include for normal rough and **straight cutting**, plumbing angles, all cutting and waste and split courses necessary for bond, bonding at angles, intersections and junctions of walling of all thicknesses, split courses, cutting and pinning up to columns, beams, slabs, etc., hoisting and building at any level, forming all openings and reveals to same and all cutting and waste to walling in short lengths such as mullions unless specifically measured.
- (ii) Prices for hollow block walling must further include for all necessary solid blocks or fine concrete filling to open ends of blocks at intersections, ends and angles of walling.
- (iii) Prices for damp-proof courses, which are measured the net area covered, shall include for all cutting, waste, and extra material in laps at joints, angles, etc.

B. CEMENT

All cement used for making mortar shall be Portland cement as described in “Concrete Work”.

C. SAND

All sand used for making mortar shall be clean, well-graded siliceous sand of good sharp quality, equal to sample, which the Project Engineer shall approve. It shall be free from lumps of stone, earth, loam, dust, salt organic matter and any other deleterious substance, sieved through a fine sieve and washed if so directed by the Project Engineer.

D. LIME

- (i) Lime for mortar shall be non-hydraulic or semi-hydraulic quick lime or hydrated lime in accordance with B.S. 890, Class ‘B’.

Quick lime shall be run to putty immediate after delivery to the site in a pit dug on the site or in an approved container. The water to be first run into the pit or container and the lime to be added until it is completely submerged and stirred until all lumps are disintegrated and the resulting mild lime shall then be run through a 3mm.square mesh sieve and run into a pit or other container and kept clean and moist for not less than 4 weeks before use.

TRADE PREAMBLES

- (ii) Hydrated lime shall be added to water in a clean receptacle thoroughly mixed to the consistency of thick cream and allowed to stand, and be kept clean and moist for not less than 16 hours before use.

A. CEMENT MORTAR

Cement mortar shall be composed of Portland cement and sand in 1:4 ratio by volume, measured in specially prepared gauge boxes and thoroughly mixed in an approved mechanical mixer or mixed dry on a clean and approved mixing platform, with added afterward until all parts are completely incorporated and brought to a proper consistency. The use of re-tampering of wholly or partially set mortar will not be allowed.

B. CONCRETE BLOCKS

- (i) Concrete blocks shall be solid, hard, true to size and shape with sharp arises in accordance with B.S 2028 type 'A', and approved by the Project Engineer.
- (ii) They shall be obtained from an approved manufacturer or manufactured on site in approved block making machines. The cement aggregate mix used shall be not less than 1:9 by volume and the maximum size of aggregate shall not exceed 12mm.
- (iii) All solid and hollow concrete blocks used in walling must be capable of withstanding a crushing pressure of not less than 2.80 N/mm² after 28 days.
- (iv) The blocks on removal from the machine shall be carefully deposited on edge on racks under sheds erected by the Contractor and left for 3 days during which period they shall be kept constantly wet after which they shall be placed on edge in the open on racks and protected by sacking or other approved covering and kept wet for further 5 days. Thereafter the blocks shall be left in the same position without wetting for a further 20 days.
- (v) No blocks will be allowed to be used in the work until 28 days old and until samples have been taken and approved by the Project Engineer.

- (vi) They shall be laid dry except for the top surface, which shall be wetted immediately before mortar is spread on. After laying no further water shall be applied.
- (vii) The concrete blocks shall be 200mm.high to bond satisfactory with all other walling.

A. STONE WALLING

- (i) The stone for walling shall be sound and hard throughout, free from all defects, and shall be obtained from a quarry approved by the Project Engineer. It shall be chisel dressed into true rectangular blocks, with each surface even and at right angles to all adjoining surfaces.
- (ii) The contractor shall if necessary re-dress the beds of stones on the site to the minimum extent required to obtain uniformity of coursing, and his Tender shall be deemed to include for such re-dressing.
- (iii) Stone block for general walling shall nominally be 200mm. high, 90mm. 140mm or 190mm. thick as required for the works, the maximum permissible variations of any of the foregoing dimensions being 12mm.
- (iv) Stone shall not be less than 400mm. long but a proportion of 20% will be permissible in lengths between 300mm. and 400mm long. Samples shall be submitted to the Project Engineer for approval and when so approve shall become the standard for the works.

B. STABILIZED EARTH

These shall consist of cement mixed with selected approved red soil in a proportion not less than 1:20 by volume.

The manufacture and curing of the blocks shall generally be as described for concrete block above.

C. BEDDING AND JOINTING

The blocks shall be bedded and joined in cement and sand mortar as described with beds and joints not more than 12mm. or less than 6mm. thick, all flushed up and grouted solid as the work proceeds.

MASONRY AND BLOCKWORK (CONT'D)

A. REINFORCED WALLING

Walls of less than 200mm. thickness shall be reinforced with one of 20-gauge hoop iron 20mm. wide, built into every third course, well lapped at junctions and joints and carried at least 100mm. into abutting walls at intersections.

B. PROTECTION

All walling shall be properly protected while mortar is setting, as the Project Engineer shall direct.

C. SETTING OUT RODS

The contractor shall provide proper setting out rods and set out all work on the same for courses, opening heights, etc., and shall built the walls, piers, etc., to widths, depths and heights indicated on the Drawings. Setting out rods to be gauged in order to allow for an average height of 200mm for each course.

D. CURING OF WORK

All walls shall be maintained in a damp condition for at least 24 hours after laying. Wall under construction shall be damped by applying water with a brush and no hoisting directly on the wall shall be permitted. When the work ceases on any

section of the wall, polythene or Hessian shall be draped over the wall, for at least 24 hours. If Hessian is used it shall be maintained continuously wet.

E. WALL TIES

Wall ties shall be provided to connect walls to steel or concrete columns and beams to connect two unborded leaves of wall.

Wall ties shall be provided at 300mm centres both vertically and 600mm centres horizontally. Wall ties shall be staggered when used to connect two leaves of unborded walls.

ROOFING

A. GENERALLY

Bituminous felt, flashing, etc., have been measured the net area covered. Prices shall include for all straight cutting and waste and laps and in case of flashing, aprons, covering to kerfs, etc., where the net covered girth is measured and necessary overlaps for bond with adjoining areas.

BITUMINOUS FELT ROOFING

B. BUILT-UP ROOFING

The built-up roofing shall be in accordance with B.S 747 (classes 1,2, and 5) applied to a screeded base and shall comprise the following applications (see Clause 'E' below), laid strictly in accordance with the manufacturer's printed instructions and the Code of Practice 144.101.

C. STORAGE

Rolls must be transported and stored on end, one roll high, and adequately protected from the sun.

D. SCREED

The minimum fall for the screed on flat roofs be 1 in 30. The screed must be thoroughly dry and swept clean before commencing laying operations.

E. SEQUENCE

- (i) Jointing Compound: - One application of hot bituminous compound weighing not less than 16.3 Kgs per 10 square metres.
- (ii) First Layer: One layer of self-finished felt weighing not less than 13.6 Kgs per Sq. m.
(Class 1A)
- (iii) Jointing Compound: As described in (i) above.
- (iv) Second Layer: One layer of self-finished felt weighing not less than 13.6 Kgs per Sq. m.
(Class 1A)
- (v) Jointing Compound: As described in (i) above.
- (vi) Third Layer: One layer of mineral surfaced roofing felt weighing not less than 36.2 Kgs Per 10 Sq. m. (Colour to be decided by The Project Engineer)
(Class E)

RESINCOT PROFILED OR CORRUGATED GALVANISED SHEETS**A. MATERIALS:**

Resincot galvanized corrugated sheeting and accessories shall be of approved manufacture in accordance with B.S 3083 and of an approved colour. The thickness

of the sheeting shall be as specified and shall be laid and fixed strictly in accordance with the manufacturer's printed instructions.

Resincot galvanized profiled sheeting and accessories shall be approved manufacture in accordance with BS 3083 and of an approved colour. The thickness of the sheeting shall be as specified and shall be laid and fixed strictly in accordance with manufacturer printed instructions.

B. LAPS:

Sheeting shall be laid with ends laps of 150mm. and side laps of one corrugation on the side away from the prevailing wind.

C. FIXING TO PURLINS:

The sheets shall be fixed to 150 x 50mm timber purlins with 8mm. galvanized gimlet pointed screws 114mm. long. All screws and bolt fixings shall have "Selawasher" plastic washers or other equal and approved.

D. HOLES:

Holes shall be drilled through the ridges of corrugations, not in the hollows.

E. RIDGES ETC.

Ridges and other accessories shall be supplied as shown on the Drawing and shall be fixed to purlins as above described.

CARPENTRY

A. ALL TIMBER

Shall be in accordance with the latest approved Grading Rules issued by the Government of Kenya (Legal Notice No.358). Timber for carpentry shall be **SECOND (OR SELECT GRADE).**

B. GENERALLY

The Contractor as it arrives on the site shall inspect all timber, and any timer brought on the site and not complying with the specification or not approved must be

removed forthwith from the site and only timber as approved shall be used in the works.

The Contractor shall upon signing the contract, purchase sufficient supplies of specified hardwood to avoid possible shortage at a later date.

C. SPECIES OF TIMBER

The following timber shall be used: -

<u>Standard Common Name</u>	<u>Botanical Names</u>
Podocarpus	Podocarpus spp.
Cypress	Cypress
Cedar	Juniperus Procera
African Mahogany (munyama)	Khay Anthotheca
African Teak (Mvule)	Milicia excelsa

D. TOLERANCES IN THICKNESS

Shall conform with the following extracts from the Government of Kenya Grading Rules (or the metric equivalent).

(i) Hardwood Grading (First and Second Grades)

The following tolerances in thickness will be omitted: -

- (a) 1 ½ mm oversize on pieces up to 25mm in thickness
- (b) 3mm oversize on pieces over 25mm and up to 50mm in thickness
- (c) 6mm oversize on piece over 50mm in thickness.

- (ii) Softwood grading: Strength Grades (for Carpentry) first and second Grades. Undersize not allowed.

Oversize. All timber to be sawn oversize by 1 ½ mm per 25mm thickness and width. Not more than 3mm in thickness and not more than 6mm in width.

- (iii) Softwood Grading Appearance, Grades (for Joinery) First and Second Grades. All as for Strength Grades above.

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 this own cost all work necessary to eradicate insect attack of timber which becomes evident including the replacement of timber attack or suspected of being attacked, notwithstanding that the timber concerned may have already been inspected and passed as fit for use.

A. SEASONING OF TIMBER

All timber shall be seasoned to moisture content of not more than 22% for Carpentry.

B. PRESSURE IMPREGNATION TREATMENT

All carpentry timber, sawn joinery and timber groups for fixing shall be treated with pressure impregnated “Celcured” or “tanalith” solution with a minimum net retention of 5.6 Kg of dry salt per cubic meter. If so required “Charge Sheets” issued after treatment with “Celcured” or “Tanalith” shall be submitted by the Contractor to the Project Engineer for his retention. All cut ends and any other cut faces or timbers sawn after treatment shall be treated before fixing with “Celcured” B or “Wolmanol” solution brushed on. The contractor’s prices for such timber hereinafter must allow for the above treatment.

C. INSPECTION AND TESTING

The Project Engineer shall be given facilities for inspection of all works in progress whether in workshop or on site. The contractor is to allow for testing or prototypes of special construction and the Project Engineer shall be at liberty to select any samples he may require for the purpose of testing i.e. for moisture content, or identification, species strength, etc., such test will be carried out by the Forestry Department.

A. CLEARING UP

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

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

B. WORKMANSHIP

All carpenter's work shall be accurately set out strictly in accordance with the drawings and shall be framed together and securely fixed in the best responsible manner with properly made joints, all brands nails and screws shall be provided as necessary, directed, and approved, the contractor's prices shall allow for all the foregoing.

All workmanship shall be of the best quality.

C. DIMENSIONS

Dimensions of timber for carpentry left with sawn faces shall comply with the previous clause specifying tolerance in thickness. Dimensions for wrought members shall be as described in joinery.

D. JOINTING

All timber shall be as long as possible and practicable 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. If splitting is likely, or is encountered in the course of the work, holes for nails are to be prebored at diameter not exceeding $4/5^{\text{th}}$ of the diameter of the nails. Client nails must be bent at right angles to the grain.

Lead holes are to be bored for all screws. When the use of bolts is specified the holes are to be bored from both sides of the timber and are to be of the diameter $D/16$ where D is the diameter of the bolt. Nuts must be brought up tight but care is to be taken to avoid crushing of the timber under the washers.

JOINERY

A. ALL TIME TIMBER

All timber shall be First (OR PRIME) Grade. Species of timber tolerance shall be as defined under "Carpentry".

B. GENERALLY

All joiner's work shall be accurately set out on boards to full size for the information and guidance of the artisans before commencing the respective works, with all joints iron work and others connected therewith fully delineated. Such setting out must be submitted to the Project Engineer and approved before such respective works are commenced.

All joiners' work shall be cut out and framed together as soon after the commencement of the building as is practicable, but not wedged up or glued until the building is ready for fixing same. Any portions that warp, wind or develop shakes or other defects within six months after completion of the works shall be removed and new fixed in their place together with all other work which may be affected thereby all at the contractor's own expense.

All work shall be properly mortised, tenoned, housed shouldered, dovetailed, notched, pinned branded, etc., as directed and to the satisfaction of the Project Engineer and all properly glued up with the best quality glue.

Joints in joinery must be as specified or detailed, and so designed and secured as to resist or compensate for any stresses to which they may be subjected. All nails, sprig etc., are to be punched and puttied. Loose joints are to be made where provision must be made for shrinkage, glued joints where shrinkage need not be considered and where scaled joints are required. Glued for load bearing joints or where conditions may be guaranteed casein or organic glues may be used.

All exposed surfaces of joinery work shall be wrought and all arises “cased off” by planing and sandpapering an approved finish suitable to the specified treatment.

C. INSECT DAMAGE

All timber shall be free of insect damage as defined under “Carpentry”.

D. SEASONING OF TIMBER

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

A. DIMENSIONS

3mm reduction of specified sizes will be allowed to each wrought face except where described as finished size in which joinery shall hold up to the full dimensions.

The contractor is to note that all joinery timber size nominal unless otherwise stated as finished sizes. The nominal sizes have been calculated in accordance with Standard method of Measurement of Building works for East Africa 1st Edition metric and no regard has been taken of metre sizes of timber at present being sold.

B. FIXING JOINERY

All beads, fillets and small members shall be fixed with round or oval brads or nails well punched in and stopped. All larger members shall be fixed with screws. Brass

screw shall be used for fixing of all hardwoods, the heads let in and pelleted over with wood pellets to match the grain.

C. **BEDDING FRAMES ETC.**

The contractor's rates must include for bedding frames, sills, etc., in mortar or dressing surfaces of walls, etc. in lieu.

D. **PLUGGING CONCRETE AND WALLS**

Round wood plugs shall not be used, all work described a plugged shall be fixed with screws to plugs formed by drilling concrete walls, etc., with a proper tool of suitable size at 750mm spacings and filling the holes completely with "Philplug" rawl plastic or Rawlplugs in accordance with the manufacturer's instructions. Alternatively, and where so agreed by the Project Engineer hardwood dovetailed fixing slips dipped in "Wolmanol" or "Celcured" solution and cut and pinned or bedded in cement (1:3) mortar may be used.

E. **FIBREBOARD**

Shall be 12mm "Celotex" or equal and approved.

F. **PLYWOOD**

Shall comply with B.S 1455 (First Quality "interior type unless otherwise specified).

G. **BLOCKBOARD**

Shall be laminated board faced both sides with 4mm plywood. Exposed edges shall be lipped with 19mm hardwood and rates shall include for lipping.

A. **PLASTIC SHEETING**

Shall be "Formica" sheeting 1.5mm thick and securely fixed with approved type waterproof adhesive and in the colours approved by the Project Engineers.

B. **CHIPBOARD**

Shall be resin bonded and shall comply with BS 2604.

C. PROTECT JOINERY

Any fixed joinery which in the opinion of the Project Engineer 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.

D. FLUSH DOORS

All flush doors shall be manufactured to the thickness specified and consists of 100mm. Wide fixing all around with horizontal core battens not more than 75mm. Centre pressure impregnated as described and bored with 12mm diameter ventilation holes at 300mm centres. Doors shall have two lock blocks and be faced both sides with 6mm ply and have 25mm mvule twice rebated lipping all round or otherwise be equal to an approved sample. External flush doors shall be as described above but faced both sides with marine quality plywood; same should be for kitchen and bathroom.

E. PRICES TO INCLUDE

Prices of items hereafter shall include for the foregoing labours, etc., and in addition all prices for linear items are to include all internal and external angles, either mitred or tongued, all fair fitted, stopped, notched or returned ends all similar incidental labours and all the lengths.

F. BOTTOM EDGES

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

G. IRONMONGERY

All locks ironmongery shall be fixed with screws etc. to match. Before the woodwork is painted, handles shall be removed. Carefully stored and refixed after completion of painting and locks oiled and left in project working order. All keys shall be labelled with the door reference marked on labels before handing to the Project Engineer on completion.

IRONMONGERY

A. GENERALLY

All ironmongery shall be fitted and fixed in accordance with the manufacturer's printed instructions. Rates for fixing are to include for all cutting, sinking, boring, notching and fitting in hardwood or softwood and for supplying all necessary and matching screws.

All locks shall be provided with a master key system and prices shall include for this. The requirement must be obtained by the contractor before ordering. The keys of all locks shall have labels attached with door reference marked on before handing to the Project Engineer.

B. MOVEABLE PARTS

All locks, springs and other items of ironmongery with moveable parts shall be properly tested, cleaned and adjusted where necessary to ensure proper working order at the completion of the works and left in perfect working order by the Contractor.

C. SAMPLES

- (i) Samples of all ironmongery specified shall be submitted to the Project Engineer for approval and the approved samples shall thereafter be regarded as the standard for the work. Ironmongery, which in the opinion of the Project Engineer does not conform to this standard, shall be removed from the site.
- (ii) Alternatively, ironmongery of an equal standard will be acceptable providing samples are submitted to and approved by the Project Engineer before orders for such ironmongery are placed.

METAL WORK

A. ALL MATERIALS

Shall be of the best quality, free from defects. The materials in all stages of transportation, handling and piling shall be kept clean and injury from breaking, bending and distortion prevented.

B. NAILS, SCREWS AND BOLTS

Shall be of the best quality stainless steel grade 316 of lengths and weight approved by the Project Engineer. Nails shall be to B.S. 1202 and bolt to B.S. 916.

C. WORKMANSHIP

All work shall be carried out in the most workmanlike manner and strictly as directed by the Project Engineer.

Welding shall be neatly cleaned off and units shall be prefabricated in the workshop wherever possible, the minimum of site welding being employed.

All screwed work shall have full internal and external threads and holes shall have been cleaned off. Counter sinkings must be concentric.

D. NACO LOUVRES

Shall be of steel, aluminium-lacquered, single control type, unless otherwise described, carefully screwed into timber sub-frames or plugged and screwed to walling. Louvers of equal quality of other manufacture may be substituted on approval.

Prices shall include for oiling and adjusting and leaving clean and undamaged on completion.

E. MILD STEEL

For burglar bars and reinforcement shall comply with B.S. 19 No. work shall be fabricated until the site dimensions have been checked and no additional claim will be accepted should final dimension differ from these on the drawings.

All welds shall be ground smooth and the contractor shall ensure that the metalwork is prepared for painting as described in painting and decorating.

The contractor is to ensure that all work is erected plumb and true and be so maintained until properly secured by permanent fixings.

A. PAINTING

All steel is to be sand blasted and any loose scale, dirt or grease shall be removed before any painting is commenced. One coat of red oxide primer type A to B.S 2523 shall be applied at the shop.

Any damage to the priming paint shall be made good to the Project Engineer's satisfaction.

B. MATERIALS GENERALLY

(i) MATERIALS

Specified in this section may be applicable to any or all the subsequent sub trades in metalwork.

(ii) SUPPLIERS

Obtain all materials from suppliers approved by the Engineers.

(iii) STANDARDS

Produce the manufacturer's certificate of compliance with the standards specified if so requested by the Engineer.

(iv) FINISHES

Metal commodities for making components must be either pre-finished or suitable to receive the finishes specified.

C. SECTION ETC.

(i) HOT ROLLED STEEL SECTIONS

Except equal and unequal angles: to B.S. 4: part 1, made from steel to B.S. 4360 part 2.

(ii) HOT ROLLED EQUAL AND UNEQUAL ANGLES

Part 1 (metric converted from imperial dimensions) or to B.S. 4848: part 4 accordinated metric dimensions. Do not substitute sections or dimensions other than those specified without the prior approval of the Engineer.

(iii) HOT ROLLED HOLLOW STEEL SECTIONS

Part 2, made from steel to B.S. 4360: part 2.

(iv) HOT ROLLED STEEL BARS

To B.S. 4449.

(v) COLD ROLLED STEEL SECTION

To B.S. 2994, made from steel to B.S. 1449: part 1 B (HR, CR, HS, OR CS quality unless otherwise specified or shown on the drawings).

(vi) STEEL TUBES AND TUBULARS

To B.S. 1387 medium thickness unless otherwise specified. If steel tubes to B.S. 1775 are required they will be specified or shown on the drawings.

(vii) STAINLESS STEEL TUBES

To B.S. 3014, welded unless otherwise specified.

(viii) COPPER AND ALUMINUM ALLOYS

If the alloy is not specified or stated on the drawings, it is to be suitable for the application.

(ix) ALUMINUM ALLOY BARS, TUBES AND SECTIONS

To B.S. 1161 AND B.S 1474.

(x) COPPER AND COPPER ALOY RODS AND SECTIONS

To B.S. 2874

(xi) COPPER AND COPPEY ALLOY TUBES

To B.S. 2871: part 2

(xii) TIMBER FOR CORES OF DRAWN SECTIONS

To B.S. 1186: part 1, concealed surfaces class, straight grained of mahogany or other approved hardwood.

A. MESH

(i) STEEL MESH FABRIC

To B.S. welded type, and square, structural or long mesh as specified or shown on the drawing.

(ii) MOSQUITO MESH

Approved fine wire mesh or gauze of non-corroding metal, for example aluminium.

B. PLATE SHEET AND STRIP

(i) STEEL PLATE

For welding to B.S. 4360, section 2 unless otherwise specified. Steel to this standard is equally suitable for bolting and riveting, and may be used unless steel plate to B.S. 1449 is specified.

PAVINGS AND PLASTERWORK

A. GENERALLY.

- (i) Prices for paving shall include for preparation of concrete floor and painting with cement grout as described, and any extra thickness consequent upon the floor not being finished to the true levels and also for all temporary rules and for all formwork to stop pavings at openings or edges as required. Prices for tile and similar paving shall include for any pointing to exposed edges.
- (ii) Plastering to walls has been measured over concrete columns, lintels, etc., flush with wall face, and prices for plastering shall include for hacking concrete or for raking out joints to form key, and for any necessary rubbing out.
- (iii) Prices of superficial items of paving and plastering are to include for narrow widths and small quantities, fair edges and arises, rounded external angles up to 10mm. radius, making good to metal windows or door frames and making good around pipes, holder bats, and other metalwork and for all similar incidental labours unless specifically measured.
- (iv) Prices of lineal items are to include for all short lengths, angles, arises, mitres, ends and the like and for all necessary rubbing out.

- (v) Prices for floor or wall tiling shall include for all straight cutting and waste, small quantities and narrow widths.

B. CEMENT

Cement shall be described in “Concrete Work”.

C. SAND

Sand shall be as described in “Masonry and Blockwork”.

D. LIME

Lime and treatment before use shall be as described in “Masonry and Blockwork” except that it shall comply with B.S. 890, Class ‘A’.

E. WATERPROOFING COMPOUNDS

All waterproofing compounds are to be to the Project Engineer’s approval and used strictly in accordance with the manufacturer’s printed directions.

A. PAVING

All materials for paving and plastering must be measured in proper gauge boxes in the proportions specified and mixed on clean wood or iron platforms and turned over at least three times dry until the mix is of a uniform colour. Water shall then be added by means of a rose nozzle and the materials again turned over until the mass is thoroughly mixed with water. Alternatively, mechanical mixing methods may be used to obtain the same result as approved by the Project Engineer.

B. PREPARATION FOR PAVING AND SCREEDS

As soon as the paving has set sufficiently, it is to be covered with a well wetted layer of sawdust, Hessian or other approved material and this layer is to be kept damp for at least seven days during which period no traffic is to be allowed over paving. When no longer required as a protection to the surface, the materials are to be removed the paving left clean and perfect.

All paving shall be laid with joints coinciding with the construction joints in the concrete beds upon which they are laid and the pattern set out accordingly.

C. VERMICULITE ROOF SCREEDS

Vermiculite screeds are to be mixed in the proportions of 250 kgs. Pozzolana cement to 1 cubic metre Vermiculite Grade 5, all in strict accordance with the Manufacturer's printed instructions. The screed is to be finished with 10 mm cement and sand (1:3), troweled smooth to receive roof finish as previously specified. No vermiculite is to be laid in rainy weather and screeds are not to be walked on for three days after lying.

D. SCREEDS TO RECEIVE FLOOR AND WALL FINISHES

There are to be laid true and level, particular care being taken to obtain a perfectly smooth surface to receive P.V.C and similar floor finishing.

E. CEMENT AND SAND PAVINGS

To be in cement and sand (1:4) and finished perfectly smooth with a steel trowel.

E. SKIRTINGS

Skirtings to cement paved floors shall be in cement and sand (1:4) to match the paving, with rounded edges and 38 mm radius cove at junction with paving.

A. JUNCTION STRIPS

At the junction of differing floor finishing fix in position 3mm x 25mm plastic jointing strips cut to lengths, bedded in and finished flush with pavings. All plastic jointing strip shall be black in colour.

B. FLOOR HARDENER

This shall be cast insitu with screed as specified with three coats of sodium silicate or other equal and approved hardener in accordance with the manufacturer's instructions.

C. GRANOLITHIC AND TERRAZZO PAVING AND WALL FINISHES

(a) GENERALLY

- (i) Construction joints between bays of paving are to be straight and vertical and are to coincide as far as possible, with those in the concrete under.
- (ii) After spreading and before finally striking to screen levels the pavings etc., are to be lightly tamped each stage of laying operation is to be properly carried out at the optimum degree of stiffness of the mix so that the aggregate remains correctly distributed throughout the pavings etc., and so finished that the surface is true to level, dense, smooth and free of laitance and other defects and blemishes. The use of dry cement or sand to absorb surplus moisture will not be allowed.
- (iii) The thickness of the pavings etc., in these Bills of Quantities include for the combine screed or backing and granolithic or terrazzo finish.
- (iv) All granolithic and terrazzo finishing shall be divided into areas not exceeding 3 square metres with dividing strips as specified.

GRANOLITHIC AND TERRAZZO PAVING AND WALL FINISHES (CONT'D)

(b) SCREED AND BACKING

To be in cement and sand (1:4).

(c) GRANOLITHIC

- (i) To be composed by volume of one part of cement, one part of sand and two parts 6mm black trap chippings free of dust laid or applied to screeds or backings whilst they are still green.

- (ii) Paving shall be 40mm minimum combined thickness comprising 20mm thick cement and sand (1:4) backing and 20mm. thick granolithic.
- (iii) Dados shall be 20mm minimum combined thickness comprising 12mm thick cement and sand (1:4) backing and 8mm thick granolithic.
- (iv) Polished granolithic to be finished with a metal roller and all surplus cement lightly brushed off when surface is sufficiently hard to resist dislodgement of aggregate, when the surface is hard enough it shall be wet ground, using a machine, until the aggregate is uniformly revealed and then well washed with clean water. Any small voids or holes left in the surface are to be filled with cement grout rubbed down-by hand. Mouldings etc. not accessible to machines are to be hand rubbed and polished with carborundum. After an interval of 1 to 3 days the surface is to be finally machine ground using the fine abrasive.

(d) TERRAZZO

- (i) To be composed of one part of “Snowcrete” “Colourcrete” or other equal and approved white or coloured cement to two parts of clean imported marble chippings well washed and free from dust. The marble chipping may vary in colour and from 3mm to 9mm dependent on the effect required and sample areas must be prepared for Project Engineer's approval.
- (ii) Pavings to be 25mm minimum thickness overall. As for granolithic (ii) preceding.
- (iii) Polished terrazzo to be finished as granolithic (iv) preceding.

A. PLASTIC DIVIDING STRIP

To be 3mm x 25mm strip set in position before paving is commenced, and embedded straight and true.

B. PLASTERING GENERALLY

- (i) All surfaces to be plastered or rendered shall be brushed clean and be well wetted before plaster is applied. All plaster and rendering shall be kept continuously damp for seven days after application.

All arises shall be finished true and slightly rounded except where otherwise stated, and shall be run at the same time as the adjoining plaster.

No partially or wholly set plaster or rendering will be allowed to be used or re-mixed.

- (ii) The contractor shall prepare samples of the plastering and rendering as directed until the quality texture and finish required is obtained and approved by the Project Engineer, after which all plastering executed in the work shall conform to the respective approved samples.
- (iii) The contractor shall cut out and make good all cracks, blisters and other defects and leave the whole of the work perfect on completion. When making good defects, the plaster or rendering shall be cut out to a rectangular shape with edges undercut to form dovetailed key, and all finished flush with face of surrounding plaster or rendering.

C. INTERNAL OR EXTERNAL CEMENT AND SAND RENDER

Plaster described as internal cement and sand (1:4) render or external cement and sand (1:4) render shall be executed in two coats and be composed of one-part cement to four parts sand. The first coat shall be laid to a uniform surface finished with wood float well scored and allowed to dry out for at least 7 days before

applying the finishing coat. The second or finishing coat shall be thoroughly worked and finished hard and true with a steel trowel or wood float as specified hereinafter. The total finished thickness of plaster shall be not less than 12mm thick.

A. INTERNAL GAUGED PLASTER

Plaster described as “Internal gauged plaster in two coats” shall consist of a first or rendering coat composed of one-part cement, two parts lime and nine parts sand and a finishing coat composed of one-part cement, three parts lime and six parts sand. Application and thickness will be as for last item.

B. GLAZED WALL TILING

- (i) Glazed wall tiles shall be 600 x 300 x 6mm thick cushion and tiles with matching fittings, all conforming to B.S 1281 in colours specified by the Project Engineers.
- (ii) Tiles are to be bedded in an approved tile-fixing compound applied strictly in accordance with the manufacturer's printed instructions.
- (iii) Walls are to be dry before tiles are fixed and tiles are not to be soaked in water before use. Tiling is to be set and closely straight jointed with 1.5mm joints. If non-lu tiles are used, cardboard or plastic spacer pieces are to be used to obtain constant joint width. On completion tiling is to be pointed in white or coloured cement and cleaned down.

GLAZING

A. GENERALLY

- (i) Glass for glazing and mirrors shall be of approved manufacture and is to comply with B.S. 952 in all respects, free from flaws, bubbles, specks and other imperfections.

- (ii) Each pane of glass where its dimensions contain fractions of centimeter above both in width and height. Louver blades have been similarly measured in regard to length.
- (iii) Prices for glazing shall include for back-puttying, fixing glazing clips of springing as required, cutting glass to sizes, cleaning all glass inside and out, removing all paint and putty marks, replacing any broken, scratched or cracked panes and leaving all glazing sound and perfect at completion.

B. CLEAR SHEET GLASS

Clear sheet glass shall be Ordinary Glazing (Q.Q) quality.

C. POLISHED PLATE GLASS

Polished plate and Georgian wired polished plate to be General Glazing (G.Q) quality.

D. OBSCURED GLASS

To be of the types described and as approved by the Project Engineers.

E. MIRRORS

To be S.Q quality plate glass mirrors of approved manufacture with beveled edges and fixed at all corners to walls with raw plugs and brass screws with removable chromium-plate dome heads.

F. PUTTY

- (i) The putty for glazing to metal windows is to be gold size metal window putty specially designed for tropical use, all as B.S 544 (Type 2 putty) or patent mastic putty as approved by the Project Engineer.

- (ii) All putty shall be delivered on site in the original manufacturer's sealed cans or drums and used direct there from, with the addition only of pure linseed oil if necessary. No mineral or other oils may be used in the putties except genuine linseed oil.

A. GLAZING

- (i) Glass panes shall be cut to sizes to fit the openings with more than 1.5mm play round.
- (ii) The rebates of all windows shall be painted one coat before puttying.
- (iii) All glass, where fixed with putty, is to be back and front puttied and care must be taken to ensure that putty does not project beyond the sight lines of panes and is to be neatly mitred at angles.
- (iv) Putty, which has not set hard within seven days, must be removed and the glass re-putted at the contractor's expense.
- (v) Allow for removing all cracked or broken panes of glass, cleaning rebates and re-glazing with new glass throughout the progress of the works and for cleaning all glass on both sides and leaving perfect upon completion.

B. BEDDING STRIPS

Wash-leather, velvet, etc., bedding strip to edges of glass is to be sufficient width to be turned over 6mm to each side of pane and shall be trimmed to the sight lines of the pane.

PAINTING

A. GENERALLY

- (i) Prices must include for rubbing down with glass paper between successive coats and all cutting in at edge.
- (ii) Prices shall include for all work in parti-colours and all cuttings to line.

B. MATERIALS

- (i) Paints shall be obtained from M/s Crown Paints or other manufacturers approved by the Project Engineer.
- (ii) The materials for all other finishes shall be of the best quality available of approved manufacture.
- (iii) Before commencing painting, the Contractor shall submit to the Project Engineer for approval a list of all the brands of paints and finishing including the necessary primers and undercoats he intends to use and immediately upon being so approved, orders shall be placed and total requirements obtained for the works.
- (iv) Once approved, no other brand of material shall be used without the express permission of the Project Engineer, in writing.

C. MORDANT SOLUTION

All galvanized metal work to be painted shall first receive a coat of a propriety mordant solution, approved by the Project Engineer as suitable for this purpose.

D. KNOTTING

To B.S 1336.

E. STOPPING

To be composed of linseed oil putty, white lead, red lead and gold size suitable proportioned and mixed.

F. POLYURETHENE

To be polyurethane approved by the Project Engineer.

G. WAX POLISH

Wash polish is to be furniture polish of an approved proprietary brand.

PAINTING

TRADE PREAMBLES

PAINTING (CONT'D)

A. DELIVERY OF PAINTS TO SITE

- (i) All paints etc., shall be delivered on site in the original drums or tins, and shall be mixed and applied strictly in accordance with the manufacturer's printed directions. The only addition which will be allowed to be made will be liquid thinners, driers etc., supplied by the makers for the purpose. No paint, distemper, etc., shall be thinned more than approved by the Project Engineer.
- (ii) Paint for external work shall be of the special quality recommended by the manufacturers for external use.

B. GENERAL WORKMANSHIP

- (i) The priming, undercoats and finishing coats shall each one be of different tints and the priming and undercoats shall be the correct brands and tints to suit the respective finishing coats, all in accordance with the manufacturer's directions.
- (ii) All surfaces must be thoroughly cleaned down previous to painting and decoration work and no external painting may be done in rainy weather. All paint must be thoroughly well worked on and excess of paint in any coat must be avoided.
- (iii) All brushes, tools and receptacles are to be kept clean and free from dirt or old paint and are to be thoroughly cleaned each time after use.
- (iv) Each coat is to be well brushed into the surface so that every part, including joints, angles etc., is adequately covered, but care is to be taken to avoid excessive or uneven thickness of paint film, particularly at edges and in angles, etc.
- (v) Each coat of paint etc. shall be properly dry and shall be well rubbed down with fine sandpaper and be brushed clean before the next coat is applied. The paintwork shall be finished smooth and free from brush marks.
- (vi) Where so required or directed, painting shall be in parti-colored and picked out and cut in and the prices shall include for this.

PAINTING (CONT'D)

GENERAL WORKMANSHIP (CONT'D)

- (vii) All ironmongery, metal or plastic plates and electrical outlet plates and fitting and the like shall be removed before painting is commenced, and re-fixed on the completion of the work.
- (viii) The Project Engineer will allow no sprays or roller painting unless permission is given.
- (ix) The contractor shall so arrange his programmed of work that all other trades are completed and away from the area to be painted when painting begins.

A. SAMPLES AND COLOURS

He Project Engineer will select all colors from the B.S range of colors. Samples and colour cards of all paints, distemper, and materials shall be submitted for approval of the Project Engineer before the same are applied and sample panels shall be executed for the Project Engineer's approval where directed. Such samples when approved shall become the standard for the work.

B. PREPARATION AND PRIMING OF PAINTED SURFACES

(a) PLASTERED AND RENDERED SURFACES

- (i) Plastered surfaces are to be perfectly smooth, free from defect and ready for decorations. All such surfaces shall be allowed to dry for a minimum period of four weeks and rubbed down with No.2 grade sandpaper to remove trowel marks stains, etc. After the priming coat, all cracks and imperfections are to be made good with 'Polyfilla' (or a similar approved hard filler), well rubbed down and then touched up with the priming coat.
- (ii) Priming for plastic emulsion paint shall be the paint thinned with 25 percent water.
- (iii) Priming for oil paint shall be with alkali-resistant primer.

(b) HARDBOARD SURFACES

- (i) Priming for plastic emulsion paint shall be the paint thinned with 25 percent water.
- (ii) Priming for oil paint shall be with a thin oil primer.

PREPARATION AND PRIMING OF PAINTED SURFACES (CONT'D)**(c) FERROUS METALWORK**

All surfaces shall be thoroughly brushed down with wire brushes to remove all scale, rust, etc., and rubbed down with No.2 Grade sandpaper and brushed and left perfectly clean immediately prior to decoration

- (i) Shop-Primed: Surface to receive oil paint shall have all bare places touched up with approved metal zinc chromate primer.
- (ii) Unprimed: Surface shall be given one coat of primer as last.
- (iii) Galvanized: Surface shall be treated before painting with mordant solution. The surfaces shall then be thoroughly washed down with clean water, allowed to dry and primed as last.
- (iv) Coated: Surfaces already treated with bituminous solution shall receive an insulating coat of anti-bitumen primer or 'Shellac' knotting.

(d) WOOD SURFACES TO RECEIVE PAINT

- (i) The woodwork shall have all knots or resinous parts carefully treated with self-knotting aluminum primer. All cracks, nails, or other holes shall be thoroughly cleaned out and after priming all such cracks etc., are to be filled with matching hard stopping which is to be rubbed down flush with the adjoining surface.
- (ii) Priming for oil paint shall be self-knotting aluminum primer.
- (iii) The back of all joinery work is to be primed before fixing.

A. PREPARATION, PRIMING ETC., OF CLEAR TREATED WOOD SURFACE

All wood surfaces to receive clear treatment shall be rubbed down to a stain finish with fine sandpaper immediately prior to application.

B. COVERING UP

All floors etc., shall be covered up with dustsheets when executing all painting and decorating work.

C. DELIVER UP CLEAN

Paint splashes, spots and stains, shall be removed from floors, woodwork, etc. Any damaged surfaces shall be toughed up and the whole of the work left clean and perfect upon completion.

ROAD WORKS**A GENERALLY**

The Specification of work and materials in this section, which repeat similar work in proceeding sections, shall be deemed to the full specification of work and materials contained in the preceding Bills.

ACCESS ROADS AND CAR PARKS**B EXCAVATION**

Excavation shall be to levels approved by the Project Engineer. All soft spots are to be excavated and filled with approved filling thoroughly compacted.

C FALLS

Roads and car parks shall have a minimum fall of 1 in 40. The actual falls will be decided by the Project Engineers on Site.

D COMPACTION OF FORMATION

The maximum dry density of the soils to be compacted shall be determined by Test 9 as described in B.S. 1377/49.

The dry density of the soil in the filed shall be determined by Test 10 as described in B.S. 1377/49.

The relative compaction of the formation shall be determined by the percentage rates of the dry density in the field (Test 10) to the maximum dry density (Test 9).

The relative compaction of the formation is to be not less than 100% when compacted at optimum moisture content plus a minus 2%. Water shall be used as necessary to achieve the desired moisture content.

E COMPACTION ON SUB-BASE

The murram sub-base shall be built up in layers as described hereafter, each layer shall be compacted at B.S. optimum moisture content plus or minus 2% until relative compaction is obtained of 95% for the lower layer and 102% for the top layer. Water shall be used as necessary to achieve the desired moisture content.

EXTERNAL WORKS (CONT'D)

A MURRAM SUB-BASE

The murram shall be approved clean, hard, dark coloured; Imported murram free from all vegetable matter, clay or other deleterious substances and obtained from an approved source.

The murram sub-base shall be 150mm, Thick (finished) laid in two layers to the required compaction as described herein to form on completion a firm dense surface.

B. HAND PACKED STONE BASE MATERIAL

The rock from which the stone and screenings are to be produced shall comply with the following: -

ACV: not greater than 40%

LAA: not greater than 60%

SSS: loss on 5 cycles to be not more than 12%

The stones shall be free from an excess of flat or elongated particles; soft and less durable rock, clays, loam, topsoil and other deleterious matter. The larger stones shall have a maximum dimension slightly greater than the thickness of the required compacted layer and be of a shape acceptable to the Engineer. The smaller stones shall have a reasonably uniform grading and be of a nominal size suitable, in the opinion of the Engineer, for filling the surface voids of the as placed larger stones. The nominal size will be of the order of 50 mm (2").

The screenings shall consist of tough durable crushed rock, free from an excess of flat, elongated, soft or disintegrated pieces and harmful material, such as loam, clay, organic matter, or other deleterious substances and shall be to the Engineer's approval. The grading of the screenings shall form a smooth curve and shall be within, and approximately parallel to, the following grading limits: -

BS Sieve Size	Percentage by Weight Passing BS Sieves
3/8 "	100
3/16"	85 – 100
No. 36	30 – 50
No. 100	10 – 30
No. 200	0 – 20

Sandy soil which may, with the approval of the Engineer, be added to the screenings or used in lieu of the screenings, shall comply with the following requirements: -

- (i) It shall consist mainly of sand sizes and have a reasonable smooth grading.
- (ii) The fraction passing No. 200 sieve shall be less than half the weight passing No. 36 sieve.
- (iii) PI shall not be greater than 5%.

STOCKPILING MATERIAL

The site of the stockpile shall be levelled, graded and drained, all vegetation removed and if necessary the area shall be surfaced with murrum or other material as directed by the Engineer. Each category of material shall be stockpiled separately and not intermingled with each other or any other material.

PLACEMENT OF STONE FOR HANDPACKED STONE BASE

On the prepared area, the pitching stone shall first be laid, each individual stone being positioned by hand, closely packed with the greatest dimension vertical, and the largest and flattest and downwards. The majority of the stones will be slightly higher than the final thickness of layer required. When an area has been covered in this way a second placing of stones of smaller size, keystone, shall be positioned in the spaces between those first placed and shall be wedged home by hammering. The points of pitching stone projecting beyond the required height shall then be knapped, and a third placing of stone shall follow the second and so on until in the opinion of the Engineer the voids are sufficiently filled to permit compaction. No hand packed stone layer of greater compaction thickness than 230 mm shall be laid.

COMPACTION AND SLUSHING

After placement of the stone in the specified manner the material shall be initially compacted with a heavy smooth steel-wheeled roller, weighing not less than 12 tone and/or vibratory roller, and shall continue until the layer is thoroughly keyed, showing virtually no movement under or ahead of the roller.

All rolling shall be longitudinal and shall commence at the outer edges of the road, and progress towards the center of the road except that on super-elevated curves, rolling may progress from the lower to the higher edge.

The irregularities that may show up during compaction shall be corrected by loosening the surface removing or adding material as may be required, and recomposing.

After the stone has been rolled and keyed, binder material, where necessary, shall be spread dry in thin layers and boomed into the interstices and dry rolling continued with approved vibratory and smooth swivel-wheeled rollers until no more binding material will go in.

The layer shall then be saturated with water slushed and compacted with a smooth-steel-wheeled roller weighing not less than 12 tonnes. This rolling and slushing, with the addition of more binder material where necessary shall continue until all surface voids are filled and there is no visible movement under the roller.

All surplus fines shall be brushed off to expose a closely-knit compact mosaic of stones as the finished surface of the layer.

A. TOLERANCES FOR HANDPACKED STONE BASE

The following tolerances shall apply to the hand packed stone base course: -

Thickness	3m Straight Edge	(iv) Width
+ 10 mm	+ 6 mm	+ 150 mm
- 0 mm	- 6 mm	- 0 mm

B. MEASUREMENT AND PAYMENT FOR HANDPACKED STONE BASE

The hand packed stone base material will be paid for per cubic metre of material measured in place upon the road. The volume of material shall be calculated as the product of the compacted thickness specified or ordered by the Engineer and the net area requiring to be laid. The rate shall be the full inclusive price for providing spreading and compacting the material.

C. PRIMING COAT

The priming coat shall consist of Grade MC 30. Medium curing cutback bitumen or emulsion as directed by the Project Engineer.

Priming shall not commence until all loose fines, superficial films and foreign material have been removed from the surface of the base by sweeping with mechanical or hard hand broom. The prepared base shall be watered, if necessary, in order to ensure that the surface is damp when the prime coat is being applied. Care shall be taken not to cause free water to lie on the surface.

On the properly cleaned and prepared base, the MC 30 cut back bitumen shall be applied at a temperature of 43°C, and at a rate of 1 litre per square metre by means of a pressure distributor. The prime coat shall be applied over the full width of the base and shall be left undisturbed for a period of not less than two (2) days and preferably until complete absorption has taken place and the applied prime coat has dried off thoroughly. Any excess prime remaining on the surface shall be blotted with crusher fines or sand.

After the primer has been applied the surface of the base shall be checked for smoothness and accuracy of elevation, grade and cross-section and any irregularities or inaccuracies shall be corrected by filling in or surfacing with premixed bituminous material and compacting until specified requirements are obtained to the satisfaction of the Project Engineer, all at the Contractor's expense.

PREMIX SURFACING

PREMIX WEARING COURSE

.01 The Term "Premix" shall mean mixture of dried, hot aggregate of pre-determined grading and hot straight run bitumen in pre-determined quantity to give adequate strength and stability and shall apply both to the mix and the compacted layer on the road.

.02 The actual quantity of binder and the aggregate used in various proportions shall be determined by laboratory tests and trial mixes.

.03 The Contractor shall be responsible for the design of the mix and shall provide the design information to the Engineer together with sample sections on the site

based on the designed proportions of the aggregate and binder to the Engineer's approval.

.04 Once the design mix has been approved it shall not be varied by the Contractor without written authority of the Engineer.

.05 Notwithstanding the Engineer's approval the Contractor shall be responsible for compliance with the provisions of this Specification.

.06 The Materials used shall comply with the following requirements: -

.01 Bitumen grades 80/100

.02 **COARSE AGGREGATE**

.01 Los Angeles Abrasions – Max. 35

.02 Aggregate Crushing Value – Max 28

.03 Sodium Sulphate Soundness – Max 12

.03 **FINE AGGREGATE**

.01 Sand equivalent min. 40.

.02 Sodium Sulphate Soundness max 12.

.04 **MINERAL FILLER**

.01 Shall be cement, lime, limestone or other mineral matter and shall be NON-PLASTIC

.05 **GRADING**

.01 Passing 0.425mm 100%

.02 Passing 0.075mm 75%

.06 **GRADING**

The mix grading shall comply with the table below: -

Sieve Size	Percentage by Weight Passing
------------	---------------------------------

14	100
10	90 – 100
6.3	62 – 92
4	50 – 80
2	35 – 65
1	25 – 50
0.425	14 – 33
0.300	11 – 27
0.150	6 – 27
0.075	3 – 8

.07 PREMIX WEARING COURSE

.08 Asphalt Mix

The mix shall comply with the following table: -

Test	Result Required
.01 Crushing Ratio	60 – 100%
.02 Marshall Stability (N) (Test ASTM, D 1559)	5000 – 9000
.03 Flow (mm)	2 – 5
.04 Voids in total mix (%)	3 – 8

.08 Mixing shall be carried out in an approved stationary plant at controlled temperatures as follows: -

.01 The materials shall be mixed in such a manner that on discharge from the mixer the mixture is uniform in composition and all particles of the aggregate are

completely coated. The mixing time shall be the minimum to ensure such coating and shall not exceed 90 secs. From the addition of the bitumen.

.09 When permitted by the Engineer, soil binder material may be added to screenings or used in lieu of screenings, provided it complies with the following requirements: -

.01 The fraction passing BS sieve No. 200 shall be less than half that passing No. 36 sieve.

.02 The plasticity index shall be not greater than 8 and preferably not greater than 5.

.09 MURRAM (GRAVEL) FOR SUB-BASE MATERIAL

.01 Where murram is specified for sub-base construction, naturally occurring lateritic gravel or decomposed stone and coral shall be used. The material may be in either a loose or cemented to an acceptable size on the roadbed during consolidation. The proportion of clay in the material must not be excessive and test results for the grading of the material and the Attenburg Limits must be produced by the Contractor prior to any material being delivered to site.

A. MANUFACTURE AND LAYING

The premix shall be manufactured in an approved plant and shall, where required by the Project Engineer be laid by means of an approved paving machine such as a Blaw-Knox or Barber-Green type paver, or otherwise shall be laid in an approved manner.

B. BITUMEN

The bitumen used in the premix shall be straight-run bitumen as follows: -

Base Course	-	80 - 100
		Penetration
Wearing Course	-	80 – 100
		Penetration

The bitumen shall be from an approved source delivered in sealed drums and opened with care to ensure cleanliness.

.10 BITUMEN AND BITUMEN EMULSIONS

.01 Before any bitumen or bitumen emulsion is delivered to the site, the Contractor shall provide the Engineer with a certificate from the manufacturer that the material to be supplied complies in all respects to the relevant specification given or referred to hereinafter.

.02 Any bitumen or bitumen emulsion delivered in leaking containers or deteriorated containers may be rejected. The types of bitumen binders required will normally be as follows: -

.01 Prime Coat

On stone base course (R.C. 30 or MC 30)

On stabilized base course (Alternatively R.C.

Or MC 1)

A. AGGREGATE

The aggregate shall be black trap, hard, dense stone free from dust, impurities or a mixture of softer stone. Before commencing manufacture the Contractor must submit to the Project Engineer samples of all sizes of stone he proposes to use and these, when approved, shall form the standard for the work. If the samples are rejected, the Contractor shall be responsible for providing samples from alternative sources.

B. BASE COURSE

The base course premix shall be of the specified thickness after consolidation of crushed black trap aggregate with 80 – 100 penetration straight run bitumen and approved filler.

The grading shall comply with Table 2 of B.S. 1621. The soluble bitumen binder minimum shall be raised from 3.0% to 3.5%.

C. WEARING COURSE

The wearing course premix shall be of the specified thickness after consolidation of crushed black trap aggregate with 80 – 100 penetration straight run bitumen and approved filler.

The grading complies with Table 5 of B.S. 1621.

The finish surface shall be to the required gradients and cambers and shall be well rolled and neatly finished off at all curbs, walls, drainage galleys etc., to the approval of the Project Engineer.

D. CONCRETE KERBS

The rates entered by the Tenderer in Bills of Quantities for the provision and placing of precast concrete kerbs shall include for all necessary concrete bedding and haunching, and all necessary shuttering all in accordance with the specification and the drawings.

Concrete kerbs shall comply with B.S. 340 (Figure 7) for 250 x 125mm splayed, plain or circled kerbs.

Kerbs will be set on concrete (1:3:6) foundations size 225mm wide x 100mm thick and a 100mm thick x 200mm high haunching behind.

Kerbs to be bedded, jointed and pointed in cement mortar (1:3) and to be laid true to line, perfectly level or to even gradients and to be free from all chips, cracks, blemishes and cement stains at joints.

A. WORKMANSHIP

Excavation in Trench for Pipe Culverts, Headwalls and Wing walls

.01 Trenches for culverts, headwalls, wing walls shall be excavated to line and depths shown on the drawings or as directed by the Engineer and shall be of

sufficient width to give working clearance in the trench but for the purpose of measurement and payment, the width of the trench shall be taken as $1.5D$ where D is the outside measurement of the pipe. Backfilling of trenches around culverts shall be done to a density of 100% BS Compaction. Excavation for inlet and outfall drains, catch water drains and trench or subsoil drains shall be to the dimensions ordered by the Engineer.

B. GROUTED STONE PITCHING

.01 The stones used for the grouted pitching shall be hard angular rock, roughly cubical in shape and of dimensions such that they can be laid with a minimum thickness equal to that specified.

.02 The interstices of the grouted pitching shall not be filled with fill material, but may be choked with large rock spalls. The pitching shall be thoroughly soaked with water and grout of 1:4 cement: sand mortar shall be rammed into the interstices and smoothed off flush with the pitched face.

.03 Grouted pitching to embankments and around structures shall be constructed as soon as possible after the embankments have been built. The surface of the filling to receive the pitching shall be compacted and trimmed to slope and the stone hand laid interlocked and rammed.

CONCRETE PAVING BLOCK

A. SCOPE

Concrete paving blocks shall comply with the requirements of the Specification for precast concrete paving blocks published jointly by the Cement and Concrete Association, the County Surveyor's Society and Interpave, September 190 (or as amended by subsequent British Standards).

B. CONSTRUCTIONAL DETAILS

LAYING PATTERN

The laying pattern shall be that specified for vehicular traffic or the herringbone type.

SURFACE LEVELS OF PAVEMENTS

The following levels shall apply to the various layers of concrete block pavements.

Layer	Tolerance
Formation	+20 mm – 30 mm
Sub-base	+20 mm
Road base (where required)	+15 mm
Pavement Surface (except adjacent to gullies)	+6 mm

Surface levels of Paving Blocks Adjacent to Drainage Installations

The surface levels of paving blocks immediately adjacent to gullies, surface drainage channels and outlets shall not deviate from the design level by more than +6mm, -0mm and on the upper level of drainage installation +0mm, -10mm.

DEVIATION FROM DESIGN PROFILE

The deviation from the design profile measured under a 3m straight edge shall not exceed 10 mm.

(v) LEVELS OF ADJACENT BLOCKS

Levels of any two adjacent blocks shall not differ by more than 2 mm.

(vi) CROSSFALLS AND GRADIENTS

A minimum cross fall of 2.5% shall be adopted where practicable. Longitudinal gradients shall not be less than 1%.

(vii) A PAVEMENT CONSTRUCTION**(viii) Preparation of Sub-grade**

The sub grade shall be prepared to the required formation and shall be sufficiently wide to extend to the near face of the proposed edge restraint and around existing structures. The sub grade shall be drained and protected against inundation and ground water by piped or channeled storm water drainage and sub soil drainage. All drainage works located beneath the

Pavement shall be completed in conjunction with sub grade preparation before commencement of sub-base construction. Any unsuitable material shall be removed from the sub-grade and treated or replaced with suitable material properly compacted.

(ix) PREPARATION OF SUB-BASE**(x) New Sub-base**

Sub-bases shall be constructed by following construction requirements and using one or other of the materials complying with Department of Transport Specification for Road Works as listed below: -

Granular sub-base materials type 1

Soil-Cement

Cement-bound granular material

Lean Concrete

Wet mix macadam

Wet lean concrete.

When no road base is to be laid, the surface of the sub-base shall be close-knit to prevent laying course material from sinking.

(xi) EXISTING SUB-BASE

Where an existing sub-base is to be used, it shall be inspected to ensure that it is suitable for the purpose. Any unsuitable material shall be removed and replaced by sub-base material complying with the requirements of Clause 1201.2.1.

(xii) PREPARATION OF ROAD-BASE

When a road base is required, it shall be formed with materials described in the Department of Transport Specification for Road works and constructed in accordance with that Specification, e.g.

Soil-cement

Cement bound granular material

Lean concrete

Wet mix macadam

Wet lean concrete

(xiii) LAYING COURSE

(xiv) LAYING COURSE MATERIAL

The laying course shall be of uniform thickness and shall be made up of naturally occurring sand or crushed rock fines. The material shall be free from deleterious salts

or contaminants. The grading shall be within and approximately parallel to the following grading limits.

BS Sieve Size	Percentage of Weight Passing
5.00 mm	90 – 100
2.36 mm	75 – 100
1.18 mm	55 – 90
0.60 mm	35 – 59
0.30 mm	8 – 30
0.15 mm	0 – 10

MOISTURE CONTENT OF LAYING COURSE

The moisture content of the laying course material shall not deviate by more than 1% from its optimum moisture content as determined in accordance with test 12 of BS 1377.

SCREEDING THE LAYING COURSE

The laying course shall be such that after compaction it forms a uniform layer 25 mm below the blocks. It may be screed in accordance with the following two methods: -

Either

- (a) The material shall be spread loose in a uniform layer and screed to a thickness required to give a nominal 25 mm layer after completion of the paving.

Or

The material shall be spread in loose uncompacted layer approximately two thirds of the required final thickness. This layer shall be lightly compacted by means of a vibrating plate compactor. A further layer of loose material shall be spread and screeded to create a loose surface on to which the blocks can be placed.

Where closer tolerance than those quoted in Clause 1201.2 for the level of the sub-base materials have been achieved, or road base has been used, a thinner laying course can be used.

SURFACE COURSE

EDGE RESTRAINTS

Edge Restraints shall be provided along the perimeter of all paved areas and shall be adequate to support traffic loads and to prevent the escape of laying course material from beneath the paved surface. Edge restraints shall be formed before compacting adjacent blocks and the restraint together with any concrete haunching shall be mature before vibration of the surface course is undertaken. Haunching to an edge restraint on the paving face shall be vertical down to the level of the underside of the laying course.

LAYING BLOCK PAVING

The blocks shall be laid hand-tight in the design pattern working from an existing laying face edge or edge restraint wherever possible. Mechanical forces shall not be used to obtain tight joints. Block shapes designed to assist with formation of boundaries and with changes in direction may be incorporated as appropriate. Full blocks

shall be laid first; closure units shall then be laid. The area to be laid shall be completed as far as it is possible in entire block units. Infilling to boundaries and

obstructions shall proceed, as the laying of the surface course proceeds and in any case, infilling shall be completed before compaction commences.

PLASTERWORK AND OTHER FINISHES

Generally: All plasterwork and paving to be as described in the General Specification and in these Bills of Quantities.

TERRAZZO PAVING

Shall be as described for granolithic paving, but using marble chippings and colour cement. Paving:- Prices are to include for brushing concrete clean, wetting and "coating with cement and sand grout 1:1. Tyrolean rendering shall be in two coats: The first coat 10mm. thick in gauged cement mortar 1:4 (with 10% lime added to the cement) applied with a trowel and the second coat in cement and sand 1:4 applied with Tyrolean spraying machine in three layers to a total thickness between 5 and 10mm.

GLAZING

Polished Plate Glass: Shall be General Glazing Quality. Prime Rebates: Prices are to include for priming rebates before placing putty. Broken or Scratched Glass: The Contractor will be responsible at his own cost, for replacing any broken or scratched glass and handing over in perfect condition.

PAINTING,

Generally: - Note that the General Contractor is to provide scaffolding for all trades including painting.

Prices: - Prices are to include for all preparatory work priming coats and for protecting other works and for cleaning up on completion. Prices for painting on galvanized metal are to include for mordant solution as necessary.

WATERPROOFING

Supply and fix Bentonite waterproofing sheets as "mapeproof" as supplied by "Mapei Construction Chemicals" email address i.galfre@mapei.ae or other equal and approved; membrane nailed and fastened using "mapeproof CD" washers at 300 mm

intervals including all necessary surface preparations all in accordance with the manufacturer`s printed instructions and Engineers approval.

Provide 10-year waterproofing guarantee

Alternative to mapeproof

Supply and fix Vandex waterproofing solution as supplied by " Rooftech Limited" including all necessary surface preparations all in accordance with the manufacturer`s printed instructions and Engineers approval.

METAL WORK

BALUSTRADES

ROLLED PLATES, BARS, SECTIONS AND TUBES

GLASS BALUSTRADES

Supply, assemble and fix 1150-1250 mm high purpose made stainless steel (grade 3.1.6) glazed balustrading comprising of 50mm x 12mm thick stainless steel double flat bar vertical support using stainless steel spider bolt anchors/ connectors. Balusters fixed to concrete floor at 1025mm centres including 200mm x 150mm x 15mm thick stainless-steel base plate fixed to concrete reinforcement and at the top 3mm thick x 75mm diameter oval stainless-steel handrail tube; including all necessary cleats, stiffeners and the like; all to Project Engineer's instructions and approval

GRANITE

Supply and fix full length local granite slabs or other equal and approved granite slabs; to approved pattern; bedding and jointing in approved adhesive with proprietary grouting laid on cement sand bed (m/s);

BLOCKWORK

Concrete hollow block; B.S 2028; 7 N per square millimetre in 25 mm thick cement sand mortar (1:3)

ALUMINIUM DOORS

Aluminium framed doors fabricated from composite powder coated heavy duty approved standard hollow aluminium sections 150 x 80 x minimum 3 mm thick;

including glazing with 4mm + 4mm thick toughened laminated glazing; glass secured to aluminium door framing, stiles, top, middle and bottom rails using approved glazing strips and glazing beading including waterproofing all joints using approved silicon sealing compounds and including approved aluminium brackets; soft closing hinges, locks, catches, automatic door closer, oval satin door stopper, 500 mm long stainless steel pull handles, stainless steel push/pull plate, accessories, opening mechanism and any other necessary ironmongery all as approved ; including timber offcuts in hinge fixing points and fixing with powder coated stainless steel screws; plugging or fixing on aluminium framing; sealing with mastic; oiling and adjusting on completion all to Project Engineer's details and approval

EPOXY FINISH

Works to be executed by an approved specialist surface laitance and expose defects, repairing defects and cracks, fill control joints with shrinkage compensated mortar; apply moisture barrier and Captive blasting and wash with approved acid; apply primer as X-prime MT100 and finishing coat as X-Tech Epoxy Floor SL2 all as supplied by X-Calibur construction Chemistry(E.A) Limited email address niyaz@x-calibur.usa or other equal and approved epoxy all applied in accordance with manufacturer's printed instructions.

PLASTER

Plaster; 9 mm (minimum) first coat of cement and sand (1:4); 3 mm second coat of cement and lime putty (1:5) steel trowelled hard and smooth

MILD STEEL DOORS

Mild steel double door comprising of upper fixed panel 1800 x 450 mm high and two bottom openable equal leaves each 900 x 2250 mm high; door leaves fixed to and including 100 x 50 x 4 mm thick pressed frame fixed to wall with and including building frame into block wall; each openable leaf comprising of 75 x 50 x 4 mm thick pressed steel stiles and middle rails and 100 x 50 x 4 mm thick top & bottom rails (frames and stiles in rolled hollow sections) faced both sides with 3 mm thick mild steel plate infill panel spot welded to mild steel stiles and rails; each door leaf to

have 700 x 240 mm louvered vent with 18 gauge cranked louvres fixed at 45 degrees at 60 mm centres welded to stiles; with 25 x 4 mm thick mild steel flats welded to edges of the door leaf in filled with approved mosquito gauze spot welded to sub frame. Each door leaf supplied complete with 2 pairs heavy duty 150 mm pressed steel butt hinges welded to door leaf and door framing 2 No 16 mm diameter once kneed barrel bolts 250 mm long; with 50 mm diameter curved steel tube pull handles; 2 No steel padlock hasps and including priming door leaf and door frame with red oxide primer before delivery to site and all necessary welding and grinding welds smooth

FRAMELESS GLASS DOOR

12mm thick toughened frameless glass manual sliding/ openable double door; overall size 1800 x 2700 mm high in 2 No. active leaves each of size 900 x 2400 mm high and 2 No. fixed light 900 x 300 mm high complete with and including soft closing hinges, locks, catches, automatic door closer, oval satin door stopper, 500 mm long stainless steel pull handles, stainless steel push/pull plate, accessories, opening mechanism and any other necessary ironmongery all as "ASSA ABLOY" or equal and approved to Project Engineer's details and approval

ALUMINIUM PURPOSE MADE WINDOWS

Supply and fix 100 x 50 x 3 mm (minimum) thick powder coated top - hung openable aluminium framed windows, to be supplied and fixed by an approved domestic subcontractor, to be fabricated from approved composite extruded powder coated heavy duty hollow or angle sections (minimum 3 mm thick); including glazing with 8 mm thick clear glass secured to framing using approved rubber glazing strips, aluminium beading and silicone sealant where necessary; complete with 400 mm wide champagne powder coated aluminium louvres including sandwiched plastic insect gauze; frames and framing all round mitred at corners including reinforcing cleats, fixing with aluminium screws; plugging and fixing to jambs; sealing with mastic; oiling and adjusting on completion and all necessary ironmongery such as hinges, locking devices such as windows fasteners, stays locks, bolts sliding tracks etc. to Project Engineer's approval and in accordance with Project Engineer's drawing

GLASS BALUSTRADES

ROLLED PLATES, BARS, SECTIONS AND TUBES

Supply, assemble and fix 1250mm high purpose made curved glazed balcony railing comprising of 12mm thick laminated glass with polished edges comprising of 6 mm thick laminated tinted (approved colour) plus 1.52 mm ultra - safety and security polyvinyl butyral (PVB) film plus 6mm thick self-cleaning clear glass all as manufactured by Saint Gobain - coolite series; held in place in 80 mm deep x 2 mm thick bottom aluminium U-Channel screwed to grooved reinforced concrete upstand beam .complete with and including glazing beads, rubber gaskets, silicone sealant and all necessary cleats, stiffeners and the like; all to Project Engineer's instructions and approval

SKIN WALL

Selected approved quality natural stone fine machine dressed and cut to regular block size: stone load bearing blocks (7N/mm²): including double dressing to corner blocks: 20-gauge x 25mm wide hoop iron in every alternate course: with 20 Gauge hoop iron reinforcement and column-wall ties: one end cast into concrete: other end built into walling in alternate courses:

INTERNAL PAINT

One coat CROWN 'solo' or other equal and approved undercoat including skimming surfaces to smoothen them using approved filler and sanding to smooth surface; approved colour; two coats CROWN 'solo' or other equal and approved pure satin emulsion; approved colour; applied in accordance with manufacturer's printed instruction

Solid core WPC doors; all sides finished with 4mm thick WPC laminate hot pressed in vacuum machine using high quality glue; solid blocking and leaving provision for ironmongery fixing. Composition of the WPC doors to be: 70% Virgin Polymer, 15% Wood Powder & 15% Acrylic based impact modifiers

EXTERNAL PAINT

Prepare and apply acrylic external quality as Crown Permacote Ultra guard Rain-proof Silicone Paint or other equal and approved exterior surface paint to: -

GRANITO TILE SPECIFICATIONS

GRADE: Grade One. WEAR RATING: Porcelain and Enamel Institutes (PEI) Wear Rating of five (V). WATER ABSORPTION (WA)RATE: Impervious. SLIP RESISTANCE: Coefficient of friction of greater than 0.6. PRINTING:3D Digital Print Technology. BODY COMPOSITION: Full Body. THICKNESS: Above 3/4inch (18mm and above). FINISH: Micro-crystal finish of the 'Thick Collection' glass layer of more than 3mm thick. DIMENSIONS: Rectified tiles for uniform dimensions (dimensionally stable tiles) to take a maximum of 1.5mm wide grout joints. TOLERANT DISTORTION: Below 0.5% in both right-angle level and flatness straightness. Grade 1/PEI Rating of V, Water absorption rate (WA) - Impervious, Slip resistance co-efficient friction of more than 0.60, through body

PRICING NOTES**SPECIAL NOTES TO BE READ PRIOR TO PRICING THESE BILLS OF QUANTITIES**

1. The Tenderer shall tender for the above Works in accordance with the drawings, Specifications and Bills of Quantities.
2. The Tenderer is required to check the numbers of the pages of these Specifications and Bills of Quantities against the index and should he find any missing, in duplicate or indistinct he must inform the Employer at once and have the same rectified.
3. Should the Tenderer be in doubt about the precise meaning of any item or figures, for any reason whatsoever, he must inform the Employer at once in order that the correct meaning may be decided before the date for submission of the tenders.
4. No liability will be admitted or claim allowed in respect of errors in the Tenderer's Tender due to mistakes in the Specifications which should have been rectified in the manner described above.
5. The annexed Bills of Quantities must be fully priced in ink. The Tenderer shall not alter or otherwise qualify the text of these Specifications and Bills of Quantities Any alteration or qualification made without authority will be ignored and the text of the Bills of Quantities as printed will be adhered to.
6. The Tenderer shall be deemed to have made allowance in his prices generally to cover items of Preliminaries or additions to Prime Cost Sums or other items, if the Tenderer has not priced these where appropriate.
7. All items of measured work shall be priced in detail and tenders containing Lump Sums to cover trades or groups of work must be broken down to show prices of each item before they will be accepted. Lump Sums to cover items of Preliminaries shall be likewise broken down if so required.
8. In no case will any expense incurred by Tenderers in preparation of this Tender be allowed.
9. The copyright of these Specifications and Bills of Quantities is vested in the Quantity Surveyors and no part thereof may be reproduced without their express permission given in writing.

10. The Tenderer is solely responsible for the accurate ordering of materials in accordance with the Drawings and Project Engineer's instructions and no claim for any loss or expense will be entertained for orders for materials based upon the Bills of Quantities
11. If it is found on the examination of a Tender that there are arithmetical errors, then the difference between the Tender and the corrected total shall be applied as a percentage adjustment of addition or omission on all the builder's rates so that the original Tender Amount remains unaltered. When calculating the percentage adjustment, the total cost of the Preliminaries, Provisional and P.C. sums, Contingencies and any other items of a similar nature shall be excluded.
12. **ALL RATES SHALL BE DEEMED TO INCLUDE ALL GOVERNMENT TAXES AND IN PARTICULAR VALUE ADDED TAX (V.A.T). ANY SEPARATE CLAIMS ON TAXES WILL NOT BE ALLOWED.**
13. The Bills of Quantities must be priced in Kenya currency i.e. shillings and cents.

SPECIFICATIONS FOR ELECTRICAL SERVICES INSTALLATIONS

PART A

**ELECTRICAL ENGINEERING
SERVICES GENERAL
SPECIFICATION**

2 SECTION 2- ELECTRICAL WORKS GENERAL SPECIFICATIONS

2.1 General

This section specified the general requirements for plant, equipment and materials forming part of the Electrical Sub-Contract Works and shall apply except where otherwise specified. The Sub-Contract Works shall comply with the General Specification when read in conjunction with the Particular Specification and any other requirements of the Specification as previously defined.

2.2 Regulation and Standards

The Sub-Contract Works shall comply with the current Kenya Government Electrical Regulations, the current edition of the Institution of Electrical Engineers Regulations for the Electrical Equipment of Buildings, hereinafter referred to as the I.E.E. Regulations, and the Bye-Laws of the Electricity Supply Authority. The Sub-Contract Works shall also comply where applicable to Kenya Standards as published by Kenya Bureau of Standards or current edition IEC (International Electro Technical Commission) and British Standards Codes of Practice where Kenya Standards have not been published.

2.3 Quality of Materials and Manufacturing Standards

Materials and apparatus required for the complete installation as called for in the Particular Specification or Contract Drawings shall be supplied by the Sub- Contractor unless special mention is made otherwise.

Materials or apparatus supplied by others for installation or connection by the Sub- Contractor shall be carefully examined on receipt. Should any defects be noted the Sub- Contractor shall immediately notify the Engineer.

Unless otherwise specified all materials, including equipment, fittings, cables, etc., shall be in new condition and manufactured to appropriate standards of the Kenya Bureau of

Standards, the British Standards Institution, the I.E.E. Regulations or other equivalent and approved standards.

Defective equipment or that damaged in course of installation or test shall be replaced or repaired to the approval of the Engineer.

Materials and apparatus supplied by the Sub-Contractor shall be as specified and no variations will be permitted without the written consent of the Engineer. Should any replacement be necessary the Sub-Contractor shall bear the cost of any associated Builder's Work and making good finishes.

2.4 Installation Requirements - General and Liaison

The starting currents of all electric motors and equipment supplied under the Specification shall be limited so as not to exceed the maximum permissible starting currents described in the Electricity Supply Authority's (KPLC) By-Laws.

Attention is drawn to the fact that all the Sub-Contractor's work is subject to the Engineer's approval.

2.5 Installation and Commissioning

The Sub-Contractor shall be deemed to have included in the Sub-Contractor Sum for the services of a specialist or manufacturer's engineer or technician to assist in the installation and commissioning of the Sub-Contract Works or any part thereof if the Sub-Contractor has not his own suitable and competent staff available at the site of the works to carry out such functions.

2.6 Labelling

All plant, apparatus, equipment, distribution boards, distribution cases, terminals and cable cores shall be securely and properly labelled to the approval of the Engineer. The labelling shall be such as to show clearly the identification of the item and if applicable its control function and the part of the system controlled.

3 SECTION 3- H.V. SWITCHGEAR

3.1 H.V. SWITCHGEAR

3.1.1 General

The units which together comprise the switchboards are to be provided in accordance with the Contract Drawings and Schedules of equipment.

The switchboards shall be manufactured in accordance with B.S.162 and all equipment and material used in the switchboards is to be in accordance with the appropriate British Standards. The switchboards shall be flush fronted in appearance with the breaker operating mechanism easily accessible but behind the hinged door.

The Sub-Contractor shall allow for the supply of a complete set of Record Drawings relating to the switchboard, made in ink on tracing cloth.

Four sets of instruction manuals are to be provided describing the method of operating the equipment together with instructions for maintenance and adjustment and giving full details of all connections brought out to the Test Link Blocks.

3.1.2 Supply System

1.25 mVA, 415V, 3 phase, 50Hz, earthed system.

3.1.3 Type of Switchgear

The switchgear shall consist of oil circuit breakers or oil switches as indicated on the Contract Drawings. They shall be of the fully interlocked, metal clad, vertical isolation type, incorporating integral earthing facilities manufactured to the current edition of B.S. 5211 and B.S. 5463. Circuit breakers shall be fitted with manually charged spring closing mechanisms.

3.1.4 Bus-Bars

The bus-bars for each switchboard may be air insulated provided that all primary circuits in the fixed portion of the units are insulated with Epoxy Resin.

Bus-bars and current transformer joints and connections are to be insulated by epoxy resin shrouds which shall be mechanically jointed, or PVC sleeved and filled with encapsulating compound, otherwise the switchboard shall be compound insulated. The bus-bars and connections shall be constructed from high conductivity solid copper.

The bus-bars and bus-bar supports shall be arranged to withstand, without damage, the effects of any fault current up to and including the maximum rated breaking capacity of the switchgear.

Bus-bars and connections shall be suitably and adequately colour coded for phase identification.

3.1.5 Extensibility

All units shall be so designed and the bus-bars drilled so that further extension units can be added without difficulty. Space and full provision for fitting future units shall be allowed in accordance with the instructions in the Schedule of Equipment.

3.1.6 Cable Boxes

Where required, cable boxes manufactured from close grained cast iron to B.S. 2562, Part 1 where applicable, shall be provided suitable for the reception of the cable specified.

3.1.7 Special Tropical Finish

The switchgear shall be designed for use in the tropics and the following requirements shall be incorporated:

- a) All parts of the switchgear shall be totally enclosed and enclosures

shall be vermin proof.

b) Gaskets shall be Neoprene or similar material.

2.1.2 All steelwork shall be treated with a phosphoric base etching primer containing a resin bond and finished with two coats of paint.

2.1.3 The interior of all gear not having oil, compound or other insulation, and all exposed current carrying metalwork (other than contact faces) shall be sprayed with an approved type of bakelite varnish.

The final coat of paint shall be of a colour taken from B.S. 3810 or B.S. 4800 to be chosen by the Engineer.

3.1.8 Labels

Each switch shall have a designation label of Traffolyte with 10mm high black lettering on a white background. They shall be screwed to the equipment; adhesive only is not acceptable. A small similar designation label shall also be fixed to the rear of each fixed portion.

3.1.9 Relays

Protection relays shall be of the type and number listed in the schedule of requirements for HV switchgear in the Particular Specification.

All relays shall be flush mounted, and where required, shall be provided with additional contacts for remote indication etc., Bezels shall be finished in black gloss.

The relays shall have their secondary connections brought out to studs on the rear and firmly secured by suitable washers, nuts and locknuts. The relays shall have hand reset features.

3.1.10 Instrumentation

Instruments shall be fitted on the switchboard as shown on the drawings and in the schedules of requirements for HV switchgear in the Particular Specification.

Ammeters shall be MICS 100mm square dial flush mounting pattern with rotary selection switch.

Voltmeters shall be MICS 100mm square dial flush mounting pattern with rotary selector switch.

The construction of the instruments shall be in accordance with B.S. 89 and shall be of industrial grade.

3.2 Instrument Panels

Instrument panels shall be mounted at the same height on each unit and have suitably hinged front panels.

3.3 Test Link Blocks

Test link blocks shall be connected to all protection and instrumentation current transformer connections.

3.4 Small Wiring

All small wiring necessary for connecting the instruments, relays and other devices shall be included and shall have a conductor size of not less than 7/.085mm with a thermoplastic flame retarding type of insulation.

The wiring shall be distinctly coloured and marked with ferrules of an approved type at each end.

All wiring within each switchboard, not installed in conduits, shall be neatly laced and cleated to the panel structure of each switchboard and its auxiliary equipment. Where wiring passes through a hole in the metal work, thermoplastic grommets shall be used and in no case shall cables be unprotected where they come into contact with the edge of a piece of metal work.

3.5 Current Transformers

Separate current transformers shall be provided for protection and instrumentation.

Current transformers shall have a secondary rating of 5 amps. The primary currents are indicated on the drawings. Current transformers shall have overcurrent factors suitable for the prospective short circuit current of the system. Current transformers shall have overcurrent factors suitable for the respective short circuit current of the system. Current transformers required for operating relays shall have a one-second rating as defined in B.S. 3938, be suitable for the characteristics of the relay concerned and have a minimum output of 15 Va.

Current transformers shall be of the bar primary or wound primary type according to the transformer ratio with jointress ring core of either hot or coldrolled silicon iron.

3.6 Voltage Transformers

Voltage transformers shall be of the dry type with hinge isolation and in accordance with B.S. 3941. The rated output and accuracy offered should be stated. Cartridge type fuses shall be provided for protection of both primary and secondary windings.

3.7 Drawings for Approval

The following drawings shall be submitted for each switchboard for approval as soon as possible after receipt of instructions from the Engineers to proceed:

Plans and elevations showing position of instruments, relays, current transformers, voltage transformers, fuses, cable boxes and other accessories. Foundation plan showing fixing bolt centres, cables centres and other relevant dimensions, wiring and connection diagrams and schematic diagrams.

Three copies of each drawing as finally approved shall be supplied to the Engineer. In addition, the Sub-Contractor shall provide any other drawings or information required by the Engineer in order that the Engineer may satisfy himself as to the design of the plant. Manufacture shall not be commenced until all relevant drawings have been approved by the Engineer.

3.8 Miscellaneous

A tinned copper bonding bar shall be provided for the full length of the switchboard to which each unit shall be bonded.

A wall chart mounted on metal, with instructions for the treatment of electric shock, shall be supplied and fixed in the switch rooms.

Six in number heavy brass non-interchangeable padlocks, for locking switchgear, spout covers and operating mechanisms, shall be provided each with two keys.

A framed diagram showing clearly the layout of the high voltage distribution system shall be provided and fixed in the switch rooms.

3.9 D.C. Tripping Equipment

A nickel cadmium type battery adequately rated to operate the D.C. tripping circuit of the breakers shall be supplied with each switchboard. The battery shall be complete with floor mounting stand and a suitable trickle charger having a 240-volt single phase input.

From the output terminals of the battery unit wiring shall be taken to the trip terminals located at the rear of the switchboard.

4 SECTION 4- POWER TRANSFORMERS

4.1 General

Power transformers shall be dry type and of voltage ratio and rating called for in the Specification.

There will be 1No. 1.0MVA, 11kV/415V indoor power transformers.

4.2 Dry-Type Transformers

Dry-type transformers shall have Class AN cooling, windings vector group DY.11, insulation Class 'C'. The arrangements and connection of windings, tap-changing, loading and terminal boxes shall be as previously detailed in Clause

Temperature rise shall not exceed that listed in Table 13 of B.S.171 with the reduction factor listed in Table 15 applied for the climatic conditions described in the Specification.

- a) The transformer shall be complete with the following fittings: -
- b) Rating plate,
- c) Terminal marking plate,
- d) Lifting lugs
- e) Earthing terminal for frame.

4.3 Transformer Tests and Inspections

The Engineer shall be invited to inspect the transformers at the manufacturer's works during the erection of cores and windings, and to witness final tests when the transformers are fully assembled. It will be the Sub-Contractor's responsibility to inform the Engineer and give reasonable notice of the manufacturer's intention to carry out the above assemblies and tests. The tests shall be as described in clause 1802 of B.S. 171:1959.

The Sub-Contractor shall submit three copies of all relevant test certificates (B.S. 171 Clause 1802(a)) to the Engineer for approval prior to shipment of the transformers. Certificates of type tests (B.S. 171, Clause 1802 (b)) will be acceptable subject to the Engineer's approval except where specified elsewhere in the specification.

4.4 Transformer Tests on Site

The Sub-Contractor shall carry out all necessary tests to the satisfaction of the Engineer to ensure that the transformer has not been damaged in transit and is ready for service, such tests shall be made before setting to work and shall include but not limited to: -

- Continuity and polarity tests,
- Insulation resistance tests,
- Oil moisture and acidity tests

5 SECTION – 5 L.V. SWITCHBOARD AND GEAR

5.1 General

The switch gear shall be designed throughout to ensure safety during operation, inspection, cleaning and Maintenance and shall be so arranged as to minimize the risk of fire arising and spreading.

The switchboard shall be manufactured in accordance with B.S. 162 which co-ordinates the requirements for electric power switch gear and associated apparatus.

It is not intended that B.S. 162 should cover the requirements for specific apparatus for which separate British Standards exist. All equipment and material used in the switchboard shall be in accordance with the appropriate British Standard.

5.2 Switchboard Cubicle Construction

The switchboard shall be a cubicle type of flat front, back connected, sectional, painted, all steel construction of neat appearance.

It shall be floor mounted and have ring bolts, lifting lugs or other approved means of transporting and lifting.

Each switchboard section shall be completed, fully wired and checked out at the factory and shall require a minimum of installation work at the Site of the Works. Modular construction shall be used wherever practicable and provision shall be made for simplifying servicing, replacement and maintenance throughout without major dismantling.

The switchboard shall be constructed from not less than 10 gauge welded bright mild steel for framework and structural sections and 16 gauge for doors and panels which shall be adequately stiffened by folding or welded stiffeners. The switchboard base shall be of heavy gauge tube or structural section to allow moving on rollers. All doors shall be

properly stiffened and fitted with heavily cadmium plated concealed hinges and flush catches.

Removable stiffened steel covers shall be provided elsewhere on the switchboard for full access. All doors and covers shall be fitted with cemented resilient gasket seals to provide a dust proof enclosure. All hardware and fastening shall be heavily cadmium plated. No self-tapping screws shall be used.

All steelwork shall be clean and free of burrs, scale and blemishes, with all raw edges hidden and shall be finished with a rust inhibiting treatment one primer or undercoat and final coat of first quality sprayed baking enamel the colour of which shall be to approval.

The switchboard shall be arranged to provide the maximum of safety to personnel and equipment. All electrical wiring and bus-bars shall be completely enclosed. Closure panels, isolating and insulating barriers and interlocks shall be provided as required for maximum safeguard. All fuse switches shall be capable of being padlocked in the 'OFF' and the 'ON' positions.

Adequate supports shall be provided for all bus-bars and wiring and incoming and outgoing cables shall be provided with glands, cable boxes and other necessary terminations in a cable area separate from the bus bars.

All switches shall be operable from floor level, all fuses shall be within 2000mm of the floor and flush mounted indicating meters within 1650mm. The main switchboard in 11/415KV Substation shall be IP-32 Form-3B complete with 1 No 1000A Incoming MCCB, 1 No 800A Outgoing breaker – to riser copper busbars, 1 No 250A Outgoing breaker – to Essential loads panel, 2 No 125A Outgoing breakers – to Lift board and mechanical plant room board, 1 No 400A Outgoing breaker – to power factor correction bank, 2 No 63A Outgoing breakers – to switch room electric board and control pillar board and 2 No. spare spaces

Where spaces on the switchboard are provided for future circuit components to be installed, as shown on the drawings, all ancillary parts shall be provided and installed so

that future components may be installed and connected in the least time possible. Full safety precautions shall be provided with all such spaces.

The mild steel angle or channel forming the bottom rear edge of the switchboard shall be made up in sections and bolted into position such that any one section may be removed to facilitate installation of cables.

5.3 Bus-bars

All bus-bars shall be of high conductivity copper and shall be manufactured and tested in accordance with B.S. 158 and B.S. 159. They shall be mounted fully enclosed within the main enclosure of the switchboard in separate chambers in accordance with B.S. 162. The bus-bars shall be fully separated from the incoming and out-going cable areas.

Except for instruments, potential or current connections, which shall be clamped in position and be of minimum length, no circuit wiring shall be within the bus-bar chamber.

Bus-bars shall be sheathed in approved insulating material, in their respective phase colours, and secondary insulation shall be provided where bus-bars pass through supports to prevent tracing paths. Supports shall be such that the required clearances between phases, neutral and earth are maintained under rated continuous current and under fault conditions.

Provisions shall be made for expansion and contraction of the bus-bars and connections, with variations in temperature.

Interconnections between bus-bars and switchgear shall be of minimum length, properly insulated and rigidly supported.

All contact areas of the bus-bar and the connections fastened to the bus-bars shall be heavily silver-plated. Joints and connections shall be rigidly made with clamps and high

tensile steel bolts and nuts used with spring washers to maintain uniform pressure and flat washers to prevent cupping. Ready access to all joints and connections shall be provided.

5.4 Circuit Breakers

Where oil circuit breakers are called for on the drawings, they shall be suitable for the current rating and system conditions indicated and shall be in strict accordance with B.S. 116. They shall have a minimum breaking capacity of 26 MVA at 415V and shall carry a Certificate of Rating to B.S. 5311 issued by any approved testing Authority.

Where air circuit breakers are called for on the drawings, they shall be suitable for the current rating and system conditions indicated and shall be in strict accordance with B.S. 5311. They shall have a minimum breaking capacity of 31 MVA at 415V and shall carry a Certificate of Rating to B.S. 5311 issued by an approved testing Authority.

The main switchboard in 11/415KV Substation shall be IP-32 Form-3B complete with 1No 1000A Incomer MCCB, 1No 800A Outgoing breaker– to riser copper busbars, 1No 250A Outgoing breaker– to Essential loads panel, 2No 125A Outgoing breakers– to Lift board and mechanical plant room board, 1No 400A Outgoing breaker– to power factor correction bank, 2No 63A

Outgoing breakers– to switch room electric board and control pillar board and 2No. spare spaces

Each circuit breaker shall be fitted with telescopic rails to allow the breaker to be withdrawn clear of the cubicle and a racking mechanism. Safety shutters shall be provided to protect against accidental contact with the stationary isolating contacts when the breaker is withdrawn.

Interlocks shall be provided to ensure that: -

- a. The cubicle door is closed and the slide rails locked before the circuit breaker can be racked in.

- b. The trip button must be depressed before the racking mechanism can be operated in either direction.
- c. The circuit breaker cannot be pushed into the ratchet in position without the use of the racking mechanism.
- d. The cubicle cannot be opened when the circuit breaker is in the racked in or fully racked out position.
- e. The circuit breaker can be operated only when it is in the fully racked in or fully racked out position.

The circuit breakers shall have a stored energy, single shot, trip free, closing mechanism.

Inverse definite minimum time lag over current relay protection shall be provided on each circuit breaker.

Tripping under fault conditions shall be effected by a 30V D.C. trip coil energised by a 30V nickel cadmium battery and charger set. The battery and its trickle charger shall be mounted in a naturally ventilated, floor mounted, steel cubicle and located as shown on the drawings. This battery shall be suitable for tripping two low voltage circuit breakers. A manual trip push button which shall be independent of the operator's speed of operation shall also be provided.

The trip coil latching lever and the roller mechanism shall be made from anti corrosive metal. The contacts shall be silver plated, shrouded and renewable. Barriers shall be provided between phases and recessed into the base.

A mechanically operated semaphore shall be used to indicate the condition the circuit breaker using the words 'ON' AND 'OFF'.

Each circuit breaker shall be provided with the facility of locking the breaker in the 'OFF' position.

5.5 Oil Switches

Oil switches shall be identical to the oil circuit breakers, B.S. 5311 except that tripping devices are not required. Means of locking the switches in the 'OFF' position shall be provided.

5.6 Air- Break Switches

Air- break switches shall be suitable for the system conditions, indicated and shall be in strict accordance with B.S. 5419. Class II switches. Means of locking the switches in the 'OFF' position shall be provided.

5.7 Fuse Switches

All fused switches shall be supplied and installed complete with Class Q1 H.R.C. Cartridge Fuse Links complying with B.S. 88, as shown on the drawings and shall be contained in metal clad, dust proof, gasket sealed individual enclosures with non-detachable steel operating handles which shall be capable of being locked in either the 'ON' or the 'OFF' position.

The fuse switch units shall comply with B.S. 5419 and shall be withdrawable.

The fuse switch units shall have fault rating at least equal to the fault rating of the switchboard in which they are to be installed.

The fuse switch units shall be of fast make break design suitable for on load operation and shall be arranged operation of the switch when the cover is open and to prevent opening of the cover when the switch is in the 'ON' position. The H.R.C. fuse links shall be carried on the moving contact mechanism and shall be isolated from the line and load contacts when in the

`OFF' position. In the `ON' position a barrier shall be interposed between the fuse links. The switch contacts shall be separately and fully shrouded and shall be renewable.

Moving or fixed indicators shall use the words `ON' and `OFF' to indicate the fused switch condition. Indicators shall be mechanically locked with the moving contact assembly and shall operate in such a manner that all phases shall be broken before the `OFF' position is indicated.

5.8 Earth Bars

A high conductivity copper earth bar of not less than 50mm x 6mm section, adequately rated for the anticipated earth fault current, shall be installed the full length of the switchboard in the outgoing cable area within the switchboard enclosure.

Connection to the earth bar shall be made with approved cable lugs and high tensile steel nuts and bolts with washers as specified for the phase bus-bars.

The points of contacts on the earth bars shall be silver plated.

5.9 Neutral Bars

A high conductivity copper neutral bar adequately rated and supported for normal and fault conditions shall be installed in the outgoing cable area in the switchboard enclosure. This bar shall be mounted on insulators and shall be divided into sections according to the design of the switchboard. The sections shall be connected by copper links double bolted to each section.

Voltmeters shall be MICS 150mm square dial, flush mounting pattern with rotary selector switch enabling phase to phase and phase to neutral volts to be read.

Voltmeters shall be protected by means of cartridge fuses, category of duty A.C. 46 and fusing factor, 1.5. The construction of the instruments shall be in accordance with B.S. 89 and shall be of industrial grade.

The current transformers shall be of an approved type to B.S. 3938.

The Sub-Contractor shall agree with the Engineer, the arrangement of the indicating instruments, their scale deflections C.T. ratios and all information that the switchboard manufacturers may require, prior to manufacture of the switchboard.

5.10 Phase Failure Relays

Where the requirement is shown on the Drawings phase failure relays shall be installed for the operation of the emergency lighting.

Phase failure relays shall be connected across each phase and neutral of the supplies as indicated on the distribution diagram.

Relays shall be protected by means of cartridge fuses, category of duty A.C. 46 and fusing factor 1.5.

In addition, test buttons shall be provided. The test buttons shall be connected in series with each phase failure relay coil so that when any one of the test buttons is operated the emergency lighting shall come on automatically.

Test buttons and relays shall be housed in the instrument section of the switchboard.

5.11 Air- Break Switches

All individually mounted air-break switches shall be of 660-volt metal clad type, single pole and neutral, or triple pole and neutral as required, fitted with interlocking handles so that the cases cannot be opened when the handle is in the 'ON' position. All insulating material employed in the construction must be of non-hygroscopic type and to the approval of the Engineer.

The construction and performance of the air- break switch shall be in accordance with B.S.5419: Parts 1 and 2.

5.12 Switch Fuses

All individually mounted switch fuses shall be of the metal clad type, the number of poles with or without neutral, as required, fitted with interlocking handles so that the case cannot be opened when the handle is in the 'ON' position. All insulating material employed in the construction must be of non-hygroscopic type and to the Engineer's approval.

The construction and performance of the switch fuses shall be in accordance with the relevant British Standard indicated below.

- i) Units rated not in excess of 100 amps and for a system voltage not in excess of 250 volts to earth shall be in accordance with B.S. 5419 unless specifically amended by the Engineer.
- ii) Units rated in excess of 100 amps and for a system voltage not in excess of 380 volts to earth shall be in accordance with B.S. 5419.

Fuses shall be of the cartridge type, to B.S. 88 category A.C. 46, Class Q1 and fusing factor 1.5 graded to suit the loads carried.

Sub-contractor's attention is drawn to the fact that all fusing in single phase circuits shall be on the "Single pole" principle with solid link in the neutral unless otherwise noted.

5.13 Cabling

A cabling zone clear of busbars, fused switch and circuit breaker chamber, etc., shall be provided in such a manner to give minimum difficulty in connecting submain cables entering the switchboard for connection to fuses switch units or circuit breakers. The cabling zone shall be fully insulated from any live metal part so that future cabling and alterations can be carried out in complete safety without the necessity of shutting down the complete switchboard.

5.14 Distribution Boards

Distribution boards shall be clad, surface or recessed pattern with the number of ways, rating and phase arrangement (single or three phase) indicated on the drawings. Cases shall be zinc coated sheet steel of substantial construction with hinged lids fitted with foam rubber gasket, enamelled finish. Where called for in the specification the cases shall be provided with locks. For ratings of 60 amp. and over detachable drilling plates and soldering lugs for incoming cable terminations shall be provided.

Where the requirement for fuses is indicated on the Contract Drawing the Distribution Boards shall be fitted with the high-quality porcelain fuse carriers and bases, removable insulated shields to provide adequate protection against accidental contact with live metal, and circuit indicating labels fixed inside the cover.

The Distribution Boards shall be complete with HRC fuses to B.S. 88 1952, category 440 volts, A.C.5.

Where the requirement for miniature circuit breakers is indicated on the Contract Drawings, the Distribution Boards shall be fitted with moulded thermoplastic units of the combined thermal overload and magnetic short circuit tripping type to B.S. 3871, Part 1. MCB's of all ratings shall have a minimum short circuit current breaking capacity of 3,000 amps.

Where the prospective fault current exceeds 2500 amps. or where specified, careful consideration shall be given to back-up protection or the installation of miniature circuit breakers of a short circuit capacity in excess of 300 amps.

Although short circuit calculations were carried out when the Contract Drawings were prepared, the Sub-Contractor is advised to make his own calculations and assure himself that the prospective fault currents at each protection level does not exceed the short circuit capability of the switch or distribution gear he intends to install as it is his responsibility to sign the appropriate declaration in accordance with the I.E.E. Regulations.

5.15 Labelling of Switchgear and Distribution Boards

All switchgear shall have engraved labels indicating the services fed from them. The inscription shall be in white 10mm. high letters on black 'Traffolite' sheet or equal and shall be fixed on or adjacent to the apparatus by screws or rivets.

Each Distribution Board shall bear a number or inscription as called for on the Contract Drawings which shall correspond to that shown on the Record Drawings. The circuits fed from each Distribution Board shall be marked on a card or identification plate fixed to the inside of the Board or were provided for. This information must include the outlets (with cross reference to the reference numbers on Contract Drawings) fed from each fuse way or MCB and the size of the fuse or circuit breaker rating.

5.16 Drawings for Approval

The following drawings shall be submitted for L.V. each switchboard for approval as soon as possible after receipt of instructions from the Engineer to proceed: -

- iii) Plans and elevations showing position of instruments relays, current transformers, voltage transformers, fuses, cable boxes and other accessories.
- iv) Foundation plan showing fixing bolt centres, cables centres and other relevant Dimensions.
- v) Wiring and connection diagrams.
- vi) Schematic diagrams.

The copies of each drawing as finally approved shall be supplied to the Engineer. In addition, the Sub-Contractor shall provide any other drawings on information required by the Engineer in order that the Engineer may satisfy himself as to the design of the plant. Manufacture shall not be commenced until all relevant drawings have been approved by the Engineer.

5.17 LV Distribution Panel

Switch Board

- Switch board standardized sheet steel (2mm) execution including inscription plate and mounted on a metal support of 100mm
- Paint: Anti-rust primer: interior of panel RAL 7030 exterior of panel white powder coated
- Mounting: The equipment is to be mounted on the light metal frame, with terminals in the section
- Protection: 415V 3 phase with earthing
- Standards: In Accordance with SEV standards
- Voltage: Rated voltage 500V 50HZ, Service voltage 415V 50HZ, Control voltage 220V 50HZ
- Bus bars: Laminated HDHC Copper rectangular bus bar rated 800A
- TYP NS 3D Protection IP 54 rear must be accessible – Front Door, Back Door, Top closed and Baes Open
- Power Rating 1000Amps

Incoming

- Moulded case circuit breaker (make ABB or approved equivalent), nominal rating 1000A 660V 50HZ breaking capacity 50KA at 440V with over current and short circuit protection inclusive with solid state trip
- Current transformer 1000/1A
- Voltage transformer 415/110V BTV 10 with selector switch for all phases
- Electronic /KWH meter similar to ABB CE series or equal and approved

Main Riser Outgoing MCCB

- Moulded case circuit breaking four pole, breaking capacity rated 800A, make as ABB, LERGRAND, or equal and approved with BMS compatible communicating module.

Mechanical Board Outgoing MCCB

- Moulded case circuit breaker Four pole, breaking capacity rated 125A, make as ABB or LERGRAND or equal and approved with BMS compatible with communicating module

Power Factor Correction Outgoing MCCB

- Moulded case circuit breaker Four pole, breaking capacity 50KA rated 400A, 660V, make as ABB or LERGRAND or equal and approved with adjustable thermal tripper and BMS compatible with communicating module

Essential Loads Panel Outgoing MCCB

- Moulded case circuit breaker Four pole, breaking capacity 50KA rated 400A, 660V, make as ABB or LERGRAND or equal and approved with adjustable thermal tripper and BMS compatible with communicating module
- 3 phase multi-function power meter with current voltage, KW, KWH, KVARH, PFAND with BMS Compatible
- 4 x 150mm dia. Heavy gauge PVC duct complete with draw wire from switch room to electrical closet in ground floor
- Trenching, sifting and backfilling the 750mm deep trench after laying the above ducts including compaction
- 900 x 900 concrete manhole complete with manhole covers marked (Hatari) Danger indelibly engraved at the top

Generator Feed Outgoing MCCB

- Moulded case circuit breaker triple pole, breaking capacity 50KA

nominal rated 1000A, 415V 50HZ , make as ABB TYPE C401 N or LERGRAND DPX or equal and approved with adjustable thermal tripper and BMS compatible with communicating module

Control Pillar Outgoing MCCB

- Moulded case circuit breaker single pole, breaking capacity 50KA nominal rated 63A, 660V 50HZ , make as LERGRAND DPX or Merlin Gerin Type C101H or equally approved with adjustable thermal tripper and BMS compatible with communicating module

Power Room Electrics Outgoing MCB

- Moulded case circuit breaker single pole, breaking capacity 50KA nominal rated 63A, 660V 50HZ , make as LERGRAND DPX or Merlin Gerin Type C101H or equally approved with adjustable thermal tripper and BMS compatible with communicating module

Spare Outlet Outgoing

- Spare cubicle for future connection
- Change over switch comprising of 2NO. 1000A 4p motorized MCCB, Electromechanical interlocked complete with microprocessor, electronic trip, manual or bypass with BMS compatible with communicating module.

Power factor correction panel in switch room

- Constructed from rolled steel angle channel section welded to form robust structure with data-cable 16-gauge plates to SEV standards mounted on B198 Sheet 1 metal support.
Front – Doors, back – Doors, Top – Closed and Base –

Open.

- Paint: Anti-rust primer: interior of panel RAL 7030 exterior of panel white powder coated
- Mounting: The equipment is to be mounted on the light metal frame, with terminals in the section to the floor
- Protection: 415V 3 phase with earthing
- Standards: In Accordance with SEV standards
- Voltage: Rated voltage 500V 50HZ, Service voltage 415V 50HZ, Control voltage 220V 50HZ
- Busbars: Laminated HDHC Copper rectangular busbar rated 400A
- Metering: Current transformer self-cooled rating 400/5A
- Power factor meter direct reading range – 0.5 capacitive of built-in series resistors TYPE SIEMENS M01055 – D3590
- Power factor rectangular 6 steps of 100, 50, 25, 10, 5,5 controllers similar to Siemens electronic KVAR controller type 4RY81 01 3DA01 supply voltage 415V 50HZ.

6 SECTION 6 POWER CABLES

6.1 Paper Insulated Cables

These shall be 1100-volt, 3300-volt, 6600 volts, or 11000-volt grade, according to operating voltage and manufactured and tested in accordance with B.S. 6480 for cables with copper conductors.

E.H.V. cables shall be suitable for operation on an earth system, and shall be of the belted type.

Multi core cables shall be paper insulated, lead sheathed, single wire armoured and served with hessian or PVC or left bright as indicated on the diagram of distribution. Single core cables shall be lead sheathed and served. All paper insulated cables shall be of the fully impregnated non-draining type.

Sizes of cables shall be in accordance with the details given on the Contract Drawings.

6.1.1 Jointing

Where possible the core of the paper insulated cable shall be taken direct to the terminal of the apparatus. The conductor shall be sweated into a cast pattern cable socket that has been drilled to receive the conductor without excessive clearance. A cable spreader box shall be fitted to and below the apparatus and filled with compound after the cables have been installed.

Alternatively, a system of compression jointing, approved by the Engineer may be employed. All cables tails shall be taped with double lapped Empire tape and after grade insulating varnish. VRL/PVC tails shall not be fitted without the approval of the Engineer in writing. If such approval is given the tails shall be of the same cross section as the PILC cable cores. The entire responsibility for the work involved in measuring, proper cutting, jointing and sealing paper insulated cables shall be borne by the Sub-Contractor who shall employ fully qualified, certified and experienced jointers for this work. This applies particularly to the jointers working on E.H.V. jointing.

Whenever a paper insulated cable is cut prior to joining the joint shall be commenced forthwith and completed without interruption. All necessary precautions shall be taken against the ingress of moisture and impurities during the preparation of the joint. Should the cable be cut and circumstances prevent a joint being made the ends shall be suitably sealed by means of plumbers leadcaps pending the completion of the jointing work. The seals of the cables must not be removed until all preparations for jointing are complete and adequate protection from the weather arranged by the Sub-Contractor.

Before rejoining cable ends shall be tested for moisture content in an approved manner. If any moisture is discovered the wet cable or cables shall be cut out.

Care shall be taken when making off cable ends to phase out the cores to agree with the transformer terminals. No cross overs will be permitted in the leads. Phase colours shall be clearly indicated at all points of connections and shall comply with B.S. 158, Table I.

It shall be ensured that all times straight through joints are from an A end to a Z end. Under no circumstances will core cross overs resulting from joints of the same end of the cable be permitted.

6.2 PVC Insulated and Sheathed Single Wire Armoured or Unarmoured Cables with Stranded Copper Conductors

PVC insulated, single wire armoured and PVC sheathed multi core cable shall be 660/1000-volt grade, manufactured in accordance with B.S. 6346.

The cables shall be sized to comply with the current edition of the I.E.E. Regulations except where specific sizes of cables are shown on the Contract Drawings or detailed in other sections of the Specification.

6.3 PVC Insulated and Sheathed Aluminium Strip Armoured or unarmoured Cables with Solid Aluminium Conductors

PVC insulated, aluminium strip armoured and PVC sheathed multicore cables shall be 660/1000-volt grade, manufactured in accordance with B.S. 6346.

The cables shall be sized to comply with the current edition of the I.E.E. Regulations, except where specific sizes of cables are shown on the Contract Drawings or detailed in other sections of the Specification.

The cable cores shall be identified in accordance with B.S. 6346.

An approved system of compression terminations secured to the conductor by indentation made with a special dies and a portable hydraulic compressor as recommended by the cable manufacturer shall be used.

Alternatively, in the appropriate conductor sizes and, where tunnel type terminals are used, connection may be made by means of "Swage" process whereby the shape of the conductor end is rounded to fit the terminal.

To eliminate the possibility of damage to cables due to thermal expansion, allowance for movement shall be made by the introduction of a bend or set in each core adjacent to the terminal.

Aluminium armour may be used as the earth continuity conductor where the Cross section is adequate for the purpose, but under no other circumstances shall the armour be used as a neutral conductor.

6.4 Gland for PVC Insulated Armoured and PVC Sheathed Cables

The cables shall be terminated on a mechanical type cable gland. The glands shall be complete with armouring clamp suitable for bonding the armouring to equipment by means of an earth continuity conductor of adequate cross section and the bend shall be carried out at the time of making the joint. PVC shrouds shall be fitted over terminal cable gland and clamp.

6.5 Installation

Cable routes were indicated on the Contract Drawings for tender purposes only.

The exact final routing shall be agreed with the Engineer.

All work except Builders Work shall be carried out by the Sub-Contractor, who shall include for the supply and installation of all jointing material, cable supports, steel racking and making all the necessary cable joints. The cable shall be installed and tested in strict accordance with the appropriate clauses of the current edition of the

I.E.E. Regulations, the Factories Act, B.S. 6480 - Paper Insulated cables, and B.S. 6346 - PVC Insulated Cables.

Cables shall at all times be handled with care and every effort made to avoid damage. Unloading, rolling to position and mounting of cable drums shall be carried out efficiently and carefully in the recognised manner and cable shall be pulled from the top of the drum and twisting shall at all times be avoided.

Adequate numbers of drum jacks, rollers and other handling accessories shall be used and make shift arrangements will not be permitted. In all cases care shall not be frayed over loose earth, concrete or any surface but shall be adequately supported on rollers or manhandled into position.

The Sub-Contractor shall take particular care to avoid damage to other services which may run adjacent to or across the route of the cable being installed. The Sub-Contractor shall take particular care to avoid damage to other services which may run adjacent to or across the route of the cable being installed.

Cables shall be installed with a minimum of 300mm clearance from any equipment or pipework including lagging associated with other services. Where this condition is unavoidable or difficult to maintain, the Engineer shall be informed prior to the installation being commenced, otherwise the Sub-Contractor may be called upon to divert or adjust the route of any cable to the Engineer's satisfaction.

Cables passing through structural slabs shall be tightly wrapped with asbestos tape and grouted in. A hard wood surround below shaped to suit the cables passing through shall be fitted below the slab. Where cables are run vertical heavy gauge sheath metal guards shall be supplied and fixed to the wall. The casing shall be fixed from floor level to the underneath side of the appropriate and dividing box or to a height of 1.5m above floor level.

Detailed drawings showing dimensions and method of manufacture of the cable guards shall be submitted for the approval of the Engineer.

All cables shall be firmly and adequately supported from cable hangers for the whole of their length except when they are run through stoneware or pitch fibrepipes or are buried directly in the ground.

Continuity, phasing and insulation tests shall be carried out and the record of all tests shall be sent to the Engineer within 7 days of the cables being installed and jointed.

6.6 Cable Supports

Where cables run through service ducts or cable trenches, they shall be fixed by means of purpose made cable hangers which shall be of the Unistrut pattern or equal and approved. Hangers shall be of non-ferrous metal or of steel and shall be treated with one coat of zinc primer and two coats of anti-corrosive paint and shall be suitable for horizontal and vertical mounting, either cased in, or secured to concrete structure using such brackets and adapters as are available from the manufacturers.

Hangers for the support of the cables shall be spaced according to the current edition of the I.E.E. Regulations, Table B.2M or to the manufacturers recommendations as appropriate. The Sub-Contractor shall take particular care to avoid sagging of stress on any cable by wrong positioning or inadequately spaced hangers. Single and multiway cleats shall be of cast alloy, interlocking pattern, for mounting either on the steel channels or directly to concrete structure in the case of single way cleats.

The sizes of cleats shall be selected such that all cleats can be tightened down without exerting undue pressure or strain on the cables.

In the case of vertical cables, the cleats shall be so designed and of sufficient number to grip the cable firmly to prevent creeping. No cable shall be run without fixing and all cable hangers and racks shall be approved by the Engineer before installation.

Where cable routes are subject to numerous changes in level and direction, additional cable hangers shall be provided to satisfactorily negotiate all such obstructions. Where cables are spaced some distance from a supporting service, the cable racks shall be separately bolted to additional lengths of channel section which in turn shall be fixed to brackets bolted and fixed into the structure.

6.7 Cable Identification Discs

Identification discs shall be supplied for cables installed within buildings and attached with galvanised wire to each cable at intervals not greater than 12m and at all conspicuous positions such as within cable trenches, manholes, and at all cable terminations.

Discs shall be machine engraved from non-deteriorating black traffolite or similar material displaying white engraved indicating the design voltage, the description of load, and the number of cross-sectional areas of the cores. The characters shall not be less than 3mm high and shall be clearly legible.

6.8 Cable Ducts

The Sub-Contractor shall provide and lay asbestos cement or pitch fibre cable ducts under roadways or concrete walkways under which cables are to be routed.

The Main Contractor will supply and install ducts where required in the footings of buildings, but it will be the Sub-Contractor's responsibility to provide accurate details to the Main Contractor of the required positions of these ducts, and to ascertain that they are laid to the correct falls. After the installation of cables all ducts shall be adequately sealed to restrict the ingress of moisture.

The number of ducts to be provided shall be as follows: -

1 cable	-	2 ducts
2 Cables	-	3 ducts
3 cables	-	4 ducts
4 or 5 cables	-	6 ducts

6, 7 or 8 cables - 9 ducts

All cable ducts entering or within buildings including spare ways, shall be sealed at each end with Densoplast or other approved sealing substance to the satisfaction of the Engineer.

6.9 Terminal Sealing Boxes

All sealing boxes shall be of an approved make and design. The casting shall be of the split type secured together by bolts and nuts and treated inside and out with a suitable preservation compound and shall be complete with brass wiping gland.

The castings shall be made of close grounded cast iron free from all holes and flaws. The halves of the casting shall be machined and so arranged to form an effective seal.

The box shall be provided with an external armour clamp. The lead sheathing of the cable shall be firmly secured to the interior of the box by clamping and where necessary by lead packing to form an additional support for the cable.

The lead sheathing shall be plumbed to the brass wiping gland and the armouring neatly fixed by means of binding wire and the external clamp. The Sub-Contractor shall ensure that the lead sheath and wire armouring is efficiently bonded to the metal parts of the apparatus served, with 300mm x 10mm copper tape. This bond shall be fitted at the time the joint is made.

An adequate compound filling gland shall be provided on each box and shall be so placed that the compound can be poured when the sealing end box is bolted into position.

Sealing compound shall be a blend of natural bitumen base containing no coal tar derivatives of any kind and having no deleterious action whatever on the materials used in cable manufacture.

The compound shall be in accordance with B.S. 1858.

6.10 Trenching

Trenching and backfilling will be carried out by the Main Contractor, but the Sub-Contractor shall be responsible for marking out the cable routes and for the supervision of the backfilling in so far as the prevention of damage to the cables in this process is concerned.

Cables in trenches shall be laid at a minimum depth of 600mm for L.V. cables and 700mm for 11KV cables and shall be on a 75mm pad of shift soil or sand and a further 75mm shall be added before placing cable covers in position. Where laid in trenches the cables shall be completely protected by inter-locking concrete or other approved cable covers indelibly marked "DANGER, HATARI".

Cable marker posts fabricated in precast concrete, shall be installed at each cable entry into the building, each change of direction, each road or pathway crossing and throughout the length of the cable at intervals not exceeding 40m.

The marker posts shall indicate the voltage, depth and distance from the face of post of each cable installed.

Marker posts shall be provided at the position of all underground, through or tee joints and shall, in addition, to those functions detailed above, indicate the type of joint. The position of all marker posts shall be agreed with the Engineer before installation.

6.11 Testing

Before backfilling trenches and subsequent to all terminal jointing having been completed, H.V. cables shall be tested in accordance with B.S. 6480, 1966. L.V. cables shall be subjected to all insulation test at pressure of 1000 volts between cores and to earth and the results of these tests shall be recorded and communicated to the Engineer.

6.12 Cable Length, Types and Sizes

The Sub-Contractor shall be deemed to have allowed in the Sub-Contract Sum for supplying sufficient cable lengths of each type and size to complete the system and for making allowances for any additional lengths for cutting and waste.

6.13 Mineral Insulated Copper Sheathed Cables

Mineral insulated copper sheathed cables shall be manufactured in accordance with B.S. 6207 by an approved manufacturer. Where installed in corrosive situations, they shall be PVC sheathed. No cable shall have conductors less than 1.5mm² cross section.

All main and sub-main cables shall be sized as shown on the Contract Drawings.

All final sub-circuit and control cables shall be sized in accordance with the current edition of the I.E.E. Regulations unless specifically noted on the Contract Drawings or the Specification.

All mineral insulated copper sheathed cable glands shall be of the same manufacture as the cable and shall be of the compression type.

The choice of cable seal type shall be based on the manufacturer recommendation for the particular application.

In areas where a flameproof installation is specified, the glands shall be of flame proof type.

The cable glands and seals for PVC covered mineral insulated copper sheathed cables shall be of the same type as those specified in the preceding paragraph. They shall, however, be fitted with rigid impact resistant hoods and shall be filled with plastic compound as used for sealing the 44°C cable seals.

Connection of mineral insulated copper sheathed cables of 4mm² cross section and larger to apparatus shall in general be by means of cone grip type cable lugs. At a termination, each core shall be identified by colour tapes or sleeves. Where this is not practicable, the Sub-Contractor shall advise the Engineer in writing and shall obtain his decision regarding the type of connection to be provided.

Where MICS cables are fixed direct to the structure of the building, the fixings shall be by means of copper saddles, brass screws and rawl plugs.

Where MICS cables are fixed to cable tray the fixing shall be by means of copper saddles and brass bolts and nuts.

PVC covered copper saddles shall be used with PVC covered MICS cables.

Under no circumstances shall bare MICS cables be fixed to galvanised steel cable tray, galvanised steel brackets or galvanised structural steelwork.

Bare MICS cables shall only be fixed direct to painted structural steelwork and brackets or to painted PVC/Plastic coated steel cable trays as specified later.

All MICS cable fixings shall be installed 75mm either side of a fitting, accessory or right-angle bend and subsequently spaced in accordance with the current edition of the I.E.E. Regulations.

All persons employed to make terminations on MICS cables shall have attended a course of instruction approved by the Engineer. Prior to commencing work, they shall demonstrate to the Engineer their ability to make a satisfactory seal.

The greatest care shall be taken at all times when terminating MICS cables and insulation tests shall be performed 24 hours after the cable has been sealed.

Where single core MICS cables are used, all necessary precautions shall be taken to prevent hysteresis and eddy currents.

Ferrous plates or structures through which the cables pass shall be slotted and brass glands and sockets shall be used.

7 SECTION 7- APPROVED WIRING SYSTEMS

7.1 APPROVED WIRING SYSTEMS

The system of wiring has been specified in the BoQ and shall be one or more of the following systems: -

7.1.1 *System A - Cables enclosed in Concealed Steel Screwed Conduit or Trunking*

The wiring shall be carried out in an approved type of single core, plastic insulated cable, enclosed in steel screwed conduit or trunking mechanically and electrically continuous throughout.

Conduit shall be buried in the wall and floors of the building, and either run in roof space or buried in structural slabs.

7.1.2 *System B - Cables enclosed in Steel Screwed Conduit or Trunking fixed to the surfaces of Walls and Ceilings.*

The wiring shall be carried out in an approved type of single core, plastic insulated cable enclosed in steel screwed conduit or trunking, mechanically and electrically continuous throughout.

Conduit and trunking shall be run on the surface of the walls and ceilings, or in false ceiling spaces. Conduit shall be secured in position by means of spacer bar saddles, and counter sunk brass screws. Conduit shall be run horizontally on the walls or vertically to switches or outlets.

7.1.3 *System C - PVC Insulated Cables with Insulated Earth Continuity Conductor Enclosed in Concealed Non-Metallic Conduit or Trunking*

Wiring shall be carried out in an approved type single core, plastic insulated cable with earth continuity conductor enclosed in high impact, heavy gauge, non-metallic conduit or trunking.

Conduit shall be buried in the walls and floors of building, and either run in roof space or buried in structural slabs.

7.1.4 System D - PVC Insulated Cables with Insulated Earth Continuity Conductor enclosed in Non-Metallic Conduit or Trunking fixed to the Surfaces of Walls and Ceilings

Wiring shall be carried out in an approved type single core plastic insulated cable with earth continuity conductor enclosed in high impact, heavy gauge, non-metallic conduit or trunking.

Conduit and trunking shall be run on the surface of the walls and ceilings or in false ceiling spaces. Conduit shall be secured in position by means of spacer bar saddles. Conduit shall be run horizontally on the walls or vertically to switches or outlets.

7.1.5 System E - Mineral Insulated Copper Sheathed Cables

The wiring shall be carried out in single core or multi-core mineral insulated copper sheathed cables run on the surfaces of walls and ceilings, in the roof space or concealed in walls and floors.

7.1.6 System F - PVC Insulated and Sheathed Cables, Clipped to the Surface of the Walls and Roof Members or to the Ceilings

The installation shall be carried out in an approved type twin or three-core PVC insulated and sheathed cable. Cables shall be securely fixed to the surface of the walls and in the roof spaces, and shall be fixed to the underside of ceilings, only when there is no reasonable access from above.

They shall be fixed to walls and the sides of roof members or in such other positions as may be approved by means of non-corrodible, saddles or buckle clips with non-corrodible fixings spaced at intervals not exceeding 225mm. Where cables pass through holes they shall be bushed.

Under no circumstances will joints be permitted in the run of a cable. Wires shall be connected together only by looping into the terminals of accessories or by approved mechanical connectors in suitable joint boxes. Under no circumstances will taped joints be permitted.

The cables sheathing shall be carried into the switch, ceiling rose or other accessories.

Cables shall not be installed within 300mm of a metal roof, unless clipped to the lower side of wooden joints or otherwise protected from radiant heat.

7.1.7 System G - PVC Insulated and Sheathed Cables Clipped to Roof Members and Run in Metal or Plastic Conduit Drops Concealed in Walls

The wiring shall be carried out as for System F except that the cables shall be enclosed in steel or plastic conduit where drops are required to switches, distribution boards or accessories.

7.1.8 System H _ PVC Insulated Single Wire Armoured and PVC Sheathed or Paper Insulated Lead Sheathed Single Wire Armoured and Served Cables Laid in Ducts, Trenches and Saddled to walls

Cables shall be suspended on purpose - made frame and hangers, drawn through ducts or laid in trenches. Cables suspended on multiple hangers shall be so arranged that one cable can be removed without disturbing the others. Frames and hangers shall be galvanised or of non-ferrous material and shall not be fixed in contact with other metals with which they are liable to set up electrolytic action. All spacings of cable hangers and

supports shall not exceed those laid down for the relevant size and type of cable in the current edition of the I.E.E. Regulations.

8 SECTION 8- CONDUITS, TRUNKING AND ASSOCIATED FITTINGS

8.1 Steel Conduits - Steel Trunking

Conduits shall be of welded heavy gauge Class B to British Standard Specification B.S.31. In no case will conduits smaller than 19mm diameter be used on the Sub-Contract Works. Conduits installed within buildings shall be of black enamelled finish except where specified otherwise. Where installed externally, they shall be galvanised. Conduit fittings, accessories or equipment used in conjunction with galvanised conduits shall also be galvanised or otherwise as approved by the Engineer.

Metal trunking shall be fabricated from mild steel of not less than 18 swg. similar in pattern to that manufactured by M.S Walsall Conduits Ltd. All sections of trunking shall be rigid fixed together and attached to the framework or fabric of the building at intervals of not less than 1200mm. Joints in trunking shall not overhang fixing points by more than 600mm.

All trunking shall be made electrically continuous by means of 25mm x 3mm copper links across each joint in the system. Connection shall be made by means of electro-tinned bolts (head inside trough) nuts (6mm dia. minimum) flat washers and spring washers, and where the trunking is galvanised, the galvanising shall be removed within 6mm of the jointing strap, and the area painted.

All trunking fittings (i.e. bends, tees, etc) shall leave the main trough completely clear of obstruction and continuously open except through walls and floors, at which points suitable fire resisting barriers shall be provided as may be necessary.

Where trunking passes through ceilings and walls the cover shall be solidly fixed 150mm either side of ceilings and floors and 25mm either side of walls.

Screws and bolts securing covers to trunking, or sections of covers together shall be arranged so that damage to cables cannot occur either when fixing covers or when installing cables in the trough.

Where trunking is used to connect switchgear or fuse boards, such connections shall be made by trunking fittings manufactured for this purpose and not by multiple conduit couplings.

Where boxes and bends or similar fittings are used, particular attention shall be given to avoid damage to cables on corners.

Where vertical sections of trunking are used which exceed 900mm in length, staggered tie off points shall be provided at 900mm intervals to support the weight of cables.

All trunking systems shall be painted as for conduit.

Where a wiring system incorporates galvanised conduit and trunking, the trunking shall be deemed to be galvanised unless specified otherwise.

The number of cables to be installed in trunking shall be such as to permit easy drawing in without damage to the cables, and shall in no circumstances be such that a space factor of 45% is exceeded.

Conduit and trunking shall be mechanically and electrically continuous. Conduit shall be tightly screwed between the various lengths so that they butt at the socketed joints. The internal edges of conduit and all fittings shall be smooth, free insulating substance shall be removed from the screw threads. Where conduits terminate in fuse gear distribution boards, adaptable boxes, non-spouted switchboxes, etc., they shall be connected thereto by means of smooth bore male brass bushes, compression washers and sockets. All exposed threads and abrasions shall be painted (using an oil paint for black enamelled tubing and galvanising paint such as 'Rust Anodi' manufactured by C.P. Development Co. (London) Ltd., for galvanised tubing immediately after the conduit are erected. All bends and sets shall be made cold without altering the section of the conduit, the inner radius of the bend shall not be less than $2\frac{1}{2}$ times the outside diameter of the conduit. Not more than two right

angle bends will be permitted without the inter-position of draw-in box. Where straight runs of conduit are installed, draw-in boxes shall be provided at distances not exceeding 12 metres. No tees, elbows, sleeves, either of inspection or solid type, will be permitted.

Conduit throughout shall be of sufficient section and so arranged with draw-in boxes to allow easy drawing in and out of any one or all of the cables in the conduit.

All metallic and non-metallic conduit shall be swabbed out prior to drawing in cables, and they shall be laid so as to drain off all condensed moisture without injury to end connections.

Conduit and trunking shall be run below and kept at least 150mm clear of hot water and steam pipes, and at least 150mm clear of cold water and other services unless otherwise approved by the Engineer.

Conduit installed and buried in walls shall allow a minimum of 10mm cover. These conduits and those cast 'in-situ' in concrete slabs shall be given one coat of rust prevention paint before installation of conduit and before concrete is placed. Sunk circular conduit boxes shall be provided with break joint rings of white moulded material or metal.

Surfaces conduit shall be run in square symmetrical lines and shall be marked on site for approval before installation. Conduit shall be fixed by means of distance saddles spaced at not more than 1200mm, for 19mm and 25mm conduit and 1.5 metres for larger sizes.

Conduit shall be fixed each side of conduit boxes at a distance not exceeding 600mm.

Where conduit runs enter specified areas requiring flameproof equipment, barrier boxes shall be inserted immediately before the conduit enters the flameproof area. All conduit installed within this area shall be solid drawn galvanised, as shall be conduit fittings and accessories and Buxton Certified as suitable for Group II hazards. Equipment shall comply with B.S. 229, B.S. 889 and Code of Practice C.P. 1003.

In no case shall conduit from different distribution boards be connected at one junction box, likewise cables from different distribution boards shall not be housed in the same conduit.

All boxes shall conform to B.S. 31, shall be of malleable iron, and black enamelled or galvanised according to the type of conduit specified.

All conduit boxes, except loop-in pattern in concrete floors shall be fixed direct to the structure apart from the support provided by the conduit.

Both lids where required shall be heavy gauge secured by means of brass screws.

Draw-in through boxes shall be provided in all conduit systems for the drawing in or out of any cables after installation is completed.

All adaptable boxes and lids of the same size shall be inter-changeable.

Boxes used on surface work shall be tapped or drilled to line up with the conduit fixed in distance type saddles allowing clearance between the conduit and wall without the need for setting the conduit.

Draw-in boxes in the floors shall be avoided except where they are essential when they shall be grouped in positions approved by the Engineer and covered by suitable floor traps, with non-ferrous trays and covers.

The floor trap covers shall be recessed and filled in with a material to match the floor surface.

The Sub-Contractor shall take full responsibility for the filling in of all covers, but the filling in materials will be supplied and the filling carried out by the Main Contractor.

Where buried in the ground outside the building the whole of the buried conduit shall be painted with two coats of approved bitumastic composition before covering up. Paint damage and joints under screed or cast in-situ shall be similarly treated.

Where run on the surface, unpainted fittings and joints shall be painted with two coats of oil bound enamel applied to rust and grease free metalwork.

8.2 Flexible Conduit

Conduit connections to motors and equipment shall be made using a minimum of 300mm waterproof flexible conduit. The solid conduit shall be terminated in a large BESA or adaptable box enclosing sufficient coils of motor cables to enable "Tong Test" readings to be taken in each conductor. Earth continuity shall be maintained by means of a copper conductor seized in accordance with the appropriate table of current edition of the I.E.E. Regulations and insulated with Green and Yellow PVC. This conductor shall be run

externally to the flexible conduit connecting apparatus to solid conduit and shall be secured to the connecting adaptors by an approved means.

All connecting adaptors shall be solid bronze or brass pattern with standard thread for conduit connection and a thread for conduit connection and a thread to receive the flexible conduit. The adaptor shall be sweated solid to the flexible conduit and the rub screw fully tightened.

8.3 Plastic Compound

All galvanised boxes and boxes in a situation where the air flow is likely to cause excessive condensation shall be filled with a plastic compound which fulfills the following conditions: -

No effect on the physical properties of insulation at any temperature. No effect on metals, porcelain, synthetic resins, etc.,

Unaffected by atmospheric and temperature extremes. Remains plastic indefinitely.

Has a high insulation value.

8.4 Telephone Conduit

The arrangement and size of telephone conduit shall be such as to accommodate the number of circuits as indicated on the Contract Drawings. Conduit shall terminate in standard metal boxes to B.S. 1363 with flush fitting cover plate. Draw wires of piano quality steel wire of not less than 22 swg. shall be left in all telephone conduit. Draw-in boxes shall be provided in telephone conduit on the same basis as laid down for power and lighting conduit.

Telephone outlet boxes, draw-in boxes and the telephone distribution boxes shall be marked internally with yellow paint to distinguish them from boxes provided for other services.

8.5 Television Conduit

Television conduit shall be 19mm diameter thermo-plastic type installed vertically from each outlet point terminating 300mm above finished roof surface. A purpose made bend shall be screwed on to the conduit at its roof termination. Outlet points shall be the conduit at its roof termination. Outlet points shall be Belling and Lee Type 1480 complete with plug type L734/PAI, or other similar and approved, fitted to a flush plastic box to B.S. 1363. Draw-in wires as provided for telephone conduit shall be installed.

8.6 Cable Tray

Cable tray shall be fabricated from perforated mild steel tray of 150mm minimum width and 14 swg. with return flanges and coupling pieces for rigidity and strength similar to that manufactured by Messrs H. Greening (Wolverhampton) Ltd., Catalogue No. R.F. 7 type.

The cable tray shall be painted grey enamel for indoor use and shall be hot dipped galvanised for outdoor locations.

Cable tray shall be appropriately fixed on robust and substantial brackets fixed into the walls or shall be suspended on rods securely fixed to the structure together with a bracket arrangement as required to facilitate the support of the cable tray. Suspension rods shall be minimum 10mm. dia. mild steel, Brackets or suspension supports shall be provided as necessary, the spacing of which shall not exceed 1800mm.

Where the cable tray changes direction the minimum radius of bends shall not be less than 300mm on the inside of the bend and in no case shall be less than the bending radius of the cable supported.

All brackets, suspension rods and attachments shall be finished as the cable tray supported.

8.7 Rising Main Bus-Bars

The rising main bus-bar system shall comprise a sheet metal enclosure containing copper bus-bars rising through the building via the riser duct, and supplying the distribution system at suitable tap-off position.

The bus-bars shall be contained in a trunking of not less than 16 gauge sheet steel with detachable cover plates providing a reasonably dustproof enclosure. The covers shall be in sections the length of which shall be approved by the Engineer prior to manufacture.

Fixing brackets for wall fixing shall be provided at not less than 1800mm intervals

All steel work shall be given a rust preventative undercoat, and finished, in gloss enamel in an approved colour. All screws, bolts, nuts and washers shall be rustproofed.

Bus-bars shall be 4 pole 2 pole with full size neutral rated at the current indicated on the Contract Drawings, and shall consist of hard drawn, high conductivity copper bars.

Current ratings shall comply with B.S. 159 for a temperature rise not exceeding 50°C.

Copper fishplates shall be used for connection between the lengths of bars, and a high degree of conductivity shall be maintained.

The bus-bars shall be anchored rigidly in the vertical run, and approved means of taking up the maximum expansion and contraction likely to occur in the bars under normal conditions shall be incorporated. The recommendations of the manufacturers in this respect shall be closely observed.

Phase colours shall be clearly marked.

Bus-bars shall be supported and anchored by means of suitable high grade non- hygroscopic and non-tracking insulation and designed to withstand the stresses set up under fault conditions.

Where the rising bus bar systems are carried through floors, a barrier of fire resisting material shall be incorporated in the trunking at each floor level to prevent the possible spread of fire between floors.

End covers shall be fitted at the top of the run.

A suitable cable entry with terminal type scaling end box shall be provided at the lower end of the system to accommodate the main cable, the size of which is shown on the Contract Drawings.

Tap-off units shall be of the type and current rating indicated on the Contract drawings. All connections to bus-bars shall be made by means of bolted type clamps designed to ensure maximum conductivity at all times, and drilling of bus-bars will not be permitted.

A 25mm x 3mm copper tape shall be installed externally for the full length of the bus-bar trunking. The tape shall be bonded to each section at intervals not exceeding 1200mm, by means of 20mm brass bolts, washers and lock nuts.

8.8 Under floor Ducting

Where under floor ducting is specified, it shall be of two or three compartment type manufactured from 16-gauge zinc coated steel with base plate and badly welded together to make a single unit. The capacity of each section shall be adequate for the number of conductors to be drawn in and the space factor as required for compliance with the current edition of the I.E.E. Regulations shall not be exceeded.

9 SECTION 9- CABLES IN CONDUIT OR TRUNKING

9.1 General

The wiring throughout shall be carried out by looping cables progressively from point to point and no tee or other joint will be permitted. Conductors of the same circuit shall be contained in the same conduit or trunking. At distribution boards, the neutral bar in the same sequence as the live conductors are connected to the fuses or circuit breakers so that they can be readily identified.

9.2 PVC Cable in Conduits

Unless otherwise specified cables shall conform to B.S. 6004. They shall be 600/1000-volt grade, single-core. No cable smaller than 1/1.38mm (1.5²) shall be used. Cable size shall comply with circuit details as indicated on the Contract Drawings. Slack cable shall be left at all points of connection.

When used with pinch type terminals cable ends shall be prepared as follows:-

- i) 1/1.38mm. (1.5mm²) and 1/1.78mm. (2.5mm²) - the conductor doubled back on itself to present a double thickness.
- ii) 7/0.85mm (4.0mm²) to 7/1.70mm. (15mm²) - the strands well twisted together to make as solid a conductor as possible.
- iii) 7/2.14mm. (70mm²) and above - the strands sweated solid or fitted with purpose made soldering thimbles.

Cables shall be delivered to the site with seals intact and offered to the Engineer for inspection prior to installation.

Care shall be drawn in after the erection of the complete conduit and trunking system, or completed section if approved by the Engineer and all plaster has dried out. Draw wires, tapes or cables shall not be threaded in at the time conduit is being installed.

The live and neutral conductors of a circuit shall be drawn in the same conduit or enclosure.

Cable sizes shall be selected to allow for a 20% increase in load on every final sub-circuit.

Space shall be left in conduit and trunking for drawing in at some future date two additional cables of size not less than the largest cable enclosed in the conduit or trunking being considered.

Not more than six final sub-circuit cables shall run in conduit feeding outlet boxes, without the approval of the Engineer. Not more than eight cables running straight back to the distribution board shall be enclosed in any one conduit. Flexible cords shall be of 300/500-volt grade VR or PVC insulated and shall comply with B.S. 6500. No flexible cord smaller than 0.75mm² shall be used. Flexible cords for pendant fittings shall be circular heat resistant type, white finish.

10 SECTION 10 TESTING ON SITE

10.1 Installation Tests

The Sub-Contractor shall conduct testing during and at the completion of the installation and if required, again at the expiration of the Maintenance Period, tests in accordance with the relevant section of the current edition of the I.E.E. Regulations, the Government Electrical Specification and KPLC Bye-Laws.

Tests shall be carried out to prove that all single pole switches are installed in the 'live' conductor.

Tests shall be carried out to prove that all socket outlets and switched socket outlets are connected to the 'live' conductor in the terminal marked as such, and that every earth terminal is effectively bonded to the earth continuity system. Tests shall be carried out to verify the continuity of all conductors of each 'ring' circuits.

Phase tests shall be carried out on completion of the installation to ensure that correct phase sequence is maintained throughout the installation.

The Sub-Contractor shall prepare and hand over to the Engineer within 14 days of the witnessed tests three copies of the results of the above tests. The Sub-Contractor shall be required to issue to the Engineer the requisite certificates upon completion as required by the current edition of the I.E.E. Regulations.

Any faults, defects, omissions, faulty workmanship or incorrectly positioned or installed parts of the installation made apparent by such inspections or tests shall be rectified by the Sub-Contractor at his own expense.

10.2 Testing Equipment

The Sub-Contractor shall provide accurate instruments and apparatus and all labour required to carry out the above tests. The instruments and apparatus shall be made available to the Engineer to enable him to carry out such tests as he may require.

10.3 Attendance on Other Contractors

The Sub-Contractor shall generally attend on other Contractors employed on the Works and carry out such electrical tests as may be necessary.

10.4 Equipment, Plant, Apparatus and Systems

The Sub-Contractor shall test to the Engineer's approval and as specified, all equipment, plant and apparatus forming part of the Works and before connecting to any power supply and setting to work.

Where such equipment, etc., forms part of, or is connected to, a system whether primarily of an electrical nature or otherwise (e.g., Air Conditioning System) the Sub-Contractor shall attend on and assist in balancing, regulating, testing and commissioning, or if primarily an electrical or other system forming part of the Works, shall balance, regulate, test and commission the system to the Engineer's approval.

11 SECTION 11 EARTHING

The extent of earthing equipment to be installed as part of the Sub-Contract Works shall be as follows: -

11.1 Earthing System for High Voltage Supply

A main earth bus-bar of 55mm. x 6mm. of high conductivity hard drawn copper shall be mounted on insulators on the wall of the Sub-station at the position indicated on the Contract Drawings. The following connections shall be made to this bus-bar:

1. Insulated stranded cable connection to the transformer neutral
2. Bare conductors to the transformer frame.
3. Bare conductor to H.V. switchgear frame.
4. Bare conductor to L.V. Switchgear frame.
5. Insulated stranded conductor to sub-station earth electrodes.

The size of the earth continuity conductors shall be as follows:

<u>Maximum Prospective Fault Current</u>	<u>Insulated Stranded Conductor</u>	<u>Bare Copper Conductor</u>
14 KA	19/2.52 (95mm ²)	25mm x 9mm
9 KA	19/2.14 (70mm ²)	25mm x 3mm

Where necessary, earthing connections shall be protected against mechanical damage and corrosion.

Where connections are made to the earth bus-bars, contacting surfaces shall be tinned.

The earth electrodes shall comprise 8 earth rods, installed in pairs, each pair connected together and to the earth bus-bar by an insulated stranded conductor. The earth rods shall be 1.5m long by 15mm. dia, extensible type as "Copper weld" or other equal and approved, each pair of electrodes shall be located not less than 3m. apart, the first pair being not less than 3m. from the building. The head of the earth rods shall be driven to 300mm below the surface of the ground and enclosed in a concrete box with a concrete inspection cover. The metal sheaths of all H.V. and L.V. cables shall be adequately bonded to the appropriate switchgear frame.

11.2 Earthing System for L.V. Supply

Where the supply is taken at L.V. from either a Substation on the site or a remote substation, the following earthing equipment shall be installed.

6. In the main switch room (supply intake):

A copper earth bus-bar, as described in Clause 10.01.

A bare 25mm x 3 mm copper conductor from each item of isolated switchgear, connected to the earth busbar.

A complete earth electrodes system, installed as specified in Clause 10.01, connected by an insulated earth continuity conductor to the earth busbar.

7. In the switch rooms of isolated buildings on the site.

A similar earthing installation to that described in (1) above.

8. In the event of the K.P.& L. Co. providing an earth terminal at the intake position, the earth electrodes and earth continuity conductors, described in (1) and (2) above, shall be omitted.

11.3 Protective Multiple Earthing

Where protective multiple earthing (PME) is provided by the supply undertaking, the earthing lead shall be connected to the consumer's earthing terminal and, together with the neutral conductor of the installation, shall be so arranged that connection to the neutral conductor of the incoming supply can be carried out by the supply undertaking.

The earthing of the installation shall comply with the requirements laid down in the current edition of the I.E.E. Regulations. The earthing system for H.V. supply, described in Clause 10.01 shall be amended for the provision of separate earth electrodes for the H.V. and L.V. sides of the installation.

In addition, provision for earthing the neutral conductor shall be made for each distribution main at the end farthest from the transformer where it is connected to the main switchboard of an independent building or area of the site.

11.4 Consumer's Earth

The consumer's earth is deemed to be the earthing terminal at: -

1. The main L.V. switchboard
2. The L.V. switchboard at the intake position of an isolated building.

The consumer's earth will be bonded to the earth bus-bar in the sub-station in an approved manner.

11.5 Bonding

All conduit, trunking metal enclosers, the metallic sheathing of cables, the cases and enclosers of switchgear, fuse gear and apparatus of electrical nature in each building shall be so bonded as to be directly connected to the respective consumer's earth. Earthing arrangements and resistance of the earth continuity conductor shall comply with the current edition of the I.E.E. Regulations.

In situations such as bathrooms, kitchens, laundries or any situation where there is exposed metal and socket outlets or fixed appliances are installed, all metal work including hot and cold-water pipes, waste pipes, metal draining boards, the casing of electrical appliances, etc., shall be effectively bonded to the earth continuity conductor of the electrical installation so as to ensure that no difference in electrical potential can arise between these items.

Earthing system shall be tested in accordance with the current edition of the I.E.E. Regulations, and if the minimum impedance required by the I.E.E. Regulations is not obtainable, the Engineer shall be informed.

The Sub-Contractor will be responsible for rectifying any fault in the earth continuity conductor at his own expense.

12 SECTION 12 INSTALLATION OF LIGHTING FITTINGS

12.1 Fixings

Information on the proposed method of fixing each type of lighting fitting is included in Part C of the Specification.

12.2 Alignment

Care shall be taken that individual lighting fittings are aligned with the ceiling in all planes and that there is proper alignment in groups or rows of lighting fittings.

Where necessary, cast iron extension rings shall be used to provide alignment between recessed point boxes and finished ceiling levels.

12.3 Enclosures

In situations where a lighting fitting is fitted to a ceiling of combustible material, the back plate or other accessory shall be so designed that the connecting cables are completely enclosed.

12.4 Earthing of Lighting Fittings

At every lighting point an earthing terminal shall be provided and connected to the earth continuity conductor of the final sub-circuit.

12.5 Programme for Erection of Lighting Fittings

The Sub-Contractor shall liaise with the Main Contractor in order that lighting fittings can be erected at such a time that:

- i) The work of other trades is not inhibited by the presence of the fittings in-situ.
- ii) No damage is caused to finished ceilings or walls
- iii) Where fittings are located in selected spaces left open in a suspended ceiling, there is adequate clearance for the fittings, access to suspension points, and clearance for any other services in the ceiling void at that point.

No. claims will be considered for costs of extra works or damages which arise out of the Sub-Contractor's failure to comply with this clause.

13 SECTION 13- LIGHTING AND SINGLE-PHASE POWER ACCESSORIES

13.1 General

The lighting switches, socket outlets, fused spur outlets and similar accessories shall be as specified. The type of accessory to be used in each location is related to the type of wiring system in that area,

In all cases where switches are grouped together, and are connected to the same phase they shall be ganged together and mounted in a multi-gang box and plate.

Where switches control points not readily visible from the switching position the plates shall be engraved to indicate the points controlled.

All switches controlling maintained circuits shall have the word 'MAINTAINED' engraved on the switchplate.

Multi-gang switch boxes, containing switches supplied from different phase shall have integral fixed separators segregating the switches on different phases. Each such segregated compartment shall have a separately fixed metal cover clearly marked 'Danger' 415 volts' and the overall switchplate shall cover the whole.

13.2 Special Accessories

Accessories for special purpose such as speed controls for small motors, dimmers, flameproof or sparkless switches, etc., shall be as specified. Where special accessories are supplied as part of the Sub-Contract Works, they shall have a finish to match the other accessories installed in the same area.

14 SECTION 14- PLANT POWER WIRING

14.1 General

Wiring to motor outlets and control outlets in Plant Rooms, Ice Flake Machine, etc., and to remote motor and control outlets forming part of the Mechanical Engineering Services installation, shall be carried out in one of the wiring systems described in the specification.

The approximate locations of motor and control outlets, distribution boards and control panels are shown on the Contract Drawings. Details of the size and type of cables, and rating of fuse ways or circuit breaker are shown on the diagram of connections.

Precise instructions on the Sub-Contractor's responsibilities for the supply, fixing and connecting of equipment such as isolators, starters, control switches, sensing elements, annunciator panels, etc., are given in the Particular Specification. Where such items of equipment are provided by others it will be their responsibility to issue to the Main Contractor schematic diagrams; diagrams of connections and details of any special requirements, such as the provision and specification of screened cables and to ensure that the equipment is suitable for the electrical characteristics of the supply available.

15 SECTION 15- NON-METALLIC CONDUIT

15.1 General

Non-metallic conduit shall be best quality new super high impact grade heavy gauge Class 'A' rigid PVC unplasticized conduit as manufactured by Ega Africa Ltd., suitable for plain connections.

15.2 Manipulation

The conduit shall be bent and formed strictly in accordance with the manufacturer's instructions.

i) Small sizes, i.e., 15mm, 19mm and 25mm, shall be bent cold by inserting the correct size bending spring. It is essential for right angle bends that the conduit is bent past 90° to allow for 'spring back'.

ii) Larger sizes of conduit shall be preheated before inserting rubber cord to prevent kinking. Conduit badly formed or bent, or damaged in any way, shall not be used.

15.3 Joint of Plain Conduit

Joints shall be made water-tight by the use of 'Egaweld' cement applied with a brush or rag. 'Egaweld' shall be applied to the complete circumference of the conduit. Conduit shall be thoroughly cleaned at the ends to ensure a good adhesion to the end fittings.

'Egaweld' shall not be permitted to enter into the conduit.

15.4 Conduit Fittings

All conduit fittings and accessories including couplers, reducers, stopping plugs, lock nuts and male and female bushes shall be manufactured to B.S. 4607 Part 1, 1970.

Solid tees shall not be used. Solid or inspection elbows or bends or inspection tees shall be used only in exceptional circumstances and then only with the Engineer's approval.

Where it eases the installation of cast-in-situ back entry boxes on the looping system, purpose made bends manufactured by Egatube and comprising a tight bend with a push socket at one end and a threaded socket at the other may be used.

15.5 Fixing of Conduit

Conduit shall be installed on the loop-in system and shall be either cast-in-situ in the main concrete structure concealed in chases case in concrete wall, or chases cut in solid partition walls, run in ceiling spaces or in hollow partitions or floors; concealed below the floor screed, whichever shall prove to be the most suitable method of installation for use in the building under construction. Unless it is clearly specified or shown on the drawing, the method of installing conduit shall be subject to the approval of the Engineer.

Sunken conduit run in chases in walls or ceilings shall be fixed by spacer bar saddles fixed not more than 900mm apart.

Surface conduit shall also be fixed 125mm. on both sides of all boxes, the box itself being securely fixed. Where such an arrangement of boxes and saddles would prove to be both unsightly and unnecessary, short lengths of conduit not exceeding 900mm. in length between boxes need not be secured further than by connection to the adjacent boxes. In such cases the Engineer reserves the right to insist upon additional fixings being provided, should he for any reason whatsoever consider additional fixings necessary.

Where two or more lines of conduit run parallel to each other, on the surface of walls, etc., the distance between them shall be not less than 20mm. and conduit shall not cross.

Conduit shall be installed in such a manner as to prevent interference with other services and shall be kept at least 150mm. clear of gas or water pipes, and heat in excess of 68°C.

A means of expansion shall be provided in conduit runs in excess of 6m. without any bend or set, by the use of "Egatube" expansion couplings, which shall also be used at building expansion joints.

Conduit cast-in-situ shall be frequently secured to the steel reinforcement work, with heavy binding wire to prevent movement of the conduit and conduit boxes during the pouring and vibrating of the concrete. Outlet boxes shall be filled with paper to prevent ingress of concrete, and all boxes shall be securely fixed to the shuttering with nails, or by means which shall be visible as a marked-on removal or the shuttering only where these marks can be concealed. Conduit shall be installed after the first grid of steel reinforcement work is securely fixed and all open ends of conduit shall be protected by couplings plugged with a suitable non-metallic stopping plug. The number of right angle bends in conduit cast in-situ shall not exceed two between boxes. Immediately prior to installing the wiring all conduit and fittings shall be dried and cleaned out by drawing through a cloth swab. Rawl plugs shall be used for fixings to brickwork, self-tapping screws for fixing to aluminium section, rawl- nuts, spring toggles, gravity toggles or rawl- bolts shall be used for fixing to other materials as approved by the Engineer.

Corners shall be turned by easy bends or sets made in accordance with the manufacturer's instructions without altering the section or splitting the conduit.

15.6 Circular Inspection Boxes

Boxes will not be permitted in floors unless approved. Boxes cast-in-situ must face downwards from the ceiling/floor section.

Small standard circular non-metallic conduit boxes, conforming dimensional with B.S. 31/1940 with standard circular non-metallic (3mm) lids and nylon fixing screws, shall be provided and fixed at all junctions.

The above circular boxes or equivalent looping boxes shall be provided and securely fixed for all ceiling points. When the conduit is run on the surface, all circular boxes for ceiling points shall be fixed with screws.

Where ceiling roses occur and the ceiling box is recessed below the finished level of the ceiling, suitable extension rings to accommodate the ceiling rose must be provided.

Where ceiling boxes, including extension rings, are flush with the ceiling surface, breakjoint rings shall be provided to hide the joints.

Where a non-metallic outlet box of thermoplastic material is used for the fixing or suspension of a lighting fitting, care shall be taken to ensure that the temperature of the box does not exceed 60°C and the box shall be fitted with Egafrica steel insert clips.

15.7 Stopping Plugs

All spare ways in junction boxes, etc., left for possible future extension shall be fitted with stopping plugs.

15.8 Continuity

Where fittings and accessories require earthing, an earth continuity conductor shall be run through the conduit. The earth continuity conductor shall be of copper minimum size 1.0mm² and shall be continuous between terminals. Where the earth terminal is formed by a brass screw and washer, 'Ross Courtney' terminations shall be used.

All metal boxes shall be equipped with an earth terminal.

Each final sub-circuit that is required to be earthed shall be provided with its own individual earth continuity conductor which shall be run from a

terminal on the earth bar in the distribution board or consumer's control unit protecting the particular final sub-circuit.

PART B
ELECTRICAL ENGINEERING SERVICES PARTICULAR SPECIFICATION

16 SECTION 16- PARTICULAR CONDITIONS

16.1 Location of Site

The site of the proposed Sub-Contract works shall be in Malindi, Kilifi County Kenya.

16.2 Description of Project

The project shall comprise the development of a social fish banda, social hall, ablution block and access road.

16.3 Commencement of Works

The Sub-Contractor in submitting his tender shall be deemed to have included for commencing any necessary work on site at such time as will comply with the Main Contractor's Program.

16.4 Climatic Conditions

The following climatic conditions apply at the site of the works and all plant, equipment, apparatus, materials and installations shall be suitable for these conditions.

Maximum temperature-	46°C
Minimum temperature-	21°C
Average temperature range-	21.3 - 31.3°C
Relative humidity range-	50% - 85%
Altitude-	50 M above sea level
Latitude-	3° 57'S
Longitude-	39° 42'E

The Sub-Contractor shall be deemed to have taken account of the above details in his prices and his planning of the execution of the works.

Unless otherwise stated, all ratings of plant, equipment and apparatus shall be interpreted as site ratings and not sea level or other ratings.

16.5 Scope of Sub-Contract Works

The Sub-Contract Works shall comprise the supply, delivery, erection, testing, commissioning and setting to work of the Electrical Engineering Services as detailed in this Specification and accompanying Contract Drawings.

The Sub-Contractor shall include for all apparatus and appliances not particularly called for in this Specification or on the Contract Drawings but which are necessary for the completion and satisfactory functioning of the Sub-Contract Works.

No claims for extra payment shall be accepted from the Sub-Contractor due to his failure to adhere to the above requirements.

It is deemed that if, in the opinion of the Sub-Contractor at the time of tendering, there existed a discrepancy between the Specification and the Contract Drawings, that the Sub-Contractor clarified this difference with the Engineer before tendering.

The works to be installed under this Sub-Contract shall comprise but not restricted to the following: -

1. K.P.L.C Main incoming electricity supplies.
2. Main Low Voltage Switchboard, sub-main switchboards, distribution boards and consumer units.
3. Electrical distribution systems and works associated with mechanical services.
4. Sub Mains cable and associated sub boards.
5. Lighting and Power Installations.

6. Lightning Protection System.
7. Security Lighting System.
8. Fire Alarm and Detection system.

16.6 Ordering

The Sub-Contractor shall order materials from the quantities taken from his own approved working drawings and not from the quantities shown on the Contract Drawings or in the Specification

16.7 Builder's Work Requirements

The structural and other provisions allowed for are indicated on the Contract Drawings. If the Tenderer requires any other provisions, he shall mark them in a contrasting colour and submit them as part of his tender.

16.8 Statement of Compliance

The Tenderer shall provide as an integral part of his bid, a statement of compliance in which he shall clearly declare any items of the Specification to which his offer does not comply and the alternative which is included in the offer.

16.9 Storage of Materials

The Sub-Contractor shall be liable for the cost of any storage accommodation provided specially for their use. No materials shall be stored or stocked on suspended slabs without the prior approval of the Architect.

If the Sub-Contractor does not wish to use the storage space provided by the Main Contractor, he may, at the Engineer's discretion, be allowed to store these in his premises. In this case, the Sub-Contractor shall be required to provide a security bond specifically covering these materials intended for use on the Sub-Contract Works.

16.10 Labour Camps

Labour camps will not be permitted on the site and the Sub-Contractor shall allow for all transport and other charges in moving labour to and from the site.

16.11 Site Visit

The tenderer is recommended to visit the site and shall be deemed to have satisfied himself with regard to the conditions under which the Sub-Contract Works shall have to be carried out.

17 SECTION 17- INCOMING ELECTRICITY SUPPLIES

17.1 General

The electricity supply shall be derived from the Kenya Power and Lighting Company network. The incoming low voltage cables from Transformer will be supplied, installed and connected to the main Low Voltage Switchboard by K.P.L.C. The Main Low Voltage Switchboard shall be supplied and installed under this contract.

A Provisional Sum is included in the appropriate price schedule for the serviceline charges that will become payable to the Kenya Power and Lighting Company.

The Sub-Contractor shall ascertain the size and type of incoming Low Voltage supply cables that will be installed by the Supply Authority and thereby ensure that the correct glands and terminations for the service cables entries into the Main Low Voltage switchboard are provided.

17.2 Earthing

Earthing and bonding shall be carried out to comply with the regulations currently in force and copper tape mesh system shall be installed adjacent to the Kenya Power and Lighting Company supply intake.

The copper tape mesh system has been decided on due to the nature of soil resistivity at the proposed site for construction.

A provisional sum has been included in the appropriate price Schedule for any additional cost that may be necessary to achieve an effective and permanent earthing system.

Provision shall be made for protective multiple earthing at the main meter boards with the final connection between the neutral and the consumers earthing terminal being effected by the Kenya Power and Lighting Company Limited's electrode system.

17.3 Metering Power Supplies.

The electricity power supply to the building shall be metered via K.P.L.C.'s maximum demand (kVA) and energy (kWh) meters supplied at 415V and connected at the Main Low Voltage Switchboard by K.P.L.C. The entire building is connected to both supplies from K.P.L.C. and standby generator.

17.4 Attendance

The Sub-Contractor shall pay all attendance and liaise fully with Kenya Power and Lighting Company in ensuring satisfactory completion of all their work.

18 SECTION 17- MAIN L.V. SWITCHBOARD

18.1 Scope of Work

This section of the Specification covers the supply, installation, testing and commissioning of the Main Low Voltage Switchboard in accordance with the Contract Drawings and Specification.

18.2 Contract Drawings

The Schematic Layout of Main Electrical Distribution for the Building is shown on the contract Drawings.

The Sub-Contractor shall be deemed to have studied all the Contract Drawings and to have allowed for any necessary provisions in this section of the works required thereby.

18.3 Low Voltage Switchboard General Requirements

The Low Voltage Switchboard and meter boards shall be self-supporting floor mounted cubicles with front access incorporating the equipment as detailed on the Schematic Layout of Main Electrical Distribution System.

They shall also be supplied complete with all internal connections, voltmeter, instrument selection switches, cable glands or boxes and current transformers for the supply Authority's meters. The switchboard shall have a separate compartment to house the Kenya Power and Lighting Company metering equipment.

The switchboard shall be in accordance with the Specification.

The main Low Voltage Switchboard shall be capable of extension and the busbar section shall allow for this provision. The Engineer reserves the right to make such variations to the layout and dimensions of the switchboards as are deemed necessary to suit site conditions.

The arrangement of these switchboards shall be capable of accommodating power supply connection to all part of the buildings.

18.4 Fuse Switches

The fuse switches shall be as shown on Schematic Layout of Main Electrical Distribution and shall be as manufactured by Merlin Gerin to BS 5419 or equal and approved. The fuse switched shall be provided complete with Class Q1 H.R.C. cartridge fuse links and three spare fuse links of each size fuse.

18.5 M.C.C.B.'s

Moulded case circuit breakers (M.C.C. B's) of fault breaking capacity of over 50KA shall be installed and shall be of Merlin Gerin manufacture (or equal and approved) unless otherwise stated.

These M.C.C. Bs shall be as shown on Schematic Layout of Main Electrical Distribution system. Where switches or isolators are specified, these shall be moulded case switches and shall be capable of interrupting currents up to 10 times the rated current. They shall be as manufactured by Merlin Gerin or equal and approved.

19 SECTION 19- ELECTRICAL DISTRIBUTION SYSTEM

19.1 Scope of Work

This section of the Specification covers supply, installation, connection, testing and commissioning of the Sub-main cables, consumer units and distribution boards in accordance with the Contract Drawings and Specification.

19.2 Sub-main Cables

The sub-main cables and methods of installation shall be as shown on the Schematic and Layout Drawings and/or as specified in this Specification. The cables shall be as manufactured by BICC, East African Cables Ltd. or other equal and approved.

19.3 Distribution Boards and Consumer Units

The distribution boards and consumer units shall conform with the requirements of this Specification and shall be as manufactured by M/S Square D. Ltd., ABB, Schneider or other equal and approved.

Schematic of individual distribution boards and consumer units have been prepared and the Sub-Contractor should note that power boards consist of single phase and three phase sub-circuits ways.

All neutral conductors in a single-phase distribution board shall be connected in the same circuit sequence as its phase conductor, i.e., phase wire No. 1 connected to No. 1 terminal on the neutral bar, etc.

In addition to this requirement for every distribution board each phase and neutral conductor shall have clipped to its sheath in the distribution board a clip-on numbered

tag corresponding to its circuit number. The tag shall be of a type made by M/S. Critchley Brothers Ltd or equal and approved type. All circuit numbers shall commence from left to right.

19.4 Electrical Services Associated with Mechanical Services Installation

19.4.1 Scope of Work

Work to be carried out under this section includes the supply, installation, wiring to and connection to the mechanical equipment power supply isolator or its control panel. The supply, installation, testing and commissioning of the equipment control panel, wiring between control pane; and equipment shall be by the Mechanical Equipment sub-contractor.

The electrical services shall be associated with the following mechanical equipment: -

- a) Domestic water pumps (duty and standby) and the associated controlpanel.
- b) Rainwater pumps (duty and Standby) and the associated controlpanel.
- c) Fuel Interceptor pump (petrol interceptor pumps) (duty and standby)and associated control panel.
- d) Sprinkler pumps (duty and standby) and associated control panel.
- e) Wet Riser Pumps (duty and standby) and associated control panel.
- f) Waste water treatment plant pumps (duty and Standby) andassociated control panel.
- g) Hose reel pumps (duty and Standby) and associated control panel.
- h) Domestic/Rain water transfer pumps (duty and standby and the associated control panel.
- i) Air conditioning and Mechanical ventilation services and their associated controlpanels.

The Electrical Services shall also be associated with the provision of power supply up to the isolator or control panel of the following specialised equipment: -

- j) Electric passenger lifts and associated control panel.
- k) Electric Bullion Hoist and associated control panel.

- l) ELV equipment.
- m) Surveillance equipment
- n) Fire protection system

19.5 Fuse Switches (Loose Equipment)

Fuse switches shall conform with the requirements as detailed.

19.6 Isolator (Loose Equipment)

Isolators shall conform with the requirements detailed in this specification but with exception that solid links shall be suitably sized to carry the full rated current of the respective isolators. Unless otherwise stated, isolators shall be designed for load making/load breaking duties.

19.7 Cable Tray

Sizes, proposed fixing arrangements and routes of the galvanised cable tray have been detailed on the layout drawings. The cable tray shall conform with the requirements as detailed

19.8 Cable Schedule

The sub-contractor shall prepare a suitable cable route and schedule for all major Low Voltage cables within the Facility. The schedule shall be submitted with working drawings after contracts have been exchanged. During the course of installation, each major cable shall be suitably identified along its route by traffolite cable markers, in accordance with the Sub-Contractor's cable schedule.

19.9 Rising Main Bus bars

There shall be for sub- boards for each block and additional board for mechanical loads.

Phase colours of the incoming cables to each board shall clearly be marked and the current ratings shall comply with B.S. 159 for a temperature rise of 50°C.

All connections to the boards shall be made by means of bolted type clamps designed to ensure maximum conductivity at all times, and drilling of bus-bars in the boards shall never be permitted.

19.10 Fire Barriers

Where the rising bus bar systems, vertical cable tray installations, vertical trunking installations pass through floors, a barrier of fire resisting materials shall be incorporated around the installations at each floor level to prevent the possible spread of fire between floors.

The fire barrier shall be foil clad, wire mesh reinforced 5mm thick fire barrier curtain, complete with metal fixing strips as RBC Envirograf 1983 - 1993 tested to BS 476-part 20/22 or equal and approved.

19.11 Power Factor Correction Equipment

19.12 Scope of Works

This section of the specification covers the supply, installations, connections, testing and commissioning of the power factor correction equipment and to ensure that at the peak of the demand the power factor shall be maintained at 0.95.

- 4.11.0 The anticipated maximum demand for the building is 600 KVA. The KVA rating of the capacitors is provisionally taken as 200 KVAR switched in six steps of 50 KVAR 50 KVAR, 25 KVAR, 25 KVAR, 25 KVAR, 25 KVAR each.

The power factor correction equipment shall be in separate free standing steel cabinet and shall be interconnected with the main L.V. Switchboard. The equipment shall be installed in the switchroom.

The power factor correction equipment shall be dry resin encapsulated, shall have low losses and shall be self-healing. The capacitors shall be delta connected.

The power factor relay shall be cyclic type with built in power factor meter.

The capacitors shall incorporate automatically switching facilities to vary the capacitors in circuit depending on load variations.

20 SECTION 20 LIGHTING AND POWER INSTALLATION

20.1 Scope of Work

This section of the Specification covers supply, installation, connection, testing and commissioning of the lighting and single-phase power installation in accordance with the Contract Drawings and Specification.

20.2 Wiring System

Final sub-circuit wiring shall be carried out using single core PVC insulated copper cables enclosed in a system of high impact heavy gauge PVC conduit. The conduits shall be embedded in the fabric of the building or run surface on the roofmembers.

All single phase 13A socket outlets shall be wired using 30A ring main circuit system or 20A radial circuits as shown on the Contract Drawings.

An insulated earth continuity conductor shall be enclosed in all non-metallic conduits.

20.3 Lighting Luminaries

Lighting Luminaries shall be of the type and manufacture as detailed in this Specification.

All luminaries shall be supplied and installed complete with lamps and tubes of the wattage specified.

All fluorescent tubes shall be warm white as manufactured by Thorn Lighting or other equal and approved and shall conform to B.S. 1853.

20.4 Lighting Switches and Socket Outlets

In general areas Lighting switches shall be flush mounted, single pole, 15A rating, rocker operated grid switches with ivory moulded plastic cover plates.

Socket outlets and spur units shall be flush mounted 13 Amp. rating with rocker operated switches and ivory plastic moulded cover plates.

All lighting switches and socket outlets shall be as manufactured by M/S Crabtree Ltd., MK. Electric Ltd., Nettle Accessories Ltd. or other equal and approved.

20.5 Cooker Control Units

Cooker control units shall be flush mounting, with 45 Amp. D.P. switch, 13 Amp switched socket and neon indicators. An appropriate connector block shall be installed at low level.

The cooker control units shall comply fully with B.S 4177 and shall have ivory plastic cover plates.

20.6 Connector Boxes

Connector boxes for cookers and water heaters shall be flush mounted with moulded cover plates. The connector boxes shall be supplied complete with terminal blocks and cords grips, terminals shall be capable of accommodating up to 2 No. 10mm² stranded copper conductors.

20.7 Ramp Lighting

The work under this section includes the supply and installation of the ramp lighting as shown on the Contract Drawings. The ramp lights shall comprise of 18W PL lamp in 300mm dia. polycarbonate post top lanterns as specified on the contract drawings or equal and approved.

The ramp light shall be on top of the ramp parapet wall.

20.8 External lighting

The works under this section includes the supply and installation of the external security lighting and floodlighting of the building.

The external security lighting comprises of 18W PL lamps fitted in 300mm diameter white polycarbonate spheres suitable for external wall mounting. These security luminaries shall be controlled via photoelectric cell mounted on roof. The photo electric cell shall detect darkness in the evening and then energises the contactor coil to switch on power supply to the external luminaries via the respective distribution boards located in the riser ducts.

The car park lighting shall be controlled by photoelectric cells. Power supply to the car park lighting shall be derived from the consumer unit at the Gate House.

20.9 Adaptor Boxes

All adaptor boxes draw-in boxes, conduit boxes, lighting points boxes, boxes for sockets, telephone outlets, television outlets, camera boxes etc. shall form part of conduit layout installations.

20.10 Sub-Main Cables

All main and sub-main cables shall be supplied complete with glands, lugs etc.

21 SECTION 21- LIGHTNING PROTECTION SYSTEM

21.1 Scope of Work

Under this section of the specification, the Sub-Contractor shall supply, deliver, install and test a lightning protection system as shown on the Contract Drawings.

The Sub-Contractor shall include for the supply and installation of the roof tapes network, all bonding to down conductors and other metal works and earthing as indicated on the appropriate drawings.

21.2 Description of Installation

The installation is based on the recommendation of Kenya Bureau of Standards and I.E.C 62561 and shall comprise a network of 25mm x 3mm flat copper roof tapes running on the ridges and parapet wall and bonded to a selected 20mm diameter reinforced steel (lengths welded to form a sound and effective electrical continuity down to the concrete foundation bases). At the basement level, the down conductors shall be bonded to a system of effective earthing comprising of earth mats as specified herein.

21.3 Bonding of Roof Copper Tapes

The roof copper tapes shall be fixed onto the roof ridges; parapet wall etc by means of special holdfasts.

All roof tanks and other metal works projecting from the roof shall be bonded to the roof copper tapes.

21.4 Earthing of Lightning Protection System

Earthing of the lightning protection system shall be effected by bonding 20mm diameter reinforced steel down conductor to 25mm x 3mm earth matt constructed from the 25mm x 3mm copper tape as detailed in the contract drawings.

The earth matt shall be placed in an earth pit 1200mm x 1200mm x 800mm deep. The earth matt shall then be filled with red soil mixed with charcoal in the ratio of 3:1. The earth pit shall then be covered by concrete slab.

The periodical testing of the earthing for lightning protection system shall be conducted at the earth testing point in the basement column and as clearly shown on the contract drawings.

The expected earthing test result for this specification shall never be above 5 ohms.

21.5 Earth Continuity Test for Down Conductors

It will be the responsibility of the Electrical Sub-Contractor to ensure that the 20mm reinforced steel down conductor is properly welded to guarantee earth continuity from roof to foundation level.

The electrical sub-contractor shall witness and be satisfied that concrete pouring to the columns with lightning protection down conductors does not affect the welded points.

**FIRE DETECTION AND ALARM SYSTEM
(SPECIFICATIONS)**

21.6 SUB-CONTRACT SUM AND VARIATIONS

Sub-Contract Sum

The sub-contract sum shall comprise:-

- a) A price for imported materials delivered to site, less import duty and VAT.
- b) A price for import duty and value added tax on imported materials
- c) A price for materials purchased locally and delivered to site.
- d) A price for all labour in Kenya.
- e) A price for all other costs necessary for the execution and completion of the Sub-Contract Works.

The price of imported materials shall be necessary for the execution duration of the Sub-Contract Agreement with a provision for foreign variation adjustment.

The price for value added tax (VAT) and import duty shall be an estimate and shall be included in the Sub-Contract Sum as provisional sums from which payment will be made for the actual VAT and import duty paid directly to Government by the Sub-Contractor for materials imported for incorporation in the Sub-Contract Works for which receipt shall be produced before payment is certified by the Engineer.

The price of materials purchased locally shall be a fixed price for the duration of the Sub-contract Agreement.

The price for all other costs necessary for the execution and completion of the Sub-Contract Works shall be a fixed price for the duration of the sub-contract Agreement. It will be deemed that the sub-contractor provided in the sub-Contract Sum for all costs that may be incurred in the execution and completion of the sub-Contract Works in compliance with all parts and clauses of the Specification and the Sub-Contract Agreement and for any increase in the cost of materials during the currency of the Sub-contract Agreement. Any claims for errors or omissions when preparing the tender for the Sub-Contract Works or for increased costs other than labour price fluctuations and exchange rate variations will not be entertained.

Labour Price Fluctuations

a) Definitions

Valuation Period - shall be the calendar period in which the labour being valued was executed.

Base Month - shall be the calendar month prior to that in which the tender was returned. The rates of the base month are deemed to equate to the price level represented by labour price proportion of the Sub-Contract Works during the valuation period.

Payment of Fluctuation Adjustment

The conditions applicable to the Main Contract shall apply.

Payment for Materials

Payment will be made for materials available for installation either delivered to and stored on site or stored in Kilifi off-site to the approval of the Engineer. If payment is requested for materials stored off-site the following conditions shall be met by the Sub-Contractor:

- a) The materials shall become the property of the Employer and shall be suitably labelled to indicate the ownership of the materials.
- b) The replacement value of the materials shall be covered by insurance taken out as in the Sub-Contract Agreement.
- c) The defects liability period for the materials shall commence on the date of the practical completion of the main contract works, provided that the Sub-Contract Works are practically complete.
- d) The cost of storage and of transportation to site will be deemed to have been included in the price for materials shown in the Schedule of Prices.
- e) The Sub-Contractor shall have stated in his tender his intention to store materials off site.
- f) The materials shall be housed in secure and weather-proof premises to the approval of the Engineer.

Amounts certified will be paid to the Sub-Contractor through the main Contractor. Retention amounting to 10% of the labour cost will be withheld, but no retention will be held on the cost of materials. To cover this, the Sub-Contractor shall provide a performance bond of 20% of the total Sub-Contract value.

Appendix to the Sub-Contract Agreement

The completion periods of the Sub-Contract Works to be inserted in the appendix in accordance with the Sub-Contract Agreement will be tied to the main contract completion dates and the Contractor's Construction Program.

Nominated Sub-contractors and Nominated Suppliers

The full intent and spirit of conditions relating to the Main Contract Agreement shall apply to the Sub-Contract Agreement and for the purpose of this application the terms "Contractor" and "Bills of Quantities" where they appear in these conditions shall be construed to mean "Sub-Contractor" and "Price Schedules" respectively.

Signing for Materials Supplied

The Sub-Contractor shall be required to sign a receipt for all the materials and articles supplied by the Employer at the time of taking delivery thereof, as having received them in good order and condition and will thereafter be responsible for any loss or damage and for replacement of any such loss or damage with materials at his own cost and expense to the satisfaction of the Engineer.

Trade Names

Where trade names of manufacturers' catalogue numbers are mentioned in the Specification, the reference is intended as a guide to the type of article and quality of material requirement. The sub-Contractor may use any article of materials equal in type and quality of those described in the Specification subject to the prior approval of the Engineer and at the Engineer's absolute discretion. The onus of proof as to the equivalent quality will rest with the Sub-Contractor who will be deemed to have provided in the Sub-Contract Sum for the article or material described in the Specification.

Casing up and Protecting

The Sub-Contractor shall be responsible for advising the Contractor, in writing, of the need for casing up or protecting to the satisfaction of the Engineer all parts of the Sub-Contract Works liable to damage.

Sub-Contractor's Superintendence

The Sub-Contractor shall constantly keep on the site a literate Agent or Representative competent and experienced in the kind of work involved who shall give his whole time to the Superintendence of the Sub-Contract Works. Such Agent or Representative shall receive on behalf of the Sub-Contractor directions and instructions, which shall be deemed to have been given to the Sub-Contractor in accordance with the Conditions of the Sub-Contract Agreement.

The Sub-Contract Works shall be executed under the direction and to the entire satisfaction in all respects of the Contractor and Engineer who shall at all times during the normal working hours have access to the Sub-Contract Works and to the yard and workshop of the Sub-Contractor and subsidiary Sub-Contractors or other places where work is being prepared for the Sub-Contract Works.

The working hours shall be those generally worked by the good employers in the Building and Civil Engineering Trades in Kenya. No work shall be carried out at night or on gazetted holidays unless the Contractor shall so direct.

No work shall be covered up nor any concreting be carried out in the absence of the Clerk of Works or the site Resident Engineer without the prior approval of the Engineer.

Administrative Procedures and Contractual Responsibility

Wherever within the Specification it is mentioned or implied that the Sub-Contractor shall deal direct with the Employer or Engineer or Architect, it shall mean "through the Contractor" who is responsible to the Employer for the whole of the project works including that part of the works which is the subject to this Sub-Contract.

Work included in the Sub-Contract

It will be deemed that the Sub-Contractor allowed in the Sub-Contract Sum everything necessary for the proper execution and completion of the Sub-Contract Works according to the true intent and meaning of the

Contract Drawings and the Specification taken together and to the approval of the Engineer. It will be deemed that the Sub-Contractor took cognizance of and complied with this requirement when preparing his tender for the execution and completion of the Sub-Contract Works. Any claim based upon qualifications included in any documents which accompanied the Sub-Contractor's tender will not be entertained.

The onus for discovering any differences that may exist between the Contract Drawings and the text of the Specifications will be taken to rest with the Sub-Contractor and it will be deemed that any such differences have been found and clarification sought by the Sub-Contractor and afforded to him by the Engineer prior to the Sub-Contractor submitting his tender for the execution and completion of the Sub-Contract works.

Should any differences be found between the Contract Drawings and the text of the Specification after the submission of the tender, the Engineer will, at his absolute discretion and without prejudice to the Employer, decide the procedure to be followed.

It will be deemed that the Sub-Contractor prior to submitting his tender for the execution and completion of the Sub-Contract Works obtained all particulars, information, explanation and clarifications from all appropriate sources, including the Engineer, necessary for the complete and correct preparation of the tender. Any claim based upon want of knowledge in any respect of the Sub-Contract Works will not be entertained.

Structural Provision for the Works

The preliminary major structural provision has been made for the Sub-Contract Works based on the outline information ascertained during the preparation of the Specification.

The preliminary major structural provision made will be deemed as adequate unless the Sub-Contractor stated otherwise when submitting his tender.

Any minor structural provision or alteration to the major structural provisions required by the Sub-Contractor shall be shown on the working drawings to be submitted to the Engineer before commencement of the Work by the Contractor.

No requests for alterations to the preliminary major structural provisions will be approved except where they are considered unavoidable by the Engineer. In no case will they be approved if the building works is so far advanced as to cause additional costs or delays in the work of the Contractor.

Positions of Services, Plant, Equipment, Fittings and Apparatus

The Contract Drawings give general indication of the intended layout. The positions of the equipment and appliances, and also the exact routes of the ducts, mains, and distribution pipework shall be confirmed before installation is commenced. The exact sitting of the appliances, pipework etc. might vary from that indicated.

The routes of the services and the position of the apparatus shall be determined by the approved dimensional details on the working drawings or on site by the Engineer in consultation with the Sub-Contractor or the Contractor.

Services through ducts shall be arranged to allow maximum access along the ducts and the services shall be readily accessible for maintenance. Any work which has to be re-done due to negligence in this respect shall be the Sub-Contractor's responsibility.

The Sub-Contractor shall be deemed to have provided in his Sub-Contract Sum for locating terminal points of the services (e.g. push buttons,

indicators, control switches, and other initiating devices) in positions plus or minus 1.5m horizontally and vertically from the locations shown on the Contract Drawings. Within these limits no variations in the Sub-Contract Sum will be made unless the work has already been executed in accordance with previously approved working drawings and with the approval of the Engineer.

Installation Liaison

The Sub-Contractor shall liaise with the Engineer and the Contractor in planning the Sub-Contract Works before work is commenced. Particular care shall be taken by the Sub-Contractor to ensure there is a close liaison with the other Sub-Contractors in installing services to prevent fouling of services positions, cable routes, switch positions, access positions etc. Any work which has to be re-done due to negligence in this respect shall be the Sub-Contractor's responsibility.

Where large items of equipment such as switchboards, plant and machinery, tanks, cylinders or duct work or long lengths of tube are to be installed, or cable has to be flaked out before drawing in, the Sub-Contractor shall advise the Contractor in good time so that the access and other facilities are provided for installation before work is commenced on site.

Checking of Works

The Sub-Contractor shall satisfy himself as to the correctness of the connections he makes to all items of the equipment supplied under the Sub-Contract Agreement and equipment supplied under any other contract before it is put into operation. Details of operation, working pressures, temperatures, voltages, phase, power rating etc. shall be confirmed to others carrying out work on or associated with the system and confirmation received before the system is installed.

Setting to Work and Regulating System

The Sub-Contractor shall carry out such tests of the Sub-Contract Works as required by the British Standard Specification, British Standards Codes of Practice, the IEE Regulations or equal and approved Codes as specified hereinafter.

No testing of commissioning shall be undertaken except in presence of and to the satisfaction of the Engineer unless approved otherwise by him (Sub-Contractor's preliminary and proving tests excepted).

The Sub-Contractor shall submit to the Engineer, for approval, a suitable program for testing and commissioning.

The Engineer and the Employer shall be given ample warning in writing to the dates on which testing and commissioning will take place.

The Sub-Contractor shall commission the Sub-Contract Works and provide attendance during the commissioning of all services, plant and apparatus connected under the Sub-Contract Agreement.

Each system shall be properly balanced, graded and regulated to ensure that correct operation is achieved.

The proving of any system or plant or equipment as to compliance with the Specification shall not be approved by the Engineer except at his discretion, until tests have been carried out under operating conditions pertaining to the most onerous conditions specified except where the time taken to obtain such conditions is unreasonable or exceeds 12 months after practical completion of the Sub-Contract Works.

Prior to shipment, the Sub-contractor shall arrange for Factory inspection by the Engineer, at the Sub-contractor's expense.

Identification of the Plant and Components

The Sub-Contractor shall supply and fix identification labels to all items of the machinery and control equipment. Care shall be taken to ensure that the labels can be read without difficulty. This requirement shall apply also

to major components and items of the control equipment which are contained within equipment cubicles or plant. The labelling shall be indelible.

Contract Drawings

The Contract Drawings when read in conjunction with the Specification text have been completed in such detail as was considered necessary to enable competitive tenders to be obtained for the execution and completion of Sub-Contract Work.

The Contract Drawings are not intended to be working drawings and shall not be used as such.

Working Drawings

The Sub-Contractor shall prepare such working drawings as may be necessary. The Working Drawings shall be complete in such details not only that the Sub-Contract Works can be executed on site but also that the Engineer can approve the Sub-Contractor's proposals, detailed designs and intention in the executions of the Sub-Contract Works.

If the Sub-Contractor requires any further instructions, details, Contract Drawings or information drawings to enable him to prepare his working drawings or proposals, the Sub-Contractor shall apply in writing to the Engineer for such information at a time which is neither unreasonably distant from nor unreasonably close to the date when it is needed.

All working drawings shall be submitted to the Engineer for approval. If not so submitted the Sub-Contractor shall accept at his own cost, the risk

that any work commenced or which he intends to commence at site may be rejected.

The Engineer in giving his approval to the working drawings will presume that any necessary action has been taken or shall be taken by the Sub-Contractor to ensure that the installations shown on the working drawings have been cleared through the Contractor with any other Sub-Contractor whose installations and works might be affected.

If the Sub-Contractor submits his working drawings to the Engineer without first liaising and obtaining clearance for his installations from the Contractor, then he shall be liable to pay for any alteration or modification to his own. The Contractor's or other Sub-Contractor's installations and works, which are incurred, notwithstanding any technical or other approval which the Sub-Contractor's working drawings may have received from the Engineer.

Working drawings to be prepared by the Sub-Contractor shall include but not restricted to the following:-

- a) Any drawing required by the Contractor or the Engineer to enable structural provision to be made including builder's work Drawing or Schedules and those for the detailing of holes, chases, fixings, foundations, cables and pipework ducting whether below or above ground or in or outside or below buildings.
- b) General Arrangement drawings of all plant, control boards fittings and apparatus or any part thereof and of installation layout arrangement of such plant and apparatus.
- c) Schematic layout drawings of services and of control equipment.
- d) Layout drawings of all embedded and non-embedded pipework, ducts, and electrical conducts.

- e) Complete circuit drawings of the equipment together with associated circuit description.
- f) Such other drawings as are called for in the text of the Specification or schedules or as the Engineer may reasonably require.

Three copies of all working drawings shall be submitted to the Engineer for approval. One copy of the working drawings submitted to the Engineer for approval will be returned to the Sub-Contractor stamped as follows:-

EXAMINED AND RETURNED FOR CORRECTION

Date..... Signature.....

APPROVED IN PRINCIPLE WITH CORRECTIONS INDICATED.

Date..... Signature.....

APPROVED IN PRINCIPLE

Date..... Signature.....

Approval of Contractor's Drawings or document shall not relieve the Contractor or any of his obligations.

Six copies of approved working drawings shall be given to the Contractor by the Sub-Contractor for information and distribution to other Sub-Contractors carrying out work associated with, in close proximity to or which might be affected by the Sub-Contract Works.

Approved working drawings shall not be departed from except as may be approved or directly by the Engineer.

Approval by the Engineer of the work drawings shall neither relieve the Sub-Contractor of any of his obligations under the Sub-Contract Agreement nor relieve him from correcting any errors found subsequently in the Approved Working Drawings or other working drawings and in the Sub-Contract Works on site or elsewhere associated therewith.

The Sub-Contractor shall ensure that the working drawings are submitted to the Engineer for approval at a time not unreasonably close to the date when such approval is required. Late submission of his working drawings will not relieve the Sub-Contractor of his obligation to complete the Sub-Contract Works within the agreed Contract Period and in a manner that would receive the approval of the Engineer.

Record Drawings (as installed) and Instructions

During the execution of the Sub-Contract Works the Sub-Contractor shall, in a manner approved by the Engineer, record on working or other Record drawings at site all information necessary for preparing Record Drawings of the installed Sub-Contract Works. Marked up working or

other drawings and other documents shall be made available to the Engineer as he may require for inspections and checking.

Record Drawings may, subject to the approval of the Engineer, include approved working drawings adjusted as necessary and certified by the Sub-Contractor as correct record of the installation of the Sub-Contract Works.

They shall include but not restricted to the following information or drawings:-

- a) Working Drawings amended as necessary but titled "Record Drawings" and certified as true record of the "as installed" Sub-Contract Works. Subject to the approval of the Engineer such working drawings as may be inappropriate may be omitted.
- b) Fully dimensioned drawings of all plant and apparatus.
- c) General arrangement drawings of equipment, other areas containing plant forming part of the Sub-Contract Works, indicating the accurate size and location of plant and apparatus suitable cross-referenced to the drawings mentioned in (b) above and hereinafter.
- d) Routes, types, sizes and arrangement of all electric cables, conduits, ducts and wiring including the dates of installation of buried works.
- e) System schematic diagrams showing all salient information relating to the control and instrumentation.
- f) Wiring and piping diagrams of plant and apparatus.
- g) Schematic diagram of individual plant, apparatus, and switch and control boards. These diagrams should include those peculiar to individual plant or apparatus and also those applicable to system operation as a whole.
- h) Operating instructions.
- i) Schematic and wiring diagrams shall not be manufacturer's multipurpose general issue drawings. They shall be prepared specially for the Sub-Contract Works and shall contain no spurious or irrelevant information.

Two copies of the Record Drawings of the Sub-Contract Works and Schematics shall be provided not later than one month after the date of the practical completion.

Record Drawings shall be on approved linen or plastic material.

Notwithstanding the Sub-Contractor's obligations referred to above, if the Sub Contractor fails to produce, to Engineer's approval either

- i. The marked up drawings during executions of the Sub-Contract Works, or
- ii. The Record Drawings

Within one month of practical completion, the Engineer will have these drawings produced by others. The cost of obtaining the necessary information and preparation of such drawings will be deducted from payments due to the Sub-Contractor.

Hand Over

The Sub-Contract Works shall be considered complete and the defects liability period shall commence only when the Sub-Contract Works and supporting services have been tested, commissioned and operated to the satisfaction of the Engineer and officially approved and accepted by the Employer, provided always that the handing over of the Sub-Contract Works shall be coincident with the handing over of the Main Contract Works.

The procedure to be followed will be as follows:-

- a) On the completion of the Sub-Contract Works to the satisfaction of the Engineer and the Employer, the Sub-Contractor shall request the Engineer to arrange the Hand Over.
- b) The Engineer shall arrange a handover meeting or a series thereof at site.
- c) The Sub-Contractor shall arrange with the Engineer and the Employer for a complete demonstration of each and every service to be carried out and

for the instruction to be given to the relevant operation staff and other representatives of the Employer.

- d) The Sub-Contractor shall prepare approved Hand Over Certificates and a full list of all control and items of equipment, tools, spares and the like.
- e) In the presence of the Employer and Engineer, Hand Over will take place, subject to agreement of the Hand Over Certificates and associated check lists.

Painting

It will be deemed that the Sub-Contractor provided for all protective and finish painting in the Sub-contract Sum for the Sub-Contract Works. Any special requirements are described elsewhere in the Specification.

Guarantee and Liability for Defects in Materials and Workmanship

Any defects which shall appear within the "Defects Liability Period" stated in the Appendix to the Conditions annexed to the Main Contract Agreement and which shall be due to materials or workmanship causes occurring before the completion of the Sub-Contract Works shall within a reasonable time after receipt of the Engineer's Written instructions be made good by the Sub-Contractor (unless the Engineer shall otherwise direct in writing) at his own cost.

Construction Programme and overtime

The Sub-Contractor will be deemed to have discussed the construction programme for the Main Contract with the Contractor or, if not appointed, with the Architect and Quantity Surveyor before submitting his tender for the execution and completion of the Sub-Contract Works.

The Sub-Contractor's tender will be deemed to have been prepared with the full knowledge of the aforementioned construction programme and to include for all Sub-Contractor's costs necessary to enable the Sub-Contract Works to be executed without causing any delay in the Main Contract Works.

The Sub-Contractor shall be responsible to the Contractor for any cost incurred by the Contractor due to delays in the main Contract Works caused by the Sub-Contractor.

The Sub-Contractor will be deemed to have included in his tender for any overtime necessary to execute the Sub-Contract Works such that delays are not caused in the Main Contract Works.

Testing and Inspection - Manufactured Plant

The Engineer reserves the right to inspect and test or witness tests of all plant, equipment and materials at the manufacturer's works. The right of the Engineer relating to inspection, examination and testing of plant at the manufacturer's works shall be applicable to insure companies and inspection authorities so nominated by the Engineer.

The Sub-Contractor shall give two weeks' notice to the Engineer of his intention to carry out any inspection or tests and the Engineer or his representatives shall be entitled to witness such tests and inspections.

Six copies of all test certificates and performance curves shall be submitted as soon as possible after the completion of such tests to the Engineer for his approval.

The plant or equipment which is shipped before the relevant test certificate has been approved by the Engineer shall be shipped at the Sub-Contractor's own risk and should the test certificate not be approved new tests may be ordered at the Sub-Contractor's expense.

The foregoing provisions relate to tests at manufacturer's works and as appropriate to those carried out at site.

Local Agents

The Sub-Contractor shall ensure that the manufacturers of any plant, apparatus or equipment which he includes in the Sub-Contract Works have appointed Agents in Kenya, who have undertaken to stock adequate spare and to provide, if required, a comprehensive maintenance service.

Any plant, apparatus, or equipment installed by the Sub-Contractor in execution of the Sub-Contract Works to which it is subsequently discovered that there is no appointed manufacturer Agent in the country, or for which there is no maintenance service available locally or adequate spare parts held in Kenya shall be removed and replaced with plant, apparatus or equipment of the Engineer's choosing at the Sub-Contractor's own cost.

Insurance

No payment in account of the Sub-Contract Works executed will be made to the Sub-Contractor until he has satisfied the Engineer either by production of an insurance policy or an insurance certificate that the requirements of insurance have been complied with in all respects.

Attendance on Sub-Contractor

The Contractor will provide General Attendance as defined in the Standard Method of Measurement of Building Works and special attendance as follows:-

"Allow use standing scaffolding, messrooms sanitary, accommodation and welfare facilities, provide space for office accommodation and space for storage of plant and materials, provide light and water for their

work, clear away rubbish, unload, provide facilities for storage, hoist, provide water and power, remove and replace dust covers, pipe casing and the like for execution and testing of the Sub-Contractor's Works and being responsible for the accuracy of the same".

The Sub-Contractor shall be responsible for providing his own lock-up shed and stores.

Government Acts Regarding Work People

The Sub-Contractor shall comply with all Government Acts, Orders and Regulations in connection with the employment of labour and other matters related to the execution of the Sub-Contract Works. In particular the Sub-Contractor's attention is drawn to the provisions of the Factory Act 1972 and it shall be deemed that his tender included for all costs arising or resulting from compliance with any Act, Order or Regulation relating to Insurance, Pensions and Holidays for Work People or to the Safety, health or Welfare of Work People.

The Sub-Contractor shall make himself fully acquainted with the Current Acts and Regulations including Police Regulations regarding the movement, housing, security and control of labour, camps, passes for transport etc. It shall be deemed that the Sub-Contractor before tendering obtained from the relevant authorities the fullest information regarding all such regulations and/or restrictions which may affect the organisation of the Sub-Contract Works and to have allowed accordingly in the tender. No claim in respect of want of information or knowledge in this connection will be entertained.

Initial Maintenance

The Sub-Contractor shall make routine maintenance inspection once a month during the liability for the Defects Period and shall carry out all necessary adjustments and repairs, cleaning and oiling of moving parts.

A monthly report of the inspection and any work done upon the lifts shall be supplied to the Engineer.

The Sub-Contractor shall also provide a 24-hours breakdown service to attend to faults on or malfunctioning of the lift installation between the routine visits of inspection.

The Sub-Contractor shall allow in the Sub-Contract Sum for the initial maintenance, inspection and breakdown service and shall provide for all tools, instruments, plant and scaffolding and the transportation thereof, as required for the correct and full execution of these obligations and the provision, use or installation of all materials as oils, greases, sandpaper, etc. or parts which are periodically renewed such as brake linings etc. or parts which are faulty for any reason whatsoever excepting always Act of God such as storm, tempest, flood, earthquake and civil revolt, acts of war and vandalism.

Maintenance and Servicing After Completion of the Initial Maintenance

The Sub-Contractor shall, if required, enter into a maintenance and service agreement with the Employer for the lift installation for a period of up to five years from the day following the last day of the Liability for Defects Period which offers the same facilities as specified in clause 1.30.00 (Initial Maintenance) above.

The terms of any such agreement shall not be less beneficial to the Employer than the terms of agreements for other similar installations in Malindi.

The Sub-Contractor shall submit with his tender for the Works, a firm quotation for the maintenance and service of the lift installation as

specified herein, which shall be based upon the present day costs and may be varied only to take into account increases in material and labour unit rate costs between the time of tendering and the signing of the formal maintenance and service agreement and which shall remain valid and open for acceptance by the Employer up to and including the last day of the Fifth complete calendar month following the end of the Liability for Defects Period.

21.7 GENERAL SPECIFICATION

GENERAL

The Sub-Contractor shall fully comply with the requirements and recommendation of the following:-

- (a) The Electric Power Act and the Rules made thereunder.
- (b) Energy Regulatory Commission regulations.
- (c) The Kenya Power and Lighting Company Limited's by-laws.
- (d) The current edition of the Regulations for the Electrical Equipment of Building issued by the IEC and any Kenya Bureau of Standards' amendments thereto except where compliance with these regulations would cause contravention of the requirements and recommendations of item (a), (b) and (c) above.
- (e) British Standard Code of Practice, C.P. 407.1972 on Electric, Hydraulic and Hand powered lifts issued by the British Standards Institution on behalf of the Council of Codes of Practice, and all British Standard Specifications recommended by that code of practice.
- (f) British Standard Code of Practice 2655 Parts 1, 2, 3, 6, 7, 9 and 10 issued by the British Standard Institution.
- (g) The requirements of the Chief Inspector of Factories for the Government of Kenya.

Builder's Works

All chasing, cutting away and making good will be done by the Contractor. The Sub-Contractor shall be responsible for making out in advance and for ensuring that the Builder's work has been carried out accurately and in accordance with the Sub-Contractor's requirements.

The Sub-Contractor shall drill and plug holes in the floors, walls, ceilings and roofs for securing services and equipment requiring screw or bolt

fixing purpose. Fixing brackets shall not constitute Builder's work and shall be provided and installed by the Sub-Contractor.

Canopy Key

It shall be possible to open the canopy or by use of secret key. The key hole shall be unobtrusive and located at high level.

Painting

All parts of the control equipment, switch gear, trunking, bed plates and closed section of metal works parts which will not be accessible for painting after erection shall white powder coated at the manufacturer's works.

Tests and Examination

Tests and examination of the entire Generator installation and all incorporated equipment and materials shall be carried out in accordance with all the requirements of BS 2655 Part 7, 1970.

Interference Suppression

Generator motors associated control equipment shall be suppressed so as not to interfere with local radio and television reception or local radio paging and closed circuit television systems or electro-medical equipment within the building. Suppression shall be carried out in accordance with B.S. 800 and all suppression devices incorporated shall comply with B.S. 613.

Manual Operation

Provision shall be made for manual operation of lifts and lowering of the lifts by means of spokeless wheel. This shall be mounted on the drive motor. The Sub-Contractor shall provide a brake release key and landing door emergency key which shall be supplied and fixed by the Sub-Contractor.

Base Frame

The complete hoisting equipment shall be mounted on a frame of fabricated steel which when stalled shall be insulated from the building structure by means of rubber or other approved sound and vibration isolating material provided and fixed in an approved manner between the base frame and supporting beams.

Work by others

The following provision shall be made by others free of charge to the Sub-Contractor:-

- (a) Floor ducts.
- (b) All builder's work such as cutting away and making good.
- (c) Enclosure work, concrete floors, concrete foundations, etc.
- (d) Provision and maintenance of temporary lighting and power supplies for tools and testing of generator equipment.
- (e) Permanent power and lighting supplies to generator rooms .
- (f) Provision of clear access to working areas.

22 SECTION 23- TECHNICAL SPECIFICATIONS (PLUMBING & DRAINAGE)

22.1 TECHNICAL SPECIFICATIONS (PLUMBING & DRAINAGE)

22.1.1 GENERAL SPECIFICATION - GENERAL REQUIREMENTS

22.1.1.1 Installations to Comply with This General Specification

The Plumbing and Drainage Installations shall comply with this General Specification which details the intrinsic properties (including materials and workmanship) of the Installations in so far as it is not overridden by the Conditions, Particular Specification, Drawings and/or written instructions of the Engineer.

22.1.1.2 Scope of the Installations

This General Specification, Particular Specification, Tender Equipment Schedule and Drawings detail the performance requirements of the Installations. The Installations to be carried out in accordance with this General Specification shall include the design where specified, installation and supply of all materials necessary to form a complete installation including any necessary tests, adjustments, commissioning and maintenance as prescribed and all other incidental sundry components together with the necessary labour for installing such components, for the proper operation of the Installations.

22.1.1.3 Statutory Obligations and Other Requirements

Technical Standards

KEBS, BS, BS EN, ISO Standards, IEC Standards and Codes of Practice, etc. shall be deemed to include all amendments, revisions and standards superseding the standards listed herein, which are published before

the date of first tender invitation for the Contract or the Nominated Sub-contract (as appropriate) unless otherwise specified.

Case of Conflict

The documents forming the Contract are to be taken as mutually explanatory of one another but in case of ambiguities or discrepancies the same shall be dealt with in accordance with the Conditions.

22.1.1.4 Execution of Installations

The International System of Units (SI)

The International System of Units (System International d'Unites) of weights and measures shall be used for all materials, equipment and measurements.

Programme of Installations

The P&D Contractor shall submit to the Engineer a detailed programme of the Installations within 4 weeks from the acceptance of his tender showing the intended method, stages and order of work execution in coordination with the building construction programme, together with the duration he estimated for each and every stage of the Installations. The programme shall include at least the following: -

- (a) Dates for the placement of orders for equipment and materials;
- (b) Expected completion dates for builder's work requirements, i.e. when work site needs to be ready;
- (c) Delivery dates of equipment and materials to the Site;

- (d) Dates of commencement and completion of every stage of the Installations in line with the building construction programme, i.e. each floor level and/or zone area;
- (e) Dates of documents /drawings submissions to relevant Government departments to obtain the necessary approvals;
- (f) Dates of requirement of temporary facilities necessary for testing & commissioning;
- (g) Dates of water supply and drainage/sewage pipe connection
- (h) Dates of completion, testing and commissioning; and
- (i) Short term programmes showing the detailed work schedules of coming weeks and months shall also be provided to the Engineer. Programmes shall be regularly updated to reflect the actual progress and to meet the PD Contractors' obligations under the Contract.

Builder's Work

All builder's work including openings or holes through building structure or partition walls; trenches, ducts and cutting; and all plinths, concrete bases, supports, ducts, etc. required for the Installations will be carried out as part of the building works by the Building Contractor at the expense of the Employer provided that the PD Contractor has submitted full details of such requirements within a reasonable time to the Engineer for approval, so that due consideration may be given before the Building Contractor commences the building works in accordance with the building programme in the areas concerned. After obtaining the said approval of the Engineer, the PD Contractor is required to mark out at the relevant locations of the Site the exact positions and sizes of all such works and to provide detailed information of such works to the Building Contractor to facilitate him to carry out the builder's works as the works proceed.

All "cutting-away" and "making-good" as required to facilitate the PD Contractor's works will be carried out by the Building Contractor, except for minor provisions required for the fixing of screws, raw plugs, redhead bolts, etc. which shall be carried out by the PD Contractor. The PD Contractor shall mark out on Site and/or supply drawings of all "cutting-away" to the Building Contractor within a reasonable time.

All expenses properly incurred and losses suffered by the Employer as a result of the PD Contractor's failure to comply with the above requirements are recoverable by the Employer from the PD Contractor as a debt under the Contract or via the Building Contractor as if it is a debt liable to the Building Contractor under the Sub-contract as appropriate.

The PD Contractor shall ensure that such works are essential for the execution of the Installations. In the event that any of such works is proved to be nonessential, unnecessary and/or abortive, the PD Contractor shall bear the full cost of such works including but not limited to any unnecessary or incorrect cutting away and making-good and shall reimburse the Employer for all cost incurred in this connection are recoverable by the Employer from the PD Contractor as a debt under the Contract or via the Building Contractor as if it is a debt liable to the Building Contractor under the Sub-contract as appropriate.

Coordination of Installations

The PD Contractor shall coordinate the Installations with those works of the Building Contractor and any other contractors and sub-contractors of the Building Contractor. The PD Contractor shall note that the drawings supplied to him only indicate the approximate locations of the Installations. He shall make any modification reasonably required of his programme, work sequence and physical deployment of his work to suit the outcome of work coordination or as necessary and ensure that all

cleaning, adjustment, test and control points are readily accessible while keeping the number of loops, cross-overs and the like to a minimum.

No work shall be carried out before approval of shop drawings or equipment has been given by the Engineer. It is the PD Contractor's responsibility to co-ordinate all Mechanical works to match with the structure of the building and the proposed arch and interior design of the building including but limited to ducts, grilles, equipment, pipes, light fittings, false ceiling layout and other services to allow a completely symmetrical and co-ordinated installation. PD Contractor shall prepare section as required to demonstrate all constraints and coordinate the same for resolving any conflicts among the services. Contractor shall ensure that all required access, clearances and false ceiling heights are achieved as per the requirements are achieved.

Cooperation with Other Contractors

The PD Contractor shall cooperate at all times with the Building Contractor and all other contractors and sub-contractors of the Building Contractor in order to achieve efficient workflow on the Site.

Any significant problems beyond the PD Contractor's control shall promptly be reported to the Engineer.

Access doors shall be provided by the Contractor as required to provide proper access to all valves, clean out, junction boxes and all other concealed items which are located above ceilings or in walls and in partitions, whether such accesses are shown in the drawings or not. The omission shall be brought to the attention of the Engineer before installation of equipment. All access doors shall be properly designed, sized and located to suit the service required or as directed by the Engineer and to his satisfaction.

Site Supervision

The PD Contractor shall keep on the Site a competent and technically qualified site supervisor to control, supervise and manage all his works on Site. The site supervisor shall be vested with suitable powers to receive instructions from the Engineer.

All tradesmen must be experienced in the trade and the work carried out shall be consistent with good practice in Kenya and to the satisfaction of the Engineer. In this connection, the PD Contractor's attention is drawn to the Special

Sample Board

The materials offered for approval shall be strictly in accordance with the specifications and tender drawings. The contractor shall submit in triplicate, the technical literature for each item of the equipment, he intends to use for the project, to the consultant for the necessary review and approval. If in case the technical literature is not available, then a sample shall be submitted in the absence of either of these, typed technical data shall be submitted duly supported by telex / letter of the manufacturer for confirmation. In case of items involving aesthetic, sink taps, Showers, Draw offs etc., samples must be submitted for approval along with the materials submittals. Each copy of the submittals shall be numbered and signed with the technical literature clearly highlighted, indicating the model, type and capacity of the equipment offered. The consultant shall retain two for copies and return one, either Approved or Not Approved, to the contractor. The contractor shall maintain and submit a status report every month, of all the Materials submittals of the Plumbing Materials & Equipments in the following proforma to the consultant:

- i. Submittal Number
- ii. Type of Material
- iii. Manufacturer / Local Agent
- iv. Date of Approval
- v. Date of Order / Order Number
- vi. Mode of Delivery (Air, Land or Sea)
- vii. ETA on Site
- viii. Status as on date of Report

Within 4 weeks of the acceptance of his Tender and prior to the commencement of the Installations, the PD Contractor shall submit to the Engineer for approval a sample board of essential components proposed to be used in the Contract. However, the PD Contractor may request the Engineer in writing for a longer period for submission if 6 weeks are practically insufficient.

Items displayed shall be deemed to be adequate for the Installations unless otherwise clearly indicated. Each sample, with clear numbering and labeling, shall be firmly fixed onto a rigid wooden or metal board. A list shall also be affixed on the sample board to show the item description, make and brand, country of origin and locations of installation (if not generally used). Samples rejected by the Engineer shall be replaced as soon as possible. Upon approval of all items, the Engineer will endorse the list on the sample board and the PD Contractor shall deliver the board to the site office for reference.

The following items shall be included in the sample board as a minimum:

- i. Pipe work, fitting and their support complete with fixing accessories;
- ii. Valves; and

iii. Vibration isolator

Additional items may be required by the Engineer and/or specified in the Particular Specification

Material Inspection

The contractor shall inform the consultant within one week upon receipt of all the materials at the site and arrange for the inspection of the same. Any material used at site which is not approved earlier specifically shall stand rejected without notice. Any item on supply differs from the one shown on the submittal catalogue copy or the sample submitted shall also be rejected at site. In such cases, the contractor shall make a fresh submittal for the item and obtain approval from the Consultant. Any time delay caused due to the above shall be on the Contractor's account. The contractor shall have to remove the rejected materials from the site and replace with approved materials at his own expenses. In the event the contractor fails to do so, the client shall have the liberty to carry out such works from other agencies and debit the ensuing amount to the Contractor.

Equipment Deviations

Subsequent to the award of the Contract, and only in exceptional circumstances where it is demonstrated in writing by the PD Contractor that the original equipment offered cannot be obtained, the Engineer may consider and accept, in writing, alternative equipment and materials proposed by the PD Contractor provided always that these are fully in compliance with the relevant Specifications and Drawings and do not impose any additional contractual or financial liabilities onto the Employer.

In the event that the approved alternative equipment or material is lower in price than the original offered equipment or material, the net difference in price between the original offered equipment or material and the approved alternative equipment or material with the executed quantities of the relevant work item shall be deducted from the Contract Sum in accordance with the Contract. The Contract Sum, however, shall not be adjusted where the approved alternative equipment or material is higher in price than the original offered equipment or material.

22.1.1.5 Drawings and Manuals

Drawings in Electronic Format

The PD Contractor shall provide drawings in electronic format as required in the following clauses. These drawings shall conform to the latest version of CAD Standard.

Installation Drawings

22.1.1.6 Drawing Submission Schedule

The Plumbing tender drawings related to this project have been listed in the Schedule of Drawings enclosed with the specifications. The tender drawings have been prepared to show the tenderer the principal equipment and general arrangement required for the project. These drawings do not indicate every detail of the work. It is the Contractor's responsibility to check the positions / locations at site. All dimensions are tentative and shall be checked with the Architectural and Structural drawings. Any discrepancy shall be brought to the attention of the consultant, in writing at the time of tender. Particular attention shall be

paid to the positioning of draw offs, valves, and other accessories, in relation to the Interior finishes and locations of various appliances. The Contractor is deemed to have studied the services drawings based on all the local regulations and have included in his prices for all builders' work associated with these drawings.

The PD Contractor shall submit a detailed installation drawing submission schedule and programme to the Engineer. The PD Contractor shall allow reasonable time in the programme for vetting of the installation drawings by the Engineer and for drawing resubmissions as necessary.

The PD Contractor shall provide at least 6 hard copies and one electronic copy, unless otherwise specified in the Contract or the Sub-contract as appropriate, of the approved installation drawings to the Engineer for distribution.

Unless otherwise indicated or instructed, the PD Contractor shall, in the stated or in adequate time before each section of the work proceeds, prepare, and submit for acceptance by the Engineer, detailed installation drawings and/or shop drawings (which may also be referred to as working drawings) to demonstrate how they propose to install the works both in 'Detail' and 'Form' to facilitate the practical installation. These drawings shall be fully dimensioned and shall be based on the basic intentions of the Drawings but shall not be simply a copy of them.

22.1.1.7 Size of Installation Drawings

Drawings submitted by the PD Contractor shall only be of standard sizes from A0 to A4 or B1 size as stipulated in ISO 5457:1999.

PD Contractor's 'Installation Drawings' and/or 'Shop Drawings' shall be prepared to such scales that will clearly show all necessary details.

The drawings shall be prepared to the same sheet sizes and scales as used for the ultimate 'As-Installed' record drawings.

22.1.1.8 Contents of Installation Drawings

In accordance with the provisions of this General Specification and as stated elsewhere in the Contract, the installation drawings must incorporate details of the actual plant and equipment items as approved by the Engineer.

The PD Contractor shall ensure all installation drawings are accurate representation of the Installations, before submitting them to the Engineer. All installation drawings shall be fully dimensioned and suitably scaled showing construction, sizes, weights, arrangements, operating clearances and performance characteristics.

- a) "Installation drawings" shall generally include, but not limited to, the following: -
- Symbols and notations same as and compatible with the Drawings' standard;
 - Complete layout/assemblies including all necessary minor items and accessories;
 - Positions of all fixings, hangers and supports;
 - Maintenance spaces for all withdrawable items, such as coils, heater elements, thermometers, thermostats, fan shafts and fan blowers, cleaning and replacement of tubes, removal of guards, etc.;

b) **Pipework Installation Drawings**

Prior to the commencement of any manufacture, fabrication, or installation, the PD Contractor shall submit to the Engineer for technical appraisal installation drawings for the pipework installation. Generally, the drawings shall be drawn to a scale of not less than 1:50. Subject to

the Engineer's approval a scale of 1:100 may be adopted where the installation is a simple one.

The locations of Sink taps, showers, draw offs and their piping routes, etc., as indicated on the tender drawings is tentative and may require some variation to suit the site requirements. The exact positions must be checked and shown on the detailed working drawings as indicated on the detailed architectural drawings and coordinated with furnishing and other services.

The drawings shall indicate the location, with dimensions given, of all pipework in relation to the building structure and other pipework and equipment. The position of all valves, strainers, check valves, etc. shall be shown together with clearances necessary for removal of strainer baskets, internal parts of all valves, motors for motorized valves, solenoids, etc.

Positions and details of all hangers and supports shall be shown and the positions dimensioned.

Positions of thermostats, thermometers, test pockets and similar devices shall be shown and dimensioned including clearances required for their removal.

Details and outline of insulation and insulation boxes shall be shown including clearances required for removal of the boxes.

c) Special Plant Rooms Co-ordination Work

Unless otherwise stated in the Contract, in the case of a plant room where the PD Contractor's equipment constitutes the major item involved (i.e. as in the case of pump room), the PD Contractor shall allow in the Tender for taking effective responsibility for the

coordination of other services/building details within these specific areas.

22.1.1.9 Manufacturer's Shop Drawings

The manufacturer's shop drawings are drawings for equipment or plant to be manufactured by a specialist manufacturing supplier in their own workshops and places away from the Site.

The drawings shall show detailed construction, principal dimensions, weights and clearances for maintenance, etc. Immediately after placing of any order or at any event within 4 weeks unless otherwise approved in writing by the Engineer, the PD Contractor shall forward to the Engineer for comment, 4 copies of manufacturer's shop drawings indicating detailed construction, principal dimensions and weights, clearances for withdrawals and/or cleaning, etc. No work shall proceed on or off Site unless drawings requiring approval are so approved in writing by the Engineer

Checking Drawings of Other Trades

The PD Contractor shall follow the design intent of the Drawings in planning and carrying out the work and shall cross check with other trades in order to verify the line, level, space and sequence in which the Installations is to be installed.

If directed by the Engineer, the PD Contractor shall, without extra charge, make reasonable adjustments to the proposed installation drawing layouts as are necessary to prevent conflicts with the work of other trades or for the proper sequence of and execution of Works. Where such modifications are of a nature and of such unforeseen complexity that they involve unreasonably extra work not covered by the Contract, they may be

covered by variation order to be issued by the Engineer wherever such a requirement is justified.

22.1.1.10 As-Built Drawings

Submission of As-built Drawings

The PD Contractor shall submit 3 sets of the first draft prints of as-built drawings within 28 days of the issuance of the certification of completion in accordance with the Contract to the Engineer for checking. The Engineer after checking the above draft prints shall return one set of the marked up copies of these as-built drawings to the PD Contractor within 42 days from the date of submission of the PD Contractor's draft prints with comments. The PD Contractor shall within a further 28 days from the date of receiving the Engineer's comments on the draft as-built drawings re-submit to the Engineer for his approval another 3 sets of the second draft prints of as-built drawings with the Engineer's comments incorporated. This process of submission and approval shall continue until the final approval of the Engineer on these as-built drawing is obtained.

The final approved as-built drawings shall be in 3 sets of hard copy and 3 sets of electronic copies. These shall be submitted within 21 days from the date of final approval. Each electronic copy shall be in the form of CD-ROM, labelled, with cross reference to a printed list of files explaining the contents and purpose of each file and supplied in sturdy plastic containers.

The detailed requirements and the media of as-built drawings set out in the Contract shall be followed as appropriate.

Size of As-built Drawings

As-built drawings shall only be of standard sizes of A0, A1 or B1 size as stipulated in ISO 5457:1999. Smaller size (A2 to A4) is accepted for installation drawings.

Content of As-built Drawings

The PD Contractor shall ensure all as-built drawings are accurate representation of the Installations, before submitting them to the Engineer. The as-built drawings required to be provided by the PD Contractor for various types of the Installations shall include, but not limited to the following: -

- (a) Plumbing and drainage layout plans such as pipe arrangement, valve arrangement, sanitary fittings arrangement, etc.;
- (b) System schematic diagrams; and
- (c) Installation details and assembly drawings such as pipework, sanitary fittings, etc. "As-built" drawings shall complete with all details to be used for commissioning purposes. Any amendments noted on these drawings during the commissioning and test stage shall subsequently be transferred to the original "As-built" drawings once the amendments have been accepted by the Engineer

22.1.1.11 Operation and Maintenance (O&M) Manual

The PD Contractor shall refer to the Specifications for any other requirements in O&M Manual.

The O&M Manual is for use by the maintenance agent of the completed Installations. It shall contain detailed technical information covering both operation and maintenance aspects of the Installations.

Operating and maintenance manuals shall contain the following:

- a) A description of the buildings to which services are applied stating their duty and functions,
- b) A listing and description of the services as installed,
- c) Details of the manufacturer's installation, operating and maintenance requirements which must be edited or otherwise reproduced to be specific for the installation.
- d) A detailed list of equipment supplied, manufacturer, address, telephone number and official order number/date,
- e) A schedule detailing the regular maintenance requirements with space for remarks and service history,
- f) A fault tree analysis of the system(s),
- g) A copy of the "As fitted" record drawings,
- h) Copies of all test and commissioning data including pre-commissioning check lists,
- i) A schedule giving the finally adjusted set points for plant, equipment and controls,
- j) A detailed listing of all spare parts giving part number and description, typical cost and availability,

- k) Any item deemed necessary by the Engineer to clearly identify to the use/operator the function and intended performance of the plant and system.

22.1.1.12 Damaged Material

Any plant or material that is damaged by any means whatsoever shall not be used in the works. Should the contractor wish to rectify such damage in order to utilize the plant or materials in the permanent works, the matter shall be brought to the attention of the Consultant, who in turn shall conduct a proper survey after which the necessary instructions shall be issued. Only after obtaining a written permission from the Consultant, shall any remedial work be carried out. Any damaged Plant or Material allegedly brought to a “as-new” condition following such a procedure, shall only be accepted after the technical appraisal & discretion of the Consultant, whose decision in such matters shall be final and binding.

22.1.2 INSTALLATION METHODOLOGY

22.1.2.1 Installation of Above Ground Drainage Systems

General

Foul water drainage above ground shall be installed generally to BS EN 12056-2: 2000.

Bolted access doors or inspection units shall be provided to all branches and bends (other than ventilating and anti-siphon pipes) and at the foot

of main soil stacks. Access doors to cast iron soil stacks shall be fitted with gunmetal bolts.

Handling and Storage

Store rubber jointing rings in protective bags and do not expose them to sunlight. Avoid any deformation.

Do not expose plastic pipes and fittings to sunlight and avoid any deformation.

Store pipes, gutters and fittings under cover and clear of a leveled, well-drained and maintained hard-standing ground

Fixing Pipes and Fittings

General Details

Inspect pipes and fittings inside and out before fixing. Reject any which are defective.

Fix pipes and fittings securely with fixings and fastenings appropriate to the location and the material.

Protection to Movement and Expansion

Make adequate provision to control and/or allow for thermal movement in the length of pipes and gutters depending on material specified and in accordance with details shown on the Drawings.

Provide expansion joints in plastic pipes by means of loops or other methods in accordance with the manufacturer's recommendations.

Protection to Movement and Expansion

Unless otherwise approved by the Engineer, pipes shall not run over electrical switchgear; inside transformer room, switch room, generator room, meter room, telephone equipment room, PABX room, riser duct for electrical services, or any other rooms containing electrical hazard.

Jointing Pipes and Fittings

Carry out all pipe joints in accordance with the manufacturer's instructions and do not allow jointing material to project into bore of pipes or fittings. Cut ends of pipes and gutters clean and square, chamfering internally or externally if required using equipment appropriate to the material.

Pipework Support

General

Support pipes on flat roofs and canopies at least 150 mm above roof and canopy finish on concrete blocks with pipe clamps. Do not use branch pipes that connect to vertical pipes as pipe supports.

Corrosion-resistant fixings such as stainless steel brackets and connections or similar corrosion-resistant fixing supports shall be used. The fixings shall be properly anchored into solid wall.

Pipe brackets shall be of stainless steel to BS EN 10088-3: 2005 number 1.4301 or SAE Grade 304 or other approved material. The pattern shall suit the type of pipe and the surface to which they are to be fixed, including where appropriate:

- (a) Flanged ends for building in;
- (b) Plain round ends for fixing in drilled holes with an approved grout;

- (c) Approved expanding bolts or stud anchors for fixing to concrete, brickwork etc.;
- (d) Threaded ends for fixing to steelwork, or wood, or panel wall with plug as required;

Plugs for fixing to hard materials shall be of proprietary plastic, fibre, soft metal or similar material. Plugs for fixing to friable materials, plasterboard and the like shall be of proprietary fixings specially designed for the purpose. Plugs containing asbestos shall not be used.

Pipe Bracket Intervals

Pipe bracket shall be installed at intervals not exceeding those shown in Table 1.5.2 for straight runs, and with not less than one bracket per length of pipe. All brackets shall be equally spaced

Table 1.5.2 - Spacing of Pipe Fixing

Pipes	Nominal Size (mm)	Maximum Spacing (mm)	
		Vertical pipes	Horizontal pipes
Cast iron and ductile iron	All	3000	1750
Steel	Up to 15	2400	1800
	20 and 25	3000	2400
	32	3000	2700
	40 and 50	3600	3000
	65 and 80	4500	3600
	125 and 150	5400	4500

UPVC	Up to 25	1500	750
	32	1800	900
	40 and 50	2000	1000
	65 to 150	2500	1200

Pipework Penetrating Building Structure

Pipes through Walls and Floors

Where pipes pass through walls or floors:

- a) Cast or build in UPVC sleeves to BS 3505: 1986 or BS EN ISO 1452-1: 2009 with 2 to 12 mm clearance to allow for expansion and movement of pipe
- b) Finish sleeves flush with finished face of walls and ceilings and projecting 100 mm above finished floor level.
- c) Provide loose plastic or chromium plated cover plates, when specified, to ends of sleeves visible in completed work. Plates shall be 50 mm larger than the external diameter of pipe and either clipped to the pipe or screwed or plugged and screwed to the adjacent surfaces.
- d) If required to be water tight, point with approved mastic sealant.
- e) No split PVC sleeves shall be permitted

Pipes through Fire Rated Walls and Floors

Where pipes pass through fire rated walls or floors which are not fire compartment walls or floor:

- a) For metal pipes pass through fire rated walls or floors which are not fire compartment walls or floors, either of the following shall be used:

The installation shall be as Clause B3.6.1 but

- Cast or built in galvanized mild steel pipe sleeves to BS EN 10255: 2004 with 20 mm clearance.
 - Well caulk the voids between the pipes and the sleeves for the full length with mineral wool or approved equivalent material designed for fire separation purposes in compliance with the Code of Practice for Fire Safety in Buildings.
- a) For non-metal or plastic pipes pass through fire rated walls or floors which are not fire compartment walls or floors, firmly fix sealing system around the pipes to properly seal up the voids between the pipes and the fire rated walls or floors in compliance with the Code of Practice for Fire Safety in Buildings. The sealing system shall be tested to BS EN 1366-3: 2009 or BS 476-20: 1987

Where pipes pass through fire compartment walls or floors:

- a) For metal pipes pass through fire compartment walls or floors, suitable intumescent coating or sealant shall be used to maintain the required fire compartment. The sealing system shall be tested to BS EN 1366-3: 2009 or BS476-20: 1987 and the installation of which shall be in accordance with the manufacturer's recommendations.
- b) For non-metal or plastic pipes pass through fire compartment walls or floors, suitable fire collars shall be used. The fire collars shall be tested to BS EN 1366-3: 2009 or BS 476-20: 1987 with integrity not less than of the fire compartment walls or floors as prescribed under the relevant Building Regulation and the Code of Practice for Fire Safety in Buildings. The fire collars shall be fixed at underneath of fire compartment floors or walls or other locations around the pipes in accordance with the manufacturer's recommendations.

Pipes through Basement Wall

Where pipes pass through external basement walls:

- a) Cast or build in cast iron or 2.5 mm galvanized mild steel sleeve to BS EN 10255: 2004 after fabrication with 2 to 12 mm clearance.
- b) Caulk space and point both ends with approved mastic sealant

Sumps

The construction of Sump Pit shall be in accordance with BS : 8007, 1987. All cement shall be sulphate resisting and comply with BS :4027, 1980. All reinforced concrete base slab walls and cover slab shall be cast in situ using grade 25 concrete and comply with BS:8110, Part 1, 1985. The Sump Pit shall be constructed to take into account the ground conditions, strictly in accordance with the structural engineering details. Sump pit shall be painted internally with epoxy mortar or pitch epoxy (2 coats) and externally with one coat of bituminous emulsion paint. A 600x600-mm access manholes shall be provided at the top, with heavy duty manhole covers as detailed in the schedule of manholes. If the pit is more than one(1.2) meter depth, it shall be provided with galvanized step irons to BS: 1247, 1975 shall be provided at 30 mm centers both vertically and horizontally, the first being 450 mm below cover level. The Sump Pit height shall be governed by the following: a. height between the top of the slab and the bottom of lowest drainage pipe drained to the sump pit b. height between the bottom of lowest drainage pipe and the sump pump switch on level. c. minimum storage height of waste water. d. height between the sump pump switch off level and the height of water required to submerge the pump discharge. As shown on the drainage standard detail drawings, the pit height varies due to the above factors, therefore It shall be the contractors responsibility to fully check and verify as per site requirement for the height needed to suit the site condition.

22.1.2.2 Manholes

Manhole covers and frames shall comply with BS 497:1976 and shall be of the sizes and types as shown on the contract drawings. In general, manhole covers and frames shall be one of three types, as follows unless otherwise specified. Heavy Duty to BS 497 Grade A Medium Duty to BS 497 Grade B Light Duty to BS 497 Grade C

22.1.2.3 Pipe Entries into Buildings

Pipe entries into buildings shall be sealed with mastic compound and plugged after installation of pipework to prevent the ingress or egress of water or vermin.

22.1.2.4 Venting and Draining

Air vents and drain valves shall be provided at high points and low points respectively in all piping systems.

Automatic air vents, or air cocks where specified, shall be supplied and installed at the highest points of pipework and where necessary for the venting of air in the installation.

They shall have gunmetal or brass bodies, stainless steel floats and guides, and non-corrodible valves and seats. Each automatic air vent shall be controlled by a lock shield valve. Air release pipes shall be run to discharge at the nearest suitable visible point. Air cocks shall be nickel-plated, of the spoutless pattern and with screwed taper thread. At least two loose keys shall be provided for each type of cock installed.

Drain valves, or drain cocks where specified, shall be fitted on the lowest points of pipework or where necessary for the water drainage of the system. Plugs for drain cocks shall be ground-in. Two loose keys of forged mild steel shall be provided with each drain cock. Drain valves/cocks shall be connected to the nearest building floor drain or drain point of adequate size.

22.1.2.5 Valves, Taps and Cocks

Valves, taps and cocks shall be of the types and working pressures suitable for the systems to which they are connected and shall be accompanied with valid letters of approval issued by the Water Supplies Department.

Wherever applicable, the following British Standards for cocks and valves shall be relevant: -

- BS 1010 Part 2 Draw-off taps and above ground stop valves.
- BS 5150 Cast iron gate valves for general purposes DN Series PN 16.
- BS 5151 Cast iron gate (parallel slide) valves for general purposes DN Series PN16.
- BS 5152 Cast iron globe and globe stop and check valves for general purposes DN Series PN16.
- BS 5156 Screw down diaphragm valves DN Series PN16.
- BS 5159 Cast iron and carbon steel ball valves for general purposes DN Series PN16.
- BS 5163 Key-operated cast iron gate valves for water works purposes DN Series PN16.

Valves and fittings of PN25 or heavier duty shall be used for high pressure system.

All components in the fire service installations and equipment shall be designed to withstand at least two times the system pressure.

All valves shall be arranged so that clockwise rotation of the spindle closes the valve.

Valves shall not be installed at locations with a change in direction of the pipework.

Isolating valves shall be of the full way gate type. Regulating valves shall be of globe type, unless otherwise specified. Globe valves shall be positioned so as not to prevent draining of the system.

Bodies of valves and cocks up to 50 mm shall be of cast gunmetal or bronze. Valves having heavy pattern hot-pressed bodies may be used subject to the approval of the Engineer. Valves over 50 mm shall have cast iron bodies.

All working parts shall be of gunmetal or bronze or stainless steel. Spindles shall be of high tensile bronze, forged brass or stainless steel with Teflon or approved packing to the manufacturer's standard. Gate valves shall have split or solid wedge gates of bronze with bronze seats. Disc valves shall have renewable discs free to rotate on the spindle.

Valves and cocks for installation in screwed jointed pipework shall have taper screwed ends. Flanges of flanged valves shall be to BS 4504 for PN16 rating.

Operating handwheels shall be of malleable iron, or of approved composition having metal insert for securing positively to the stem.

Outlets valves on fire service water tanks, sprinkler installation, and elsewhere as specified, shall have padlocks and leather straps capable of locking the valves in the "OPEN" position.

Non-return valves shall have flaps of light construction pivoting on gunmetal, bronze or stainless steel spindle. The valves shall be fitted with stops to prevent undue movement and sticking of the flap and shall be quiet in operation. The valve shall be so constructed that minimum resistance is offered in the normal direction of flow.

Pressure reducing valves for direct connection in hose reel branch pipes, and elsewhere as specified, shall be of approved spring-loaded relay-operated type or otherwise constructed to prevent high pressure build-up on the low pressure side, and shall be supplied and installed with strainer and by-pass valves. Pressure reducing valves for hydrant outlets (parity valves) shall be of the type having relief connection to drain unless otherwise specified

22.1.3 INSPECTION, TESTING AND COMMISSIONING

22.1.3.1 General

Throughout the execution of the installation, the PD Contractor shall be responsible for ensuring compliance with the Regulations included in Part A and shall notify the Engineer of any infringement which directly or indirectly detracts from the safe and satisfactory operation of the installation(s) whether or not such infringement relates to the works covered in the Contract or to those associated with others

The PD Contractor is required to appoint a competent and experienced testing and commissioning engineer responsible for the overall planning, organizing, coordinating, supervising and monitoring of the testing and commissioning works and also certifying all results and reports from the testing and commissioning works. The PD Contractor shall submit, at the commencement of the Contract, information detailing qualification and experience of the testing and commissioning engineer for the Engineer's approval.

It is necessary to require the PD Contractor to provide, at no cost to the Employer, all necessary equipment, apparatus, tools and materials for carrying out of testing and commissioning works.

Master Programmed of Testing and Commissioning Works

The PD Contractor is required to submit a programme for testing and commissioning works shall be submitted at the commencement of the

Contract, usually within the first three months. The programme shall indicate the tentative dates of all tests and commissioning works that will be carried out throughout the whole contract and all necessary submissions and approval relating to testing and commissioning and ensure that the testing and commissioning programme matches the master programme for construction and that all testing and commissioning works are complete before the completion date of the Contract.

Inspection, Testing and Commissioning Methods and Procedures

The PD Contractor is required to submit detailed inspection, testing and commissioning methods and procedures together with report formats for reporting inspection, testing and commissioning results for the Engineer's approval at least four months before commencement of testing and commissioning works, or four months after the commencement of the Contract, whichever is earlier

Labor and Materials

The PD Contractor is required to be responsible for provision of all labour and both consumable and non-consumable materials for carrying out testing and commissioning works at their expenses. Electricity supply, water and LP gas and town gas for carrying out of testing and commissioning works shall also be arranged and provided by the PD Contractor at no cost to the Employer

Supply of Inspection, Measuring and Testing Equipment

The PD Contractor is required to supply the calibrated equipment and instrument for testing and commissioning works in accordance with the requirements as specified in the Particular Specification.

Readiness for Commissioning and Testing

The PD Contractor is required to check the completion of the works to be tested or commissioned, the associated builder's works and the associated building services installations to ensure that testing and commissioning can be proceeded in a safe and satisfactory manner without obstruction.

"Type-test" for equipment shall be carried out at the manufacturers' works or elsewhere appropriate in order to demonstrate their compliance with the Regulation or requirements. "Type-test" certificates together with the corresponding drawings, sketches, reports and any other necessary documents shall be submitted to the Engineer for approval before delivery of the equipment.

Prior to the testing and commissioning works, the PD Contractor shall check the completion of the installation works, associated builder's work and related building services installations, to ensure that commissioning can be proceeded without obstruction. Before any installation is subjected to commissioning and site testing, it shall be thoroughly cleaned both internally and externally. All pipes shall be thoroughly cleaned and flushed before filling with water.

The PD Contractor shall be responsible for initially setting the plants to work including:

- a) Preliminary checks to ensure that all systems and system components are in a satisfactory and safe condition before start up;
- b) Preliminary adjustment and setting of all plant and equipment consistent with eventual design performance;

- c) Carrying out pressure test, hydraulic test and other tests required before energising the equipment and plant;
- d) Checking the proper functioning of the protective devices and safety valves in the installation and carrying out all necessary safety testing;
- e) Energising and setting to work on all plants; and
- f) Initial regulation and demonstration that the installation delivers the correct rate of flow at the conditions specified in the Contract

For specialist plant or equipment, the PD Contractor shall arrange for it to be commissioned, certified and tested by the manufacturer's skilled commissioning engineer and/or technician.

Where the tests involved other plumbing and drainage installations already in operation in other parts of the building outside the Site or works area, the PD Contractor shall co-ordinate with relevant parties, where necessary, on the temporary suspension of other plumbing and drainage installations for the tests

The PD Contractor is required to provide advanced notice for inspection, testing and commissioning works as follows: -

- a) Off-site Inspection and Testing

An advanced notice of at least one week before commencement of the inspection or test shall be provided.

- b) On-site Inspection, Testing and Commissioning

An advanced notice of at least 4 calendar days before commencement of inspection, testing or commissioning shall be provided.

Documentation and Deliverables

The PD Contractor shall record all commissioning information and testing results at the witness of the Engineer or his representatives. Commissioning and testing record shall be properly checked and certified by contractor's Testing and Commissioning Engineer and signed by the Engineer or his representative who has witnessed the testing or commissioning before submission to the Engineer. The PD Contractor shall submit full commissioning and testing report to the Engineer within 14 calendar days after completion of commissioning and testing of the installation.

22.1.3.2 Testing and Commissioning - Definitions

For the purpose of this General Specification the following definitions shall apply: -

Commissioning: the advancement of an installation from the stage of static completion to full working conditions and to meet the specified requirements. This will include setting into operation and regulation of the installation.

Setting to work: the process of setting a static system into motion.

Off-site Tests: tests carried out on items of equipment at manufacturer's works or elsewhere to ensure compliance with the requirements of Specifications and/or relevant Standards or Codes of Practice (or other standards specified).

Site Tests: tests on static plant and systems (e.g. inspection and testing of welds, hydraulic testing of pipe work, etc.) to ensure correct and safe installation and operation.

Regulation: the process of adjusting the rates of fluid flow and heat transfer in a distribution system within specified tolerances as stated in the relevant CIBSE Commissioning Code.

Performance Testing: the measuring and recording of the performance of the commissioned installation.

22.1.3.3 Testing and Commissioning - General

Any defects of workmanship, materials and performance, maladjustments or other irregularities which become apparent during commissioning or testing shall be rectified by the PD Contractor at no cost to the Employer and the relevant part of the commissioning or testing procedure shall be repeated at the PD Contractor's expenses.

The entire testing and commissioning procedure shall be undertaken by the PD Contractor's own competent specialist staff or by a competent Independent Commissioning Specialist nominated by and acting for the PD Contractor and approved by the Engineer.

Where specified in the Particular Specification, the PD Contractor shall nominate a competent independent Specialist to conduct commissioning work.

Where specified in the Particular Specification, the PD Contractor shall employ an approved specialist testing and commissioning firm who shall be named in the returned Tender Documents.

At the appropriate time in the Contract, usually within the first three months, the PD Contractor shall furnish the Provisional Testing and Commissioning Programme, methods, procedures and formats of test

records to the Engineer. This shall be updated as the work progresses towards completion.

Unless otherwise indicated, all electricity, main water and other fuels, such as town gas, necessary for the operation of the plant during preliminary runs and for full adjustments and commissioning tests will be provided at no cost by the PD Contractor unless otherwise specified in the Contract.

22.1.3.4 Off-Site Tests

Where the specified Standards or Codes of Practice stipulate, "type-tests" on items of equipment to demonstrate compliance shall be carried out at the manufacturer's works or elsewhere as appropriate. In all cases, "type-tests" Certificates shall be submitted in duplicate to the Engineer.

22.1.3.5 Site Tests

The PD Contractor shall carry out "on-site" tests in respect of all static systems to ensure safe and proper operation as conforming to the design intent. Such tests shall include test of welds and pressure tests on the hydraulic systems.

22.1.3.6 Inspection and Testing During Construction Period

Periodic Site Tests

Site inspections of "work in progress" will be made by the Engineer or the representative from time to time. The PD Contractor shall keep such inspection record for checking from time to time. Installations to be permanently covered up shall be subjected to inspection and test before

cover up. During the inspection, if the Engineer discovers any work that has been covered up before inspection and testing, this work shall be uncovered for inspection and testing to the Engineer's satisfaction. The cost involved in uncovering the work, inspecting, testing and re-concealing the work together with any consequential losses shall be paid by the PD Contractor at no additional cost to the Employer.

Test at Factory

The PD Contractor shall note that the Engineer may require witness of tests and inspections of locally and/or overseas manufactured equipment during construction at the manufacturer's works. Where this requirement is indicated in the Contract Documents, the PD Contractor shall allow for making the necessary arrangements; including and indicating the Engineer's travel and subsistence expenses in the Contract

Factory Test Certificates

Certificates of all hydraulic and other manufacturers' tests carried out at the manufacturers' works shall be forwarded in duplicate to the Engineer for approval. This approval shall normally be required before the materials or apparatus are dispatched from the manufacturer's works.

Where specified, the PD Contractor shall subject certain materials and equipment to be tested by the recognized institutions or laboratories and submit the type test certificates to the Engineer for approval.

Sampling and Analysis of Potable Fresh Water

The PD Contractor shall conduct sampling and analysis for the quality of potable fresh water upon substantial completion of the plumbing

installation. The sampling and analysis methodology shall be submitted to the Engineer for approval. Notwithstanding, the samples shall be taken at all farthest points of use in the plumbing system from the storage tank, and shall include sampling for each water supply tank in the building as minimum.

The sampling and analysis of potable fresh water for physical, chemical and bacteriological examinations shall be collected, preserved and handled using the standard techniques as listed below: -

- a) BS EN ISO 5667-1: 2006, BS EN ISO 5667-3: 2003 and BS ISO 5667-5: 2006, or equivalent standards;
- b) Annex 4 of the World Health Organization (WHO) Guidelines for Drinking Water Quality 2nd Edition Volume 3; and
- c) Section 1060 of the American Public Health Association (APHA) Standard Methods for the Examination of Water and Wastewater 20th Edition.

22.1.3.7 Documents and Data Required for Hand-Over

General

The PD Contractor shall note that the system cannot be handed over until all the foregoing requirements (where applicable) have been carried out to the satisfaction of the Engineer.

Test Certificates

Before the handover inspection, the PD Contractor shall provide the follow test/record certificates where applicable: -

- a) Copies of manufacturer's works tests/record certificates on plant items comprising heat generating plant, heat exchangers, chillers units, packaged air conditioning units, tanks, vessels, motors, fans, pumps, etc.;
- b) Copies of hydraulic and pressure test/record certificates for works carried out on Site;
- c) Copies of boiler plant efficiency test/record certificates;
- d) Copies of Registered Surveyor's test/record certificates for pressure vessels (if any);

"As-built" Drawings

All necessary copies of "As-built" drawings as detailed in the Contract Documents and this General Specification shall be provided upon handover.

Operation and Maintenance Manuals

All necessary copies of Operating and Maintenance Manuals as detailed in the Contract and this General Specification shall be provided upon handover.

Manufacturer's Name Plate

Every item of plant supplied by a manufacturer shall be fitted with a clearly engraved, stamped or cast manufacturer's name plate properly secured to the plant item and showing: -

- Manufacturer's Name;
- Serial and/or Model No.;

- Date of Supply;
- Rating/Capacity; and
- Test and Working Pressure (where applicable).

Labels and Related Instructions

Labels and notices shall be supplied and installed for all valves and piping to facilitate operation and proper maintenance of the Installation. All labels shall make cross reference to the operation and maintenance manuals and as-built drawings

All wording shall be in both Kiswahili and English. All labels shall be of adequate size as to give clearance between lettering and fixings to ensure an aesthetic arrangement on completion, and meeting with.

TECHNICAL SPECIFICATIONS (FIREFIGHTING)

22.2 TECHNICAL SPECIFICATIONS (FIREFIGHTING)

22.2.1 INTRODUCTION

General

This section, This General Specification details the intrinsic properties (including materials and workmanship) required of a fire service installation including hydrant/hosereel system, sprinkler system, manual and automatic fire alarm system, audio/visual advisory system, gas extinguishing system, portable appliances, pressurisation of staircases system, smoke extraction system and all associated electrical equipment and wiring.

Preference

The fire service installation shall comply in every respect with this Project Specification unless otherwise specified in the Particular Specification, the Drawings and/or Contract documents relating to a particular job or modified by written instruction of the Engineer.

The Project Specification takes preference over the standard specifications wherever the two Specifications might be in conflict.

Scope of Work

The scope of the Works in this Project Specification consists of the whole of the labour and all materials necessary to form a complete installation and such commissioning, adjustments, tests and maintenance as prescribed or as necessary. It shall include not only the major items of plant and equipment shown or specified but all the incidental sundry components necessary together with the cost of labour for installing such components for the completion of the Works and for the proper and functional operation and maintenance of

the installation whether or not these sundry components are mentioned in detail in the Contract. It shall also include co-operation with other contractors involved on the Contract site in respect of co-ordination, programming, scheduling and sequencing of installation of the works in all circumstances where stipulated in the Contract or proven as necessary in practice.

22.2.2 STATUTORY OBLIGATIONS AND OTHER REGULATIONS

Installation to Comply with Obligations, Regulations and Specification

The installation shall comply with this General Specification, and with the following statutory obligations, regulations and specifications currently in force in

Kenya Government

- a) KS Code (2009) Part S
- b) BS 5588-4, *Fire precautions in the design, construction and use of buildings – Part 4: Code of practice for smoke control using pressure differentials.*
- c) BS 7346-1, *Components for smoke and heat control systems – Part 1: Specification for natural smoke and heat exhaust ventilators*
- d) BS 7974, *Application of fire safety engineering principles to the design of buildings – Code of practice.*
- e) EN 12101-1, *Smoke and heat control systems – Part 1: Specification for smoke barriers.*
- f) EN 12101-2, *Smoke and heat control systems – Part 2: Specification for natural smoke and heat exhaust ventilators.*
- g) EN 12101-3, *Smoke and heat control systems – Part 3: Specification for powered smoke and heat exhaust ventilators.*

- h) SANS 193, *Fire dampers*.
- i) SANS 306-4, *Fire extinguishing installations and equipment on premises – Part 4: Specification for carbon dioxide systems*.
- j) SANS 543 (SABS 543), *Fire hose reels (with hose)*.
- k) SANS 1128-1 (SABS 1128-1), *Firefighting equipment – Part 1: Components of underground and above-ground hydrant systems*
- l) SANS 1128-2 (SABS 1128-2), *Firefighting equipment – Part 2: Hose couplings, connectors and branch pipe and nozzle connections*.
- m) SANS 1151 (SABS 1151), *Portable rechargeable fire extinguishers – Halogenated hydrocarbon type extinguishers*.
- n) SANS 1186-1, *Symbolic safety signs – Part 1: Standard signs and general requirements*.
- o) Internationally recognised equivalent standards acceptable to the local authority and demonstrated to be equivalent in terms of the type of construction, functions, performance, general appearance and standard of quality of manufacture and approved by the Engineer.
- p) Where indicated, the codes, standards and guidelines issued by the following international institutions, or internationally recognised equivalent standards acceptable to the local authority and demonstrated to be equivalent in terms of the type of construction, functions, performance, general appearance and standard of quality of manufacture and approved by the Engineer:
 - National Fire Protection Association, United States
 - Loss Prevention Council, United Kingdom
 - International Organization for Standardisation
 - American National Standard Institute
 - Committee for European Normalisation
 - Factory Mutual, United States
 - Underwriters' Laboratory, United States

Intellectual Property Rights

If the Contractor intends to use the intellectual property rights of another party in performing the Contractor's obligations under the Contract, appropriate licences shall be obtained from the relevant rights owners.

Where any software is provided in the Works, the Contractor shall submit documents showing that appropriate permission or licence has been obtained from relevant beneficial owners of intellectual property rights for the use of the software free of all fees for the whole operating life of the Works.

22.2.3 EXECUTION OF WORKS

Programme of Works

The Fire Protection Contractor (Sub-Contractor) shall obtain the programme from the Main Building Contractor (builder) and co-ordinate the Fire Protection installation programme with that of the builder.

Builder's Work

Approved pipe sleeves and pipe collars, and approved fire rated pipe sleeves and fire rated pipe collars where necessary, shall be supplied and installed by the Contractor for all fire service pipes and the like passing through compartments, walls, floors and any structural openings. Puddle flanges for inlet and outlet pipes of the tanks for fire service shall be supplied by the Contractor and will be installed by the Building Contractor unless otherwise specified.

Training of Employer's Staff

The Contractor shall provide training for the operation and where necessary maintenance of sophisticated equipment. The training shall include all training facilities, material and handouts etc. The Contractor shall submit a training schedule and proposal at least three (3) months prior to completion of the Works for the Engineer's Approval.

The Contractor shall provide adequate training to the Employer's staff to operate the fire alarm control system and to monitor and to reset/mute alarms in the fire service installation at completion of the Works and before the commencement of the Maintenance Period. The Contractor shall provide

adequate training to the Employer's staff on the operation of the fire service installation during fire alarm, fault alarm, warning alarm and other emergency situations as appropriate. The

Contractor shall provide contact telephone list as necessary to the Employer's staff.

The Contractor shall provide facilities and training programme to ensure that the Employer's operation and maintenance staff, as available, acquire full knowledge and appreciation of all aspects of the design, day-to-day operation, diagnosis and where necessary, breakdown and routine maintenance, and hence operate and maintain reasonably effectively and efficiently the system/equipment.

Sample Board

Prior to the commencement of installation work, the Contractor shall submit to the Engineer for approval in good time sample boards of electrical and mechanical accessories proposed to be used for the Contract. Each sample shall be firmly fixed onto a rigid wooden or metal board and clearly numbered and labelled. A list shall be affixed to show the item description, make and brand, name of manufacturer, country of origin, accessories to be used and locations of installation (if not generally used).

Only samples deemed to comply with the Specification shall be displayed and items shall be adequate for the whole installation unless otherwise clearly indicated as outstanding ones to be submitted later. Samples rejected by the Engineer shall be replaced as soon as possible. Upon approval of all items in a sample board, the Engineer will endorse the list of the sample board and the sample board shall be delivered by the Contractor to the Employer's site office for reference.

22.2.4 GASEOUS EXTINGUISHING SYSTEM

General

The Contractor shall be responsible for the design of the gaseous extinguishing system. Unless otherwise specified, gaseous extinguishing systems shall be of the total flooding type with pressurized open-ended piping installation on the distribution side. The automatic gas release mechanism shall be operated by means of fire detection units at the protected compartment or manually by a pull handle or push button as described below. Design the gaseous extinguishing system to comply with the standards published by National Fire Protection Association or internationally recognised equivalent standards, and demonstrated to be equivalent in terms of the type of construction, functions, performance, general appearance and standard of quality of manufacture and approved by the Engineer. All proprietary design details from the manufacturer shall be submitted to the Engineer and complying with SANS 10400-T.

Carbon dioxide system shall be designed and installed in accordance with either BS 5306 Part 4 or NFPA 12 and shall only be used in normally unoccupied areas where egress of personnel can be accomplished in thirty (30) seconds.

Other gaseous systems shall be of clean agent type and designed and installed in accordance with NFPA 2001 or any recognised system design manual prepared by the manufacturer.

Unless otherwise specified or approved by the Engineer, the clean agent used shall be FM200. For application in areas with high ceiling height or with low temperature or with limitation in storage spaces for the clean agent that makes the use of FM200 unsuitable, other clean agents such as FE13, FIC, etc. to the approval of the Engineer will be considered. Other clean agents may require additional submission, tests and other information required by the FSD. The

Contractor shall deem to allow the cost for all such submissions, requirements and tests to the satisfaction and compliance with SANS 10400-T and the Engineer when other clean agents are used.

The entire gaseous extinguishing system shall be a proprietary product certified by LPCB, UL or FM and has been approved by SAB5. All components of the installation shall be compatible with the design of the system. Any add-on device shall be approved by the system manufacturer and shall not affect the proper functioning of the system.

Quality of Extinguishing Agents

Carbon dioxide used shall be of good commercial grade, free of water and other contaminants that might cause container corrosion or interfere with free discharge through nozzle orifices. In general, carbon dioxide obtained by converting dry ice to liquid will not be acceptable. The vapour phase shall not be less than 99.5% purity with no detectable off-taste or odour. The water content of the liquid phase shall not be more than 0.01% by weight. Oil content shall not be more than 10 ppm by weight.

Other clean agent gases shall comply with NFPA 2001, in particular, the acute toxicity, the ozone depletion potential and global warming potential.

Performance of Standard Total Flooding Installation

Carbon dioxide total flooding systems shall be designed to achieve the necessary concentration, rate of application and duration to maintain the extinguishing concentration all as specified in BS 5306 Part 4 or NFPA 12 in accordance with the volume, hazard and environmental conditions of the protected enclosures. Unless otherwise specified, the rate of application in general shall comply with following requirements: -

- a) For surface fires, the design concentration shall be achieved within one (1) minute.
- b) For deep-seated fires, the design concentration shall be achieved within 7 minutes but the rate shall not be less than that required to develop a concentration of 30% in two (2) minutes.

Other clean agent gas flooding systems shall be designed to achieve an acceptable concentration stipulated in NPFA 2001 or any recognised system design manual from the manufacturer at room temperature complying with SANS 10400-T. Discharge of gas shall be substantially completed within ten (10) seconds and following discharge the concentration of clean agent shall develop throughout the protected compartment to achieve final extinguishments of fire within sixty (60) seconds.

Contractor's Responsibility for System Performance

The compartment to be protected and the location of the gas cylinders shall be as indicated on the Contract Drawings. The layout of pipework and nozzles shown on the Contract Drawing is indicative. The Contractor is responsible for the design of the complete system in co-ordination with other services.

Notwithstanding that the Contractor has demonstrated by calculation to the satisfaction of the Engineer that the system will perform to the standard required, the Contractor shall remain responsible for ensuring that under test the system does in fact perform in accordance with the Specification.

Contractor to Provide a Complete Working System

The Contractor shall supply and install all components necessary for full operation of the system in the automatic or manual mode regardless of whether such components are specified or not.

Gas Storage Pressure

All the gas extinguishing agents shall be stored in rechargeable cylinders to hold the pressurized agents in liquid form at ambient temperature. The Contractor shall select cylinders of commonly available sizes and types that can be recharged. The Contractor shall allow for at least 10% spare capacity in sizing of each cylinder.

For high pressure system, carbon dioxide shall be pressurized to a corresponding nominal pressure of 5860 kPa at 21°C. The normal filling density shall not be in excess of 68%. For low pressure system, carbon dioxide shall be kept at the design pressure of 2068 kPa by refrigeration system. The refrigerants in the refrigeration system shall have zero ozone depletion potential. Appropriate alarm and pressure relief shall be supplied and installed to cater for possible failure of the refrigeration system. Unless otherwise specified, carbon dioxide system shall be of high pressure system.

Clean agent cylinders shall be charged in accordance with NFPA 2001 or any recognised system design manual from the manufacturer.

Gas cylinders, distribution pipework, valves, nozzles and fittings shall be manufactured to standards designed to withstand the maximum pressure of stored agent allowing for variations in ambient temperature.

The gas cylinders shall be certified for the intended gas storage pressure and use and complying with SANS 10400-T.

Gas Cylinders

Carbon dioxide cylinders shall be of seamless steel construction to BS 5045 Part 1. For low pressure refrigerated system, it shall be in accordance with the manufacturer's design and certified by recognised bodies such as LPCB, UL, FM

or approved by any similar widely recognised independent regulatory body acceptable by the Engineer and complying with SANS 10400-T

Clean agent cylinders shall be constructed in accordance with NFPA 2001.

Cylinders shall be securely mounted in a frame bolted to the wall and to be so arranged that the external parts may be readily inspected and corrosion cannot occur. Each cylinder shall be fitted with an automatic pressure release device for over pressure protection of the cylinder.

Each cylinder shall be complete with gas valve, actuator, pressure gauge, flexible hose, check valve and all other necessary accessories. Where the cylinder of a proprietary system complying with SANS 10400-T is not fitted with a pressure gauge, the Contractor shall supply and install pressure gauge in the system pipework for each cylinder.

A device shall be supplied and installed for measuring the amount of liquid in the cylinder at any time. This shall be done by a method which does not require the cylinder to be detached from the manifold. If a weighing device of the type that requires suspension is proposed, means shall be supplied and installed above each cylinder for the attachment of the weighing device. The contents of the cylinders may alternatively be checked by the use of a liquid level indicator of a type approved by the Engineer.

The liquid shall be discharged from the cylinder through a siphon tube. The pressure of the liquid stored in the cylinder shall be such that freezing cannot take place at the lowest possible ambient temperature.

Means shall be supplied and installed to prevent gas discharging into empty containers and to prevent loss if the gas is released when any of the cylinders is disconnected.

Gas cylinders shall be painted signal red as specified in BS 381C in accordance with the requirements of BS 5252. The cylinder shall be free from all rust and

corrosion before painting is applied. The type of extinguishing agent, the tare weight, gross weight, liquid level at 21°C and also the degree of super pressurisation (for clean agent) where applicable shall be clearly painted on each cylinder with white paint.

Gas cylinders shall be of rechargeable and re-usable types. If the discharge of gas will require the irreversible rupture of any component of the system such that they are not reusable, the Contractor shall provide one spare set of such components for each installed cylinder. They shall be stored in a labelled and locked cabinet inside the gas cylinder room. Three keys shall be provided.

Only gaseous extinguishing systems that can be recharged locally and the refilling of gas after discharge can be accomplished within a short time shall be approved and used.

The Contractor shall submit details of the refilling arrangement including agency, address of local workshop, refilling time, etc. together with the equipment submission to the Engineer for approval. Equipment submission without details on the refilling arrangement shall not be approved.

The Contractor shall supply and install facilities to isolate or to lock the gas cylinders during routine maintenance or inspection work on the gas cylinders and control system in order to prevent accidental discharge of gas. The facilities shall give appropriate warning indication when it is switched to the 'isolated' mode.

22.2.5 MISCELLANEOUS

Labels and Notices

Labels and notices shall be supplied and installed for all pumps, valves, switches, gauges, indicators, cables, internal wiring terminals and all other equipment to facilitate operation and proper maintenance of the fire service installation. All labels shall make cross reference to the operation and maintenance manuals and as-built drawings

Labels and notices required by statutory requirements shall be inscribed accordingly whereas other labels shall indicate name and purpose of the equipment together with ratings and commissioned set values where applicable.

Labels for equipment identifications shall be made of red plastic material or multilayer formica with white lettering or as approved. Lettering shall be engraved on the plastic material or formica. All wording shall be in both Swahili and English. All labels shall be of adequate size as to give clearance between lettering and fixings to ensure an aesthetic arrangement on completion.

Notices for safety warning and instructions shall be constructed of heavy gauge aluminium sheets painted with symbols or wording as appropriate.

Notice for instruction for operation and use of the equipment shall be provided as appropriate and necessary. Instructions for use shall be provided to all equipment for use by the general public and for operation by the operating staff.

Labels and notices shall be fixed by screws. Where drilling and tapping is impracticable, approved adhesive may be used subject to prior approval by the Architect. For pipelines or valves, where applicable, labels shall be fixed by means of a key ring attached to the upper corner of the pipe mounting bracket or the hand wheel of valves. The labels shall be suspended from brass or stainless steel chain loops over the relevant pipe.

All major fire service equipment and components such as pumps and motors, flow switches, alarm valves, expansion joints, pipes and fittings, etc. shall have factory applied permanent nameplates indicating, where relevant: -

- a) Name of Manufacturer.
- b) Model.
- c) Serial Number.
- d) Design Flow Rate, Pressure, etc.
- e) Rated Duty.
- f) Operating Voltage, Phase, Ampere, and Frequency.
- g) Full Load Current and Power.
- h) Starting Method and Current.
- i) Power Factor.
- j) Date of Manufacture.
- k) IEC, British Standards or other Authorities' markings to indicate their compliance and grades of application.
- l) Any other necessary data to conform to specified requirements and to indicate the equipment performance.

Instructions for oiling and/or greasing of all fans, motors, etc. shall be attached to the relevant greasing or oiling points.

Where the equipment has an operating life less than or equal to ten (10) years, the expiry date or the 'end of service life' date has to be stated on the label attached to the equipment. Labels of approved types shall be supplied and installed for fire extinguishers, fixed sprayer units, batteries, detectors and gas extinguishing system showing the expiry date of design operating life. Unless otherwise barcode labels are provided, the label shall have a serial number of the equipment and the serial number shall be recorded on the as-built drawings.

Identification to the approval of the Engineer shall be supplied and installed for emergency luminaires of the same appearance as other non-emergency luminaires for quick identification in routine inspection.

All isolators and protective devices that can isolate the supply to the fire alarm system shall be properly labelled to the approval of the Engineer.

Danger Notices

Danger notices worded: DANGER-PLANT ON AUTOMATIC START (-) in English and Swahili shall be supplied and installed adjacent to all automatically controlled motor-driven and engine-driven pumps.

Notices, instructions of use complying with the requirements of Labour Department and Occupational Safety and Health Ordinance, Chapter 509, shall be supplied and installed.

Painting, Finishing, Protection and Identification

Painting shall follow General Specification for Building unless otherwise specified. Paint all surfaces including cable trunking/conduit, panel, box, enclosure, cladding, pipework, equipment, fitting, etc. except otherwise specified.

Self-finished surfaces like stainless steel, anodised aluminium, chrome plated, bronze, plastic, etc. are not required to be painted.

Galvanised pipework concealed in false ceiling or galvanised duct not normally accessible and/or seen need not be painted unless otherwise specified, but appropriate colour code indication shall be applied.

Equipment with factory applied paints or epoxy coatings need not be painted.

Painting and coatings for the purpose of protecting the materials from corrosion including those inside concealed spaces shall be required.

All surfaces, unless otherwise specified, shall be finished in first class paint work. All metallic surfaces shall be wire-brushed and cleaned to make it free from rust, scale, dirt and grease prior to painting. All work shall be carried out by qualified tradesmen. Water based paints with reduced volatile and preservative content or paints with reduced solvent content formulated for minimal volatile organic compound emissions complying with reputable international standards shall be used in occupied areas. In addition, all paints shall contain no mercury, lead, hexavalent chromium or cadmium compounds. All painting works shall be completed and left in ventilated environment for at least 1 week, or the curing period recommended by the paint manufacturer whichever is longer, before occupation or handover of the renovated area to minimize volatile organic compound exposure.

All surfaces shall be painted and finished as specified in the Particular Specification to meet and match the aesthetic Architectural design as required.

Painting shall be of approved type and shall be generally to CP (prepared by the

PM), and should include but not limited to the following: -

- a) Do not carry out painting work in wet, humid or foggy weather or on surface that is not thoroughly dry or if there is excessive dust in the air.
- b) Ensure that all holes, cracks and other defects in surface have been made good prior to painting.
- c) Ensure the surface is thoroughly clean and dry prior to painting. Loose material shall be removed by dry brushing with stiff broom or brush.
- d) Keep surface clean and free from dust during coating and drying.
- e) Protection freshly applied surface coating from damage.

Primer shall be applied to metal surface before the application of under and finishing coats of paint. Primer for non- galvanised metal surface shall be metallic zinc-rich primer to BS 4652, Type 2, and for galvanised surface shall be calcium plumbate primer or approved etch primer. Bare copper tubing shall be polished bright and coated with approved heat resisting clear synthetic varnish. All surfaces shall receive one primer coat, one under coat and 2 finishing coats.

The primer, under coat and finishing coat of paint shall be from the same manufacturer. The painting procedure shall be strictly in accordance with the manufacturer's instruction.

For anti-corrosion paint and primer, the correct type of thinner/activator shall be used and the mixing method shall follow the manufacturer's instructions.

Colour of the finishing coats shall be to the approval of the Engineer. Pipes and pipelines shall be complete with the identification colour code indicators when the colour of the finishing coat is not in accordance with ISO 3864.

The street hydrant body shall be painted red if it is connected to fresh water supply and painted yellow if it is connected to salt water supply. If the street hydrant is removed from service, the blank cap shall be painted blue.

Copper pipes and fittings shall be polished bright by sanding, wiped with mineral spirits and coated with an approved heat resisting clear synthetic varnish.

Where normal painting is not practicable, all possible measures to prevent corrosion to the plant shall be applied such as special protective coverings, special anti-corrosive paints, etc. as recommended by the supplier or specified in the Particular Specification

For temporary protection, all stainless steel parts shall be covered with PVC wrapper or tape until handover. All ferrous parts shall be painted or greased (whichever is most suitable). All bright parts (chrome plates, polished stainless

steel or aluminium, etc.) which are liable to deterioration shall be covered with tallow or a suitable protective coating during the progress of work. Upon completion of work, the protection coating shall be removed and the parts polished as appropriate. Any damage to the primer or protective coatings shall be made good. When it is necessary to remove, or partly remove the protection for installation or making connections, the Contractor shall ensure that the standard of protection provided originally is re-applied at the earliest possible time. All plants, pipes valves, and fittings shall be, as far as possible, thoroughly cleaned and cleared of rust and other foreign matters both before erection and before subjection to pressure tests. For temperature and/or humidity sensitive electrical or electronic control panels and equipment, the Contractor shall where necessary protect them against high humidity and/or temperature by operating portable or temporary dehumidifiers and/or air conditioners in the enclosures containing this equipment. In order to protect the equipment against dust infiltration, the Contractor shall store them in a dust free room or enclose them in heavy duty PVC sheets or bags. Where necessary, filters shall be provided in the temporary air conditioning systems.

Spares and Tools

For plant and/or equipment included in the Contract, the Contractor shall provide the types of spare parts generally wherever these are appropriate to the plant and/or equipment involved plus any additional items for the particular plant and/or equipment. Unless specified in detail, the criteria by which the Contractor shall judge the need for spare parts to be included shall be any part or component of the plant or equipment that is subject to frictional wear, vibration or temperature fatigue, rupture to safety (or otherwise), corrosion, erosion, decay, limited operating life, unacceptable deposits and/or saturation, normal fair wear and tear and is likely to fail or reach an unacceptably low performance level.

The Contractor shall provide sets of spare parts and special tools including spare sprinkler heads, detectors, replacement break glass plates, indicator lamps, special keys, fuses, parts for the gas extinguishing system after discharge, etc. as required by the statutory rules, required by specifications in Section A2 and in Section B3.12, for one year operation and maintenance after expiry of the Maintenance Period, and as required by other parts of this General Specification at the time of completion of the Works and before commencement of the Maintenance Period. The Contractor shall supply and install locked cabinet or cabinets in the plant room(s) and/or control room(s) for housing the spares and tools. Such sets of spare parts and special tools shall be submitted to the Engineer for approval within four (4) months after commencement of the Contract, or in such period as has been agreed by the Engineer in writing.

The Contractor shall also supply all the spare parts and special tools required for the whole Maintenance Period for operation and maintenance of the plant and installation. The spare parts and special tools shall be in addition to the requirements in the second paragraph of this section. At the end of the Maintenance Period, the Contractor shall ensure that the spare parts and special tools required in the second paragraph of this section are provided and stored in the cabinet.

The Contractor shall replenish and supply spare parts that may have been used during the Maintenance Period.

In addition, the Contractor shall include in the operation and maintenance manual a complete manufacturer's recommended list of all the replaceable parts, spares and special tools with model number, part number and price which are likely to prove necessary to service the plant and/or equipment. The list shall be complete with prices and the prices listed shall be fixed and open for acceptance up to the end of the Maintenance Period. The list shall include diagrams or catalogue details of the parts concerned and bona fide manufacturer's published price lists. The Contractor may add the net shipping

costs for each item plus a 15% margin to cover overheads and profit. Where appropriate, the prevailing exchange rate must be stated.

The Contractor shall submit information on the design operating life for equipment such as batteries, detectors, fire extinguishers, gas extinguishing system, etc. that are required to be replaced some years later. The Contractor shall provide three keys for each key operating facilities, locks and switches unless otherwise specified.

Provision for Water Meter

Metering of water supplies to fire service installation is not required. Provision shall, however, be made for the possible future connection of the Water Supplies Department meter at each point of connection to the main, immediately downstream of the main stop valve. The position of this future meter shall be shown on the installation drawings. The Contractor shall co-ordinate with the Building Contractor to obtain the information where necessary.

Noise and Vibration

The Contractor shall take all necessary steps to prevent the transmission of any objectionable noise and vibration which affects the occupied areas of the building.

Pumps and motors shall be balanced and aligned such that the measured vibration velocity at all three axis shall not exceed 1.8 mm/s rms in the range of 10 to 1000 Hz as defined in BS 4675, ISO 2954 and ISO 10814.

Motor driven pump set shall be mounted upon a common base plate supported by approved spring-type isolation mountings on concrete plinth.

Flexible connectors shall be installed at pump connections to take up vibration. Unless otherwise specified, flexible connector of single sphere or double sphere type made from rubber and similar materials shall not be used. Flexible connector shall be used to absorb the vibration and shall not be used

to take care of the misalignment during installation. All pumps and pipes shall be properly aligned on completion

Pumps shall be of low noise rating especially for the jockey pump set and other equipment requiring frequent operation. Acoustic treatment shall be provided as necessary and approved by the Engineer.

Acoustic treatment shall be provided to the emergency generator installation and other fire service installations and equipment to comply with statutory requirements on noise and vibration.

Equipment Bases

All bases and supports for plant and equipment shall be supplied and installed by the Contractor, except concrete plinths and blocks, which will be provided by the Building Contractor unless otherwise specified but shall be designed by the Contractor to suit the actual equipment.

Plinths and blocks shall be designed to project approximately 100 mm above the finished floor level.

Safety Facilities

Facilities for operational and maintenance safety shall be supplied and installed to comply with the Occupational Safety and Health Ordinance and with the requirements of Labour Department. All moving parts shall be appropriately covered and emergency stops shall be supplied and installed where necessary.

Adequate spaces and facilities shall be allowed for maintenance and access.

Schematic Diagram and Key Layout Drawings

Schematic diagrams and where relevant key layout drawings shall be provided to all major plant rooms and fire service control rooms. The diagrams and

drawings shall be mounted in glazed frames and installed in appropriate locations in the rooms

22.2.6 COMMISSIONING AND ACCEPTANCE TEST

Adjustments, Commissioning, Functional and Performance Tests

The Contractor shall commission the installation and carry out complete functional and performance tests for all equipment and systems installed by him/her or them, make all necessary adjustments, including setting all controls and checking the operation of all protective and safety devices in accordance with the manufacturers' instructions, the requirements of the statutory rules and regulations and to the satisfaction of the Engineer before the installations will be accepted. Prior to any tests, the Contractor shall submit detailed commissioning and testing procedures, methods, format of test records and a programme for the commissioning and testing to the Engineer for approval at least three (3) months before commencement of commissioning and testing or within four (4) months after commencement of the Contract whichever is earlier. They shall be updated as the work progresses towards completion. All commissioning and testing procedures for works that are required to be tested during construction shall be submitted in good time for approval.

The detailed procedures submitted shall follow Testing & Commissioning Procedures submitted by the Engineer with additional details and tests proposed by the Contractor to the approval of the Engineer and in accordance with the manufacturer's recommendation, relevant standards and statutory regulations. Detailed commissioning and testing procedures shall be submitted for all special systems and systems. The detailed procedures shall be prepared in two main parts covering the following: -

- a) Testing that is required to be carried out during the construction period when part of the Works is installed.
- b) Commissioning and testing required for certifying completion of the Works and before commencement of the Maintenance Period.

Immediately after each test, the Contractor's Commissioning Authority, herein referred to as "CCA" shall sign the data record sheet on site with endorsement by the Engineer's representative witnessing the test, irrespective whether the test is successful or not, and submit a copy of the data record sheet to the Engineer. For testing that is required to be carried out during the construction period, the Contractor shall submit a formal commissioning and testing report or certificate for each test and endorsed by the Contractor's CCA within fourteen (14) calendar days after the test.

Commissioning and testing shall include, but not limited to: -

- a) Factory tests and off-site tests.
- b) Visual inspection and checking.
- c) Setting to work, safety and quality tests.
- d) Commissioning, regulations, tuning and adjustment
- e) Functional tests.
- f) Performance tests.
- g) Final mock-up tests.
- h) Statutory tests and inspections.

Visual inspection and checking shall include verification of the installed equipment being the approved models. The Contractor shall submit relevant documents including delivery orders and payment vouchers to substantiate the equipment installed on site being the approved models if the identification of the manufacturer and model name cannot be seen easily on site.

The Contractor shall note that completion of commissioning and testing and the associated statutory inspection by the local authority is one of the

considerations for certifying completion of the Works. The Contractor shall make a detailed plan on the programme of the commissioning and testing works at the commencement of the Contract, in order to ensure that all of such works can be completed within the Contract period. The commissioning and testing programme submitted shall detail the types of commissioning and testing works required, the breaking down of the programme into floor-by-floor and area-by-area basis, the tests that are required during construction and at the time before the completion of the Works, the period of tests with float time allowed, the milestone dates on connection of fire alarm direct link, final mock-up test and statutory/licensing inspections, and the programme for the completion of various builder's works such as pump rooms, control rooms, water supply, electrical supply, etc. The Contractor shall in particular plan the programme so as to minimize the overlapping of different tests arranged simultaneously in different locations.

The Contractor shall arrange to enable the Engineer or the Engineer's representatives to witness all the commissioning and testing. Unless otherwise approved by the Engineer, commissioning and testing carried out by the Contractor in the absence of the Engineer or the Engineer's representatives shall not be accepted. The Contractor shall give at least 72 hours' notice, in writing, when any part or parts of the installation will be tested.

Any defects of workmanship, materials and performance, maladjustments or other irregularities which become apparent during commissioning and testing shall be rectified by the Contractor at no additional cost to the Employer and the relevant part of the commissioning or testing procedure shall be repeated at the Contractor's expenses

If considered appropriate, the Contractor shall be required to carry out demonstration to dismantle those parts/components of the installation which are considered difficult/impossible for maintenance access. The Contractor shall be responsible for carrying out all necessary modification work at no extra charge to the Employer to alleviate the difficulties associated with dismantling or maintenance access.

The Contractor shall not wait for completion of every part of the work but shall arrange for a progressive commissioning programme to achieve practical overall completion and have the whole work ready to be handed over by a date to suit the Contract completion date or any other agreed programme date.

Factory Tests and Off-site Tests

Factory test shall deem to be included. Factory test and off-site tests shall be carried out at the manufacturer's works or by an approved independent testing body/laboratory where specified, or elsewhere as approved. Where indicated, 'type-tests' on items of equipment to demonstrate compliance shall be carried out. 'Type-tests' certificates shall be submitted in duplicate to the Engineer. Factory quality and general inspection test recommended by the manufacturer shall be required. Where indicated or necessary, factory performance test shall be carried out for each of the offered equipment before delivery. Factory test certificate certified by qualified factory engineer shall be submitted in duplicate to the Engineer for approval. This approval shall normally be required before the materials or equipment are dispatched from the manufacturer's works. Factory test shall be witnessed by an independent approved agency where indicated.

The Contractor shall note that the Engineer may require witnessing tests and inspections of manufactured equipment during construction at the manufacturer's works. Where this requirement is indicated in the Contract, the Contractor shall allow for making the necessary arrangements.

Visual Inspection and Checking

Site inspections of 'work in progress' will be made by the Engineer or the representative from time to time. The Contractor shall keep such inspection record for checking from time to time. Works to be permanently covered up shall be subjected to inspection, pressure test and other tests before cover up.

During the inspection, if the Engineer discovers any work that has been covered up before inspection and testing, this work shall be uncovered for inspection and testing to the Engineer's satisfaction. The cost involved in uncovering the work, inspecting, testing and re-concealing the work together with any consequential losses shall be paid by the Contractor at no additional cost to the Employer. Any defective works and installation of poor workmanship found during visual inspection shall be rectified or replaced before proceeding with further tests.

Setting to Work, Safety and Quality tests

Prior to any commissioning and testing works, the Contractor shall check the completion of the works, the associated builder's work, the related fire services provisions and the associated building services installations, to ensure that commissioning can be proceeded without obstruction.

Before any installation is subjected to commissioning and site testing, it shall be thoroughly cleaned both internally and externally.

The Contractor shall be responsible for initially setting the plants to work including: -

- a) Preliminary checks to ensure that all systems and system components are in a satisfactory and safe condition before start up.
- b) Preliminary adjustment and setting of all plant and equipment consistent with eventual design performance.
- c) Carrying out pressure test, hydraulic test and other tests required before energizing the equipment and plant.
- d) Checking the proper functioning of the protective devices and safety valves in the installation and carrying out all necessary safety testing.
- e) Energizing and setting to work on all plants.
- f) Initial regulation and demonstration that the installation delivers the correct rate of flow at the conditions specified in the Contract.

The Contractor shall arrange for any specialist plant or equipment to be commissioned and tested by the specialist equipment manufacturer's skilled commissioning engineer and/or technician.

Commissioning, Regulations, Tuning and Adjustment

The Contractor shall regulate, balance, tune, commission and adjust the installation and equipment as appropriate and necessary to deliver the conditions and requirements specified in the Contract. The Contractor shall allow carrying out such adjustment and re-adjustment as necessary until all the requirements are met and the installation is accepted by the Engineer.

Functional Tests

The Contractor shall demonstrate to the satisfaction of the Engineer the functioning of the installation, system and equipment complying with the operational and functional intent and the requirements in the Contract. The Contractor shall demonstrate and test the proper operational mode, control and the sequence of the operation in various parts of the system and installation.

Performance Tests

The Contractor shall carry out tests to prove the performance of the installation, system and equipment in term of flow, pressure, current, sound level, and other technical/design aspects complying with the requirements in the Contract and the statutory requirements. The Contractor shall regulate, balance, tune, adjust and modify the installation, system and equipment as necessary till the performance requirements are met. The final setting and operational parameters of all equipment shall be recorded.

Where necessary, the Contractor shall carry out full load test by simulation or other approved method to prove the performance of the installation at full load condition.

Labour and Materials

The Contractor shall dispatch competent and experienced commissioning engineers and technicians to carry out the commissioning and testing of the installation. All labour and materials necessary for carrying out the work shall be provided by the Contractor, except that the Building Contractor will supply electricity and water as required unless otherwise specified. The Contractor shall supply any necessary diesel, gas or other fuel oil for engine-driven pumps and generators provided in the Works, sufficient gases required for the discharge tests of the gaseous extinguishing system installations, etc.

The Contractor shall employ a competent and experienced commissioning engineer in-charge (hereinafter referred as CEIC) approved by the Engineer to be responsible for the overall arrangement, co-ordination, supervision and certification of the commissioning and testing of all fire service installations and equipment. The CEIC shall have minimum 5 years on site experience for similar type and scale of commissioning and testing works. The CEIC shall be responsible for the submission of detailed commissioning and testing methodologies and procedures, co-ordination of the programme and sequence of commissioning and testing works, arranging the test and re-test of the installations, supervising the commissioning and testing works, and certifying results of the tests. The CEIC shall lead and co-ordinate the final mock-up test as well as the statutory inspection with the local administrative authority. The Contractor shall submit details of CEIC together with the commissioning and testing programme to the Engineer for approval.

The Contractor shall replenish all fire extinguishing media and other materials expended or used during the test and ensure that the entire installation is in “as new” condition at the conclusion of the tests.

The Contractor shall properly drain the water and exhaust the gas during and after the test as required. The Contractor shall provide and adopt measures to avoid damage to the building, installations, decorations and fixtures during the tests for any fixed fire service installations and equipment.

Water System Tests

Water systems and circuits shall be tested hydraulically to a minimum pressure of 1000 kPa or 1.5 times the working pressure whichever is higher applied at the highest point of the system and held for a period of not less than 15 min without leaks appearing. All pipework shall be thoroughly cleaned and flushed before test. The Contractor shall ascertain that there is adequate drainage nearby to discharge by large hose in order to ensure flooding of low level areas will not occur. Where necessary, the Contractor shall provide chemical cleaning to the pipes. After flushing out the pipework, a flow test shall be performed on the hydrant/hose reel system in accordance with the requirements of the Code of Practice for Minimum Fire Service Installations and Equipment.

A water supply test with the drain and test valves fully opened shall be made on the sprinkler system in accordance with the requirements of the LPC Rules for Sprinkler Installations. An alarm test for at least thirty (30) seconds on the water gong shall also be carried out by opening the test valve to ensure that it shall sound continuously after water flow in the system is detected. All controls and air supply system for the pre-action system, recycling pre-action system and dry pipe system shall be tested.

An actual water discharge test shall be performed on the drencher/deluge/water spray/water mist system and where required for other automatic fixed installations using water to test the water flow and discharge pattern of the nozzles.

For street hydrant system without pumps, the Contractor shall test the incoming water supply pressure at a nearby supply point and at such time as

agreed with the Engineer before the completion of the installation to establish the adequacy of the water supply pressure. If the supply pressure is inadequate, the Contractor shall propose remedial measures for the approval of the Engineer. The Contractor shall find and select the most appropriate nearby supply point for the test.

The Contractor shall provide whatever hoses or drainage channels required to safely removing the test water discharged while carrying out these tests in order to ensure that no damage to the building and property will be caused by the test water.

The Contractor shall submit hydraulic test certificates/reports that shall be signed by the Contractor's CEIC and by the Engineer or the representative who has witnessed the test. The test certificates/reports shall contain the following particulars: -

- Date of test
- Apparatus or section under test
- Makers number (if any)
- Nature, duration and conditions of test
- Result of test
- Name of Contractor's representative (in block letter) in charge of test
- Name of Employer's representative at witness the test

Gaseous Extinguishing System Tests

Gaseous extinguishing system and manifolds shall be tested in accordance with Section 7.6 and SABS Requirements and Circular Letters. Pipework shall be tested for ten (10) minutes to a minimum of 1.5 times the operating pressure of the system and 10 bars whichever is larger. A 'puff' test(s) to the installed pipework is required.

The Contractor shall refill the gas cylinders with the design agents and reset all equipment after the discharge test.

Final Mock-Up Test

Before arranging statutory inspections with Local Fire Department and an Independent Commissioning Authority (CA), the Contractor shall arrange a final mock- up test with the Engineer to demonstrate all the items required for the statutory inspections have been completed and tested to the satisfaction of the Engineer.

Before the final mock- up test, the Contractor shall ensure that all documents required for statutory inspections shall be available on site.

Further mock-up tests shall be required if the installation fails to meet with the satisfaction of the Engineer in the test. The Contractor shall not arrange inspection with local fire departments till the satisfactory acceptance of the mock- up test by the Engineer. The Contractor shall allow adequate time in the commissioning and testing programme for re-testing of the system in case of failure. The Contractor shall indicate the mock- up test and the inspection by local fire department as the milestone events in the critical path programme to be submitted to the Engineer at the commencement of the Works.

Commissioning and Testing Report and Certificate of Completion

All commissioning and testing results shall be properly recorded during commissioning and testing at the witness of the Engineer. Immediately after the commissioning and testing, the Contractor's CEIC shall endorse the data record sheet on site with endorsement by the Engineer's representative witnessing the commissioning and testing, irrespective whether the tests are successful or not, and submit a copy of the data record sheet to the Engineer. A full commissioning and testing report shall be forwarded to the Engineer

within fourteen (14) calendar days after completion of commissioning and testing of the installation.

Completion of Outstanding Works

Within one month of receiving the Engineer's substantial completion certificate, the Contractor shall complete all outstanding works listed thereon and rectify any defects that have arisen up to that time.

22.2.7 GENERAL MAINTENANCE REQUIREMENTS

The Contractor shall furnish free maintenance services for the complete fire service installation for the whole Maintenance Period unless otherwise specified. This free maintenance services shall include the following: -

- a) Routine quarterly inspections, tests and maintenance services, and routine inspections, tests and maintenance service as necessary.
- b) Emergency inspections, tests and repairs.
- c) Final inspections, tests and maintenance services, and annual inspections, tests and maintenance services.

All inspections, tests, maintenance services and repairs shall be carried out generally in accordance with the manufacturers' recommendations/instructions and to the satisfaction of the Engineer. The maintenance service is to maintain the fire service installation in a good and functional working condition. The maintenance service shall include preventive maintenance and all spare parts and spares required in the Maintenance Period.

The Contractor shall dispatch competent and experienced engineers and technicians equipped with the appropriate testing instruments, tools, equipment, etc. to inspect, service, test, adjust and maintain the fire service installation in a satisfactory operating condition. The Contractor shall allow

for carrying out such inspection, service, testing, adjustment and maintenance at a time outside normal office hours including general holidays where and when required. The Contractor shall submit a list with at least two names, telephone and pager numbers and addresses of the Contractor's English-speaking and Cantonese-speaking representative to who services calls should be directed.

Particularly in the case of complex fire service installation, the Contractor shall provide at least two senior servicemen being thoroughly familiarized with all aspects of such installation to be responsible for inspection, maintenance and testing of the installation. In this type of installation, the Contractor must be prepared to provide a high level of service, allowing for more frequent service of environmentally sensitive equipment and when necessary, to ensure prompt rectification of the faults resulting in unacceptably high rate of unwanted alarms all at the expenses of the Contractor.

All labour and materials necessary, e.g. fire alarm contacts, detectors, bells, buzzers, lamp bulbs, etc., including cleaning materials, lubricants, battery electrolyte, tools, instruments, replacement of parts, etc., and transportation required for carrying out routine and emergency inspections, tests, repairs, replacements and maintenance services shall be included in the Contract. Any renewals or repairs necessitated by reason of negligence or misuse of the equipment or by reason of any other cause beyond the Contractor's control (with the exception of ordinary wear and tear) shall be carried out at an additional cost with prior notice to the Engineer. The Contractor shall also replenish at the Contractor's own cost all fire extinguishing media and other materials expended or used during the tests including diesel or petrol fuel and ensure that the entire installations are in a satisfactory operational condition at the conclusion of each visit.

The Contractor shall be responsible for all repairs necessary to maintain the fire service installation in a safe, reliable and operative condition at all times. The Contractor must ensure that the Contractor's servicing staff shall carry out the necessary repairs by utilizing manufacturer's original replacement parts. Any

component taken down for services shall be reinstated within two (2) hours or otherwise replaced by a spare unit at the Contractor's expenses.

The Contractor shall ensure minimum interruption to the functioning of the fire service installation during each inspection, testing, repair or maintenance service. Where any part of the fire service installation is out of service temporarily during the progress of work, the Contractor shall place a suitable notice in a prominent position on the control panel so that the client is aware of the situation and the local fire department will not be called out unnecessarily. This is, however, not to be construed as an authority to leave any part inoperative for an undue length of time.

The Contractor shall, as and when instructed by the Engineer, repair or replace at the Contractor's own cost any part of the system proved to be defective by reason of Contractor's negligence, faulty design, inadequate routine maintenance and supervision, workmanship or materials. No claim whatsoever shall be made by the Contractor for such repair or replacement if it is within the scope of the Contractor's responsibility.

After each routine quarterly inspection, testing and maintenance service, the Contractor shall furnish to the Engineer within fourteen (14) calendar days a report complete with the following details: -

- a) Date and time of inspection, testing and maintenance service.
- b) Persons carrying out the task.
- c) Details of inspection and maintenance service.
- d) Results of all tests performed.
- e) Any external factors significantly affecting the service and test results.
- f) Any follow-up actions as required.
- g) The record of the fire alarm direct link being temporarily disconnected since last routine quarterly inspection with date and time.

The Contractor shall, at the Contractor's own expenses, make all suitable arrangements to avoid damage to property or installations provided by others

during the course of the Works. The Contractor shall be responsible for all losses and claims for injury or damage to any person or property arises out of or in consequence of the execution of the maintenance work.

22.2.8 EMERGENCY INSPECTIONS, TESTS AND REPAIRS

Emergency service including overtime work for minor repairs and adjustments shall be included under the Contract.

The Contractor shall be responsible for immediate answering of breakdown calls during the day or night including public holidays, whether true or false, and attention to such calls both inside and outside the normal working hours in the shortest possible time and using the quickest means of transport. In general, a response time of less than one (1) hour will be expected unless special arrangement is made and approved for very remote locations.

Any necessary repairs shall be carried out with the most practicably expeditious means to ensure minimum interruption to the operation of the fire service installation.

The Contractor shall arrange to refill the gas cylinders for the gaseous extinguishing system upon discharge and put the system into normal operation within a time as short as possible but in no case shall be longer than seven (7) calendar days. Unless otherwise there are evidences that the discharge of gases in the gaseous extinguishing systems is due to a fire, smoke that generated a fire alarm, or the default operation/act of the occupiers of the building, the cost for refilling the gas cylinders of the gaseous extinguishing systems after discharge in the Maintenance Period shall be borne by the Contractor.

The Contractor shall keep a clear and legible record of all fault callouts and shall submit this record within three (3) calendar days upon request by the Engineer for inspection. The Contractor shall also include the record of all

fault callouts in the report in Section C2.1 submitted after each routine quarterly inspection, testing and maintenance service. The record shall indicate the date, time of callout, time of attending, persons attending, brief description of the fault, location/identification of fault, cause of fault, and subsequent time of clearance for each occasion. The record will be returned to the Contractor after perusal by the Engineer but shall subsequently be submitted and kept by the Engineer at the end of the Maintenance Period during the handover inspection of the installation.

22.2.9 CERTIFICATE OF MAINTENANCE

After completion of the final inspection, testing and maintenance service to the fire service installation at the end of the Maintenance Period to the satisfaction of the Engineer, the Contractor shall within fourteen (14) calendar days issue to the Engineer a certificate of maintenance signed by the Contractor with a copy forwarded to the Director of Fire Services. Where the Maintenance Period is longer than one year, the Contractor shall also submit to the Engineer a certificate of maintenance after the completion of the annual inspection, testing and maintenance to the satisfaction of the Engineer with a copy forwarded to the Director of Fire Services in compliance with the requirements of local fire department.

22.2.10 HANDOVER OF FIRE SERVICE INSTALLATION

The fire service installation shall not deem as acceptable for handover to the Engineer until the installation is in good working order and all as-built drawings, instruction and maintenance manuals, spare parts lists, test reports, test certificates, etc. have been submitted to the Engineer.

23 SECTION 24- TECHNICAL SPECIFICATIONS (ICE FLAKE MACHINE)

23.1 TECHNICAL SPECIFICATIONS (ICE FLAKE MACHINE)

23.1.1 GENERAL SPECIFICATION - GENERAL REQUIREMENTS

Installations to Comply with This General Specification

The ICE FLAKE MACHINE Installations shall comply with this General Specification which details the intrinsic properties (including materials and workmanship) of the Installations in so far as it is not overridden by the Conditions, Particular Specification, Drawings and/or written instructions of the Engineer.

Scope of the Installations

This General Specification, Particular Specification, Tender Equipment Schedule and Drawings detail the performance requirements of the Installations. The Installations to be carried out in accordance with this General Specification shall include the design where specified, installation and supply of all materials necessary to form a complete installation including any necessary tests, adjustments, commissioning and maintenance as prescribed and all other incidental sundry components together with the necessary labor for installing such components, for the proper operation of the Installations.

Technical Data

Ice production capacity : 1 ton per 24 hours

Power supply (V – ph. – Hz) : 400 – 3 – 50

Refrigerating capacity : 5,88 kW

Power Consumption : 3,9 kW

Design outside air temperature : 25 °C

Design entering water temperature : 16 °C

Evaporating temperature : -22 °C

Compressor (brand/type) : Copeland scroll

Condenser : Air-cooled

Refrigerant : R 449A, included

Measurements (L x W x H) : Approx. 1300 x 850 x 825 mm.

Weight : Approx. 300 kg.

Materials : Piping – copper

Drum – Non corrosive, chrome plated carbon steel

Ice knife – Stainless steel

Switch board – Painted steel

Frame – stainless steel

Statutory Obligations and Other Requirements

Technical Standards

KEBS, BS, BS EN, ISO Standards, IEC Standards and Codes of Practice, etc. shall be deemed to include all amendments, revisions and standards superseding the standards listed herein, which are published before the date of first tender invitation for the Contract or the Nominated Sub-contract (as appropriate) unless otherwise specified.

Case of Conflict

The documents forming the Contract are to be taken as mutually explanatory of one another but in case of ambiguities or discrepancies the same shall be dealt with in accordance with the Conditions.

Execution of Installations

The International System of Units (SI)

The International System of Units (System International d'Unites) of weights and measures shall be used for all materials, equipment and measurements.

Programme of Installations

The ICE FLAKE MACHINE Contractor shall submit to the Engineer a detailed programme of the Installations within 4 weeks from the acceptance of his tender showing the intended method, stages and order of work execution in coordination with the building construction programme, together with the duration he estimated for each and every stage of the Installations. The programme shall include at least the following: -

- (j) Dates for the placement of orders for equipment and materials;
- (k) Expected completion dates for builder's work requirements, i.e. when work site needs to be ready;
- (l) Delivery dates of equipment and materials to the Site;
- (m) Dates of commencement and completion of every stage of the Installations in line with the building construction programme, i.e. each floor level and/or zone area;
- (n) Dates of documents /drawings submissions to relevant Government departments to obtain the necessary approvals;
- (o) Dates of requirement of temporary facilities necessary for testing & commissioning;
- (p) Dates of completion, testing and commissioning; and
- (q) Short term programmes showing the detailed work schedules of coming weeks and months shall also be provided to the Engineer.

Programmes shall be regularly updated to reflect the actual progress and to meet the ICE FLAKE MACHINE Contractors' obligations under the Contract.

Builder's Work

All builder's work including openings or holes through building structure or partition walls; trenches, ducts and cutting; and all plinths, concrete bases, supports, ducts, etc. required for the Installations will be carried out as part of the building works by the Building Contractor at the expense of the Employer provided that the ICE FLAKE MACHINE Contractor has submitted full details of such requirements within a reasonable time to the Engineer for approval, so that due consideration may be given before the Building Contractor commences the building works in accordance with the building programme in the areas concerned. After obtaining the said approval of the Engineer, the ICE FLAKE MACHINE Contractor is required to mark out at the relevant locations of the Site the exact positions and sizes of all such works and to provide detailed information of such works to the Building Contractor to facilitate him to carry out the builder's works as the works proceed.

All "cutting-away" and "making-good" as required to facilitate the ICE FLAKE MACHINE Contractor's works will be carried out by the Building Contractor, except for minor provisions required for the fixing of screws, raw plugs, redhead bolts, etc. which shall be carried out by the ICE FLAKE MACHINE Contractor. The ICE FLAKE MACHINE Contractor shall mark out on Site and/or supply drawings of all "cutting-away" to the Building Contractor within a reasonable time.

All expenses properly incurred and losses suffered by the Employer as a result of the ICE FLAKE MACHINE Contractor's failure to comply with the above requirements are recoverable by the Employer from the ICE FLAKE

MACHINE Contractor as a debt under the Contract or via the Building Contractor as if it is a debt liable to the Building Contractor under the Sub-contract as appropriate.

The ICE FLAKE MACHINE Contractor shall ensure that such works are essential for the execution of the Installations. In the event that any of such works is proved to be nonessential, unnecessary and/or abortive, the ICE FLAKE MACHINE Contractor shall bear the full cost of such works including but not limited to any unnecessary or incorrect cutting away and making-good and shall reimburse the Employer for all cost incurred in this connection are recoverable by the Employer from the ICE FLAKE MACHINE Contractor as a debt under the Contract or via the Building Contractor as if it is a debt liable to the Building Contractor under the Sub-contract as appropriate.

Coordination of Installations

The ICE FLAKE MACHINE Contractor shall coordinate the Installations with those works of the Building Contractor and any other contractors and sub-contractors of the Building Contractor. The ICE FLAKE MACHINE Contractor shall note that the drawings supplied to him only indicate the approximate locations of the Installations. He shall make any modification reasonably required of his programme, work sequence and physical deployment of his work to suit the outcome of work coordination or as necessary and ensure that all cleaning, adjustment, test and control points are readily accessible while keeping the number of loops, cross-overs and the like to a minimum.

No work shall be carried out before approval of shop drawings or equipment has been given by the Engineer. It is the ICE FLAKE MACHINE Contractor's responsibility to co-ordinate all Mechanical works to match with the structure of the building and the proposed arch and interior

design of the building including but limited to ducts, grilles, equipment, pipes, light fittings, false ceiling layout and other services to allow a completely symmetrical and coordinated installation. ICE FLAKE MACHINE Contractor shall prepare section as required to demonstrate all constraints and coordinate the same for resolving any conflicts among the services. Contractor shall ensure that all required access, clearances and false ceiling heights are achieved as per the requirements are achieved.

Cooperation with Other Contractors

The ICE FLAKE MACHINE Contractor shall cooperate at all times with the Building Contractor and all other contractors and sub-contractors of the Building Contractor in order to achieve efficient workflow on the Site.

Any significant problems beyond the ICE FLAKE MACHINE Contractor's control shall promptly be reported to the Engineer.

Access doors shall be provided by the Contractor as required to provide proper access to all ducts, dampers, fans and all other concealed items which are located above ceilings or in walls and in partitions, whether such accesses are shown in the drawings or not. The omission shall be brought to the attention of the Engineer before installation of equipment. All access doors shall be properly designed, sized and located to suit the service required or as directed by the Engineer and to his satisfaction.

Site Supervision

The ICE FLAKE MACHINE Contractor shall keep on the Site a competent and technically qualified site supervisor to control, supervise and manage all his works on Site. The site supervisor shall be vested with suitable powers to receive instructions from the Engineer.

All tradesmen must be experienced in the trade and the work carried out shall be consistent with good practice in Kenya and to the satisfaction of the Engineer. In this connection, the ICE FLAKE MACHINE Contractor's attention is drawn to the Special

Sample Board

The materials offered for approval shall be strictly in accordance with the specifications and tender drawings. The contractor shall submit in triplicate, the technical literature for each item of the equipment, he intends to use for the project, to the consultant for the necessary review and approval. If in case the technical literature is not available, then a sample shall be submitted in the absence of either of these, typed technical data shall be submitted duly supported by telex / letter of the manufacturer for confirmation. In case of items involving fans, dampers etc., and samples must be submitted for approval along with the materials submittals. Each copy of the submittals shall be numbered and signed with the technical literature clearly highlighted, indicating the model, type and capacity of the equipment offered. The consultant shall retain two for copies and return one, either Approved or Not Approved, to the contractor. The contractor shall maintain and submit a status report every month, of all the Materials submittals of the Plumbing Materials & Equipments in the following proforma to the consultant:

- ix. Submittal Number
- x. Type of Material
- xi. Manufacturer / Local Agent
- xii. Date of Approval
- xiii. Date of Order / Order Number
- xiv. Mode of Delivery (Air, Land or Sea)

- xv. ETA on Site
- xvi. Status as on date of Report

Within 4 weeks of the acceptance of his Tender and prior to the commencement of the Installations, the ICE FLAKE MACHINE Contractor shall submit to the Engineer for approval a sample board of essential components proposed to be used in the Contract. However, the ICE FLAKE MACHINE Contractor may request the Engineer in writing for a longer period for submission if 6 weeks are practically insufficient.

Items displayed shall be deemed to be adequate for the Installations unless otherwise clearly indicated. Each sample, with clear numbering and labeling, shall be firmly fixed onto a rigid wooden or metal board. A list shall also be affixed on the sample board to show the item description, make and brand, country of origin and locations of installation (if not generally used). Samples rejected by the Engineer shall be replaced as soon as possible. Upon approval of all items, the Engineer will endorse the list on the sample board and the ICE FLAKE MACHINE Contractor shall deliver the board to the site office for reference.

Material Inspection

The contractor shall inform the consultant within one week upon receipt of all the materials at the site and arrange for the inspection of the same. Any material used at site which is not approved earlier specifically shall stand rejected without notice. Any item on supply differs from the one shown on the submittal catalogue copy or the sample submitted shall also be rejected at site. In such cases, the contractor shall make a fresh submittal for the item and obtain approval from the Consultant. Any time delay caused due to the above shall be on the Contractor's account. The contractor shall have to remove the rejected materials from the site and

replace with approved materials at his own expenses. In the event the contractor fails to do so, the client shall have the liberty to carry out such works from other agencies and debit the ensuing amount to the Contractor.

Equipment Deviations

Subsequent to the award of the Contract, and only in exceptional circumstances where it is demonstrated in writing by the ICE FLAKE MACHINE Contractor that the original equipment offered cannot be obtained, the Engineer may consider and accept, in writing, alternative equipment and materials proposed by the ICE FLAKE MACHINE Contractor provided always that these are fully in compliance with the relevant Specifications and Drawings and do not impose any additional contractual or financial liabilities onto the Employer.

In the event that the approved alternative equipment or material is lower in price than the original offered equipment or material, the net difference in price between the original offered equipment or material and the approved alternative equipment or material with the executed quantities of the relevant work item shall be deducted from the Contract Sum in accordance with the Contract. The Contract Sum, however, shall not be adjusted where the approved alternative equipment or material is higher in price than the original offered equipment or material.

Drawings and Manuals

Drawings in Electronic Format

The ICE FLAKE MACHINE Contractor shall provide drawings in electronic format as required in the following clauses. These drawings shall conform to the latest version of CAD Standard.

Installation Drawings

Drawing Submission Schedule

The Plumbing tender drawings related to this project have been listed in the Schedule of Drawings enclosed with the specifications. The tender drawings have been prepared to show the tenderer the principal equipment and general arrangement required for the project. These drawings do not indicate every detail of the work. It is the Contractor's responsibility to check the positions / locations at site. All dimensions are tentative and shall be checked with the Architectural and Structural drawings. Any discrepancy shall be brought to the attention of the consultant, in writing at the time of tender. Particular attention shall be paid to the positioning of disc valves, duct work, and other accessories, in relation to the Interior finishes and locations of various appliances. The Contractor is deemed to have studied the services drawings based on all the local regulations and have included in his prices for all builders' work associated with these drawings.

The ICE FLAKE MACHINE Contractor shall submit a detailed installation drawing submission schedule and programme to the Engineer. The ICE FLAKE MACHINE Contractor shall allow reasonable time in the programme for vetting of the installation drawings by the Engineer and for drawing resubmissions as necessary.

The ICE FLAKE MACHINE Contractor shall provide at least 6 hard copies and one electronic copy, unless otherwise specified in the Contract or the Sub-contract as appropriate, of the approved installation drawings to the Engineer for distribution.

Unless otherwise indicated or instructed, the ICE FLAKE MACHINE Contractor shall, in the stated or in adequate time before each section of the work proceeds, prepare, and submit for acceptance by the Engineer, detailed installation drawings and/or shop drawings (which may also be referred to as working drawings) to demonstrate how they propose to install the works both in 'Detail' and 'Form' to facilitate the practical installation. These drawings shall be fully dimensioned and shall be based on the basic intentions of the Drawings but shall not be simply a copy of them.

Size of Installation Drawings

Drawings submitted by the ICE FLAKE MACHINE Contractor shall only be of standard sizes from A0 to A4 or B1 size as stipulated in ISO 5457:1999.

ICE FLAKE MACHINE Contractor's 'Installation Drawings' and/or 'Shop Drawings' shall be prepared to such scales that will clearly show all necessary details.

The drawings shall be prepared to the same sheet sizes and scales as used for the ultimate 'As-Installed' record drawings.

Contents of Installation Drawings

In accordance with the provisions of this General Specification and as stated elsewhere in the Contract, the installation drawings must incorporate details of the actual plant and equipment items as approved by the Engineer.

The ICE FLAKE MACHINE Contractor shall ensure all installation drawings are accurate representation of the Installations, before submitting them to the Engineer. All installation drawings shall be fully dimensioned and

suitably scaled showing construction, sizes, weights, arrangements, operating clearances and performance characteristics.

d) "Installation drawings" shall generally include, but not limited to, the following: -

- Symbols and notations same as and compatible with the Drawings' standard;
- Complete layout/assemblies including all necessary minor items and accessories;
- Positions of all fixings, hangers and supports;
- Maintenance spaces for all withdrawable items,

e) Ductwork Installation Drawings

Prior to the commencement of any manufacture, fabrication, or installation, the ICE FLAKE MACHINE Contractor shall submit to the Engineer for technical appraisal installation drawings for the ductwork installation. Generally, the drawings shall be drawn to a scale of not less than 1:50. Subject to the Engineer's approval a scale of 1:100 may be adopted where the installation is a simple one.

The locations of evaporator, condenser, compressor, storage bins and harvesting mechanism etc., as indicated on the tender drawings is tentative and may require some variation to suit the site requirements. The exact positions must be checked and shown on the detailed working drawings as indicated on the detailed architectural drawings and coordinated with furnishing and other services.

The drawings shall indicate the location, with dimensions given, of all ductwork in relation to the building structure and other pipework and equipment.

Positions and details of all hangers and supports shall be shown and the positions dimensioned.

Positions of thermostats, thermometers, test pockets and similar devices shall be shown and dimensioned including clearances required for their removal.

Details and outline of insulation and insulation boxes shall be shown including clearances required for removal of the boxes.

f) **Special Plant Rooms Co-ordination Work**

Unless otherwise stated in the Contract, in the case of a plant room where the ICE FLAKE MACHINE Contractor's equipment constitutes the major item involved (i.e. as in the case of pump room), the ICE FLAKE MACHINE Contractor shall allow in the Tender for taking effective responsibility for the coordination of other services/building details within these specific areas.

Manufacturer's Shop Drawings

The manufacturer's shop drawings are drawings for equipment or plant to be manufactured by a specialist manufacturing supplier in their own workshops and places away from the Site.

The drawings shall show detailed construction, principal dimensions, weights and clearances for maintenance, etc. Immediately after placing of any order or at any event within 4 weeks unless otherwise approved in writing by the Engineer, the ICE FLAKE MACHINE Contractor shall forward to the Engineer for comment, 4 copies of manufacturer's shop drawings indicating detailed construction, principal dimensions and weights, clearances for withdrawals and/or cleaning, etc. No work shall proceed on or off Site unless drawings requiring approval are so approved in writing by the Engineer

Checking Drawings of Other Trades

The ICE FLAKE MACHINE Contractor shall follow the design intent of the Drawings in planning and carrying out the work and shall cross check with other trades in order to verify the line, level, space and sequence in which the Installations is to be installed.

If directed by the Engineer, the ICE FLAKE MACHINE Contractor shall, without extra charge, make reasonable adjustments to the proposed installation drawing layouts as are necessary to prevent conflicts with the work of other trades or for the proper sequence of and execution of Works. Where such modifications are of a nature and of such unforeseen complexity that they involve unreasonably extra work not covered by the Contract, they may be covered by variation order to be issued by the Engineer wherever such a requirement is justified.

As-Built Drawings

Submission of As-built Drawings

The ICE FLAKE MACHINE Contractor shall submit 3 sets of the first draft prints of as-built drawings within 28 days of the issuance of the certification of completion in accordance with the Contract to the Engineer for checking. The Engineer after checking the above draft prints shall return one set of the marked up copies of these as-built drawings to the ICE FLAKE MACHINE Contractor within 42 days from the date of submission of the ICE FLAKE MACHINE Contractor's draft prints with comments. The ICE FLAKE MACHINE Contractor shall within a further 28 days from the date of receiving the Engineer's comments on the draft as-built drawings re-submit to the Engineer for his approval another 3 sets of the second

draft prints of as-built drawings with the Engineer's comments incorporated. This process of submission and approval shall continue until the final approval of the Engineer on these as-built drawing is obtained.

The final approved as-built drawings shall be in 3 sets of hard copy and 3 sets of electronic copies. These shall be submitted within 21 days from the date of final approval. Each electronic copy shall be in the form of CD-ROM, labelled, with cross reference to a printed list of files explaining the contents and purpose of each file and supplied in sturdy plastic containers.

The detailed requirements and the media of as-built drawings set out in the Contract shall be followed as appropriate.

Size of As-built Drawings

As-built drawings shall only be of standard sizes of A0, A1 or B1 size as stipulated in ISO 5457:1999. Smaller size (A2 to A4) is accepted for installation drawings.

Content of As-built Drawings

The ICE FLAKE MACHINE Contractor shall ensure all as-built drawings are accurate representation of the Installations, before submitting them to the Engineer. The as-built drawings required to be provided by the ICE FLAKE MACHINE Contractor for various types of the Installations shall include, but not limited to the following: -

- (d) Plumbing and drainage layout plans such as pipe arrangement, valve arrangement, sanitary fitments arrangement, etc.;
- (e) System schematic diagrams; and
- (f) Installation details and assembly drawings such as pipework, sanitary fitments, etc. "As-built" drawings shall complete with all details to be used for commissioning purposes. Any amendments noted on these

drawings during the commissioning and test stage shall subsequently be transferred to the original "As-built" drawings once the amendments have been accepted by the Engineer

Operation and Maintenance (O&M) Manual

The ICE FLAKE MACHINE Contractor shall refer to the Specifications for any other requirements in O&M Manual.

The O&M Manual is for use by the maintenance agent of the completed Installations. It shall contain detailed technical information covering both operation and maintenance aspects of the Installations.

Operating and maintenance manuals shall contain the following:

- l) A description of the buildings to which services are applied stating their duty and functions,
- m) A listing and description of the services as installed,
- n) Details of the manufacturer's installation, operating and maintenance requirements which must be edited or otherwise reproduced to be specific for the installation.
- o) A detailed list of equipment supplied, manufacturer, address, telephone number and official order number/date,
- p) A schedule detailing the regular maintenance requirements with space for remarks and service history,
- q) A fault tree analysis of the system(s),

- r) A copy of the "As fitted" record drawings,
- s) Copies of all test and commissioning data including pre-commissioning check lists,
- t) A schedule giving the finally adjusted set points for plant, equipment and controls,
- u) A detailed listing of all spare parts giving part number and description, typical cost and availability,
- v) Any item deemed necessary by the Engineer to clearly identify to the use/operator the function and intended performance of the plant and system.

Damaged Material

Any plant or material that is damaged by any means whatsoever shall not be used in the works. Should the contractor wish to rectify such damage in order to utilize the plant or materials in the permanent works, the matter shall be brought to the attention of the Consultant, who in turn shall conduct a proper survey after which the necessary instructions shall be issued. Only after obtaining a written permission from the Consultant, shall any remedial work be carried out. Any damaged Plant or Material allegedly brought to a “as-new” condition following such a procedure, shall only be accepted after the technical appraisal & discretion of the Consultant, whose decision in such matters shall be final and binding.

23.1.2 INSPECTION, TESTING AND COMMISSIONING

General

Throughout the execution of the installation, the ICE FLAKE MACHINE Contractor shall be responsible for ensuring compliance with the Regulations included in Part A and shall notify the Engineer of any infringement which directly or indirectly detracts from the safe and satisfactory operation of the installation(s) whether or not such infringement relates to the works covered in the Contract or to those associated with others

The ICE FLAKE MACHINE Contractor is required to appoint a competent and experienced testing and commissioning engineer responsible for the overall planning, organizing, coordinating, supervising and monitoring of the testing and commissioning works and also certifying all results and reports from the testing and commissioning works. The PD Contractor shall submit, at the commencement of the Contract, information detailing qualification and experience of the testing and commissioning engineer for the Engineer's approval.

It is necessary to require the ICE FLAKE MACHINE Contractor to provide, at no cost to the Employer, all necessary equipment, apparatus, tools and materials for carrying out of testing and commissioning works.

The ICE FLAKE MACHINE equipment shall not be started until preliminary checks have been made on the correct rotation and installation of all

plant, and control system(s) have been correctly wired and are fully operational.

Where deemed necessary by the Engineer, plant and equipment shall be tested in sections to suit the building construction rate.

Master Programmed of Testing and Commissioning Works

The ICE FLAKE MACHINE Contractor is required to submit a programme for testing and commissioning works shall be submitted at the commencement of the Contract, usually within the first three months. The programme shall indicate the tentative dates of all tests and commissioning works that will be carried out throughout the whole contract and all necessary submissions and approval relating to testing and commissioning and ensure that the testing and commissioning programme matches the master programme for construction and that all testing and commissioning works are complete before the completion date of the Contract.

Inspection, Testing and Commissioning Methods and Procedures

The ICE FLAKE MACHINE Contractor is required to submit detailed inspection, testing and commissioning methods and procedures together with report formats for reporting inspection, testing and commissioning results for the Engineer's approval at least four months before commencement of testing and commissioning works, or four months after the commencement of the Contract, whichever is earlier

Labor and Materials

The ICE FLAKE MACHINE Contractor is required to be responsible for provision of all labour and both consumable and non-consumable

materials for carrying out testing and commissioning works at their expenses. Electricity supply, water and LP gas and town gas for carrying out of testing and commissioning works shall also be arranged and provided by the PD Contractor at no cost to the Employer

Supply of Inspection, Measuring and Testing Equipment

The ICE FLAKE MACHINE Contractor is required to supply the calibrated equipment and instrument for testing and commissioning works in accordance with the requirements as specified in the Particular Specification.

Readiness for Commissioning and Testing

The ICE FLAKE MACHINE Contractor is required to check the completion of the works to be tested or commissioned, the associated builder's works and the associated building services installations to ensure that testing and commissioning can be proceeded in a safe and satisfactory manner without obstruction.

"Type-test" for equipment shall be carried out at the manufacturers' works or elsewhere appropriate in order to demonstrate their compliance with the Regulation or requirements. "Type-test" certificates together with the corresponding drawings, sketches, reports and any other necessary documents shall be submitted to the Engineer for approval before delivery of the equipment.

Prior to the testing and commissioning works, the ICE FLAKE MACHINE Contractor shall check the completion of the installation works, associated builder's work and related building services installations, to ensure that commissioning can be proceeded without obstruction. Before any

installation is subjected to commissioning and site testing, it shall be thoroughly cleaned both internally and externally. All pipes shall be thoroughly cleaned and flushed before filling with water.

The ICE FLAKE MACHINE Contractor shall be responsible for initially setting the plants to work including:

- g) Preliminary checks to ensure that all systems and system components are in a satisfactory and safe condition before start up;
- h) Preliminary adjustment and setting of all plant and equipment consistent with eventual design performance;
- i) Carrying out testing and balancing other tests required before energizing the equipment and plant;
- j) Checking the proper functioning of the protective devices and safety valves in the installation and carrying out all necessary safety testing;
- k) Energizing and setting to work on all plants; and
- l) Initial regulation and demonstration that the installation delivers the correct rate of flow at the conditions specified in the Contract

For specialist plant or equipment, the ICE FLAKE MACHINE Contractor shall arrange for it to be commissioned, certified and tested by the manufacturer's skilled commissioning engineer and/or technician.

The ICE FLAKE MACHINE Contractor is required to provide advanced notice for inspection, testing and commissioning works as follows: -

- c) Off-site Inspection and Testing

An advanced notice of at least one week before commencement of the inspection or test shall be provided.

- d) On-site Inspection, Testing and Commissioning

An advanced notice of at least 4 calendar days before commencement of inspection, testing or commissioning shall be provided.

Documentation and Deliverables

The ICE FLAKE MACHINE Contractor shall record all commissioning information and testing results at the witness of the Engineer or his representatives. Commissioning and testing record shall be properly checked and certified by contractor's Testing and Commissioning Engineer and signed by the Engineer or his representative who has witnessed the testing or commissioning before submission to the Engineer. The PD Contractor shall submit full commissioning and testing report to the Engineer within 14 calendar days after completion of commissioning and testing of the installation.

Testing and Commissioning - Definitions

For the purpose of this General Specification the following definitions shall apply: -

Commissioning: the advancement of an installation from the stage of static completion to full working conditions and to meet the specified requirements. This will include setting into operation and regulation of the installation.

Setting to work: the process of setting a static system into motion.

Off-site Tests: tests carried out on items of equipment at manufacturer's works or elsewhere to ensure compliance with the requirements of Specifications and/or relevant Standards or Codes of Practice (or other standards specified).

Site Tests: tests on static plant and systems (e.g. inspection and testing of welds, pressure loss duct work, etc.) to ensure correct and safe installation and operation.

Regulation: the process of adjusting the rates of fluid flow and heat transfer in a distribution system within specified tolerances as stated in the relevant CIBSE Commissioning Code.

Performance Testing: the measuring and recording of the performance of the commissioned installation.

Testing and Commissioning - General

Any defects of workmanship, materials and performance, maladjustments or other irregularities which become apparent during commissioning or testing shall be rectified by the ICE FLAKE MACHINE Contractor at no cost to the Employer and the relevant part of the commissioning or testing procedure shall be repeated at the ICE FLAKE MACHINE Contractor's expenses.

The entire testing and commissioning procedure shall be undertaken by the ICE FLAKE MACHINE Contractor's own competent specialist staff or by a competent Independent Commissioning Specialist nominated by and acting for the ICE FLAKE MACHINE Contractor and approved by the Engineer.

Where specified in the Particular Specification, the ICE FLAKE MACHINE Contractor shall nominate a competent independent Specialist to conduct commissioning work.

Where specified in the Particular Specification, the ICE FLAKE MACHINE Contractor shall employ an approved specialist testing and commissioning firm who shall be named in the returned Tender Documents.

At the appropriate time in the Contract, usually within the first three months, the ICE FLAKE MACHINE Contractor shall furnish the Provisional Testing and Commissioning Programme, methods, procedures and formats of test records to the Engineer. This shall be updated as the work progresses towards completion.

Unless otherwise indicated, all electricity, main water and other fuels, such as town gas, necessary for the operation of the plant during preliminary runs and for full adjustments and commissioning tests will be provided at no cost by the ICE FLAKE MACHINE Contractor unless otherwise specified in the Contract.

Off-Site Tests

Where the specified Standards or Codes of Practice stipulate, "type-tests" on items of equipment to demonstrate compliance shall be carried out at the manufacturer's works or elsewhere as appropriate. In all cases, "type-tests" Certificates shall be submitted in duplicate to the Engineer.

Site Tests

The ICE FLAKE MACHINE Contractor shall carry out "on-site" tests in respect of all static systems to ensure safe and proper operation as conforming to the design intent. Such tests shall include test of welds and pressure tests on the hydraulic systems.

Inspection and Testing During Construction Period

Periodic Site Tests

Site inspections of "work in progress" will be made by the Engineer or the representative from time to time. The ICE FLAKE MACHINE Contractor shall keep such inspection record for checking from time to time. Installations to be permanently covered up shall be subjected to inspection and test before cover up. During the inspection, if the Engineer discovers any work that has been covered up before inspection and testing, this work shall be uncovered for inspection and testing to the Engineer's satisfaction. The cost involved in uncovering the work, inspecting, testing and re-concealing the work together with any consequential losses shall be paid by the ICE FLAKE MACHINE Contractor at no additional cost to the Employer.

Test at Factory

The ICE FLAKE MACHINE Contractor shall note that the Engineer may require witness of tests and inspections of locally and/or overseas manufactured equipment during construction at the manufacturer's works. Where this requirement is indicated in the Contract Documents, the ICE FLAKE MACHINE Contractor shall allow for making the necessary arrangements; including and indicating the Engineer's travel and subsistence expenses in the Contract

Factory Test Certificates

Certificates of all hydraulic and other manufacturers' tests carried out at the manufacturers' works shall be forwarded in duplicate to the Engineer

for approval. This approval shall normally be required before the materials or apparatus are dispatched from the manufacturer's works.

Where specified, the ICE FLAKE MACHINE Contractor shall subject certain materials and equipment to be tested by the recognized institutions or laboratories and submit the type test certificates to the Engineer for approval.

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Documents and Data Required for Hand-Over

General

The ICE FLAKE MACHINE Contractor shall note that the system cannot be handed over until all the foregoing requirements (where applicable) have been carried out to the satisfaction of the Engineer.

Test Certificates

Before the handover inspection, the ICE FLAKE MACHINE Contractor shall provide the follow test/record certificates where applicable: -

- e) Copies of manufacturer's works tests/record certificates on plant items
- f) Copies of tests/record certificates for works carried out on Site;

"As-built" Drawings

All necessary copies of "As-built" drawings as detailed in the Contract Documents and this General Specification shall be provided upon handover.

Operation and Maintenance Manuals

All necessary copies of Operating and Maintenance Manuals as detailed in the Contract and this General Specification shall be provided upon handover.

Manufacturer's Name Plate

Every item of plant supplied by a manufacturer shall be fitted with a clearly engraved, stamped or cast manufacturer's name plate properly secured to the plant item and showing: -

- Manufacturer's Name;
- Serial and/or Model No.;
- Date of Supply;
- Rating/Capacity; and
- Test and Static Pressure (where applicable).

Labels and Related Instructions

Labels and notices shall be supplied and installed for all valves and piping to facilitate operation and proper maintenance of the Installation. All labels shall make cross reference to the operation and maintenance manuals and as-built drawings

All wording shall be in both Kiswahili and English. All labels shall be of adequate size as to give clearance between lettering and fixings to ensure an aesthetic arrangement on completion.

24 SECTION 25- TECHNICAL SPECIFICATIONS (BOREHOLE)

24.1 TECHNICAL SPECIFICATIONS

24.1.1 GENERAL SPECIFICATION - GENERAL REQUIREMENTS

Introduction

These specifications cover the construction of the works and shall be read in conjunction with the Contract Documents as listed in the Instructions to Tenderers

All references given are intended solely for the convenience of those using the above documents and shall be in no way exclude the application of the other clauses in the documents which may, in the opinion of the Engineer have any bearing on the point in question.

• Scope of Works

Scope of works shall include but not limited to;

- i. Preparation of hydrogeological surveys report
- ii. Drilling, casing, gravel packing, development and test pumping of borehole.
- iii. Equipping of the borehole with submersible pumps and switch gear.
- iv. All related electrical installation works.
- v. All related civil and plumbing works and connection to the existing reticulation system.

Quality and Approvals

In view of the specialized nature of the drilling work, drilling may only take place under the direct supervision of the Engineer who will provide an on-site supervisor

at all times. The Engineer will provide instructions regarding borehole depths and depths for screen installation and will supervise the placing of the gravel pack as well as borehole development and aquifer testing and water quality sampling.

Change

When the Contractor experiences particular technical problems and he or his operator seeks help or advice from the Employer and/or the Engineer and this is granted, it will only be on the condition that the Employer and/or the Engineer does not accept responsibility, if such advice or help does not lead to a successful solution of the problem, or results in damage to the Contractor.

The Contractor shall provide all ladders, access lighting facilities and assistance and all things necessary required by the Engineer to inspect any part of the Works.

The materials and workmanship shall be the best of their respective kinds and to the approval of the Engineer. The words “to the approval of the Engineer” shall be deemed to be included in the description of all items relating to design, construction, installation and materials and workmanship for the due execution of the Works.

The Contractor shall submit all data, details and samples as necessary and as reasonably requested by the Engineer of all materials that the Contractor proposes to use in the Works. Method statements which adequately demonstrate the Contractor’s proposed method of working, methods of maintaining safety and compliance with the programme shall be submitted for the Engineer’s approval prior to the commencement of work on any area of the Site.

Where the Contractor is responsible for the preparation of construction documents to describe the permanent works, such construction documents shall be approved prior to the procurement of any materials or commencement of any

work to which the documents relate. No materials, Plant or equipment shall be procured for the Contract and no work, permanent or temporary, shall commence without first obtaining the Engineer's approval.

All materials, Plant and equipment supplied shall be designed for operation under the above described conditions.

Construction Documents

Drawings and Documents which are to be submitted by the Contractor to describe the Permanent Works shall become Construction Documents upon their approval.

All drawings, technical specifications, bill of quantities, schedules, cost estimates; programme and other information to be submitted by the contractor shall be in English and shall be submitted for approval in triplicate. Following approval, the contractor shall supply a further five copies to the Engineer. Construction Documents shall not be departed from without the approval of the Engineer.

All drawings and documents submitted by the Contractor shall have been checked, signed and be ready for issue and shall bear:

- Title of the drawing or document;
- Scale;
- Date;
- Work item reference number complying with an approved numbering system;
- Name and references of the Contractor;
- Names of the employer and the Engineer;
- Date of approval by the Contractor and the signature of the person responsible for approval

Drawings and documents submitted for approval shall be delivered to the Engineer's office as designated by the Engineer.

Unless otherwise specified, the Contractor shall allow a minimum of 14 days, after the date of receipt by the Engineer for approval of drawings and documents by the Engineer.

Operation and Maintenance Manuals

The Contractor shall submit to the Engineer for approval four copies of the Operation and Maintenance (O&M) Manuals.

The Contractor shall supply the final version of the O&M Manuals prior to the issue of the Taking-Over Certificate for either the whole of the Works or the respective Section or part of the Works. Each set shall be bound together in a stout plastic or other approved cover.

O&M Manuals shall be supplied written in English language, all parts and equipment listings shall be in English

Level Datum

Before the commencement of constructional work the Contractor shall establish, in a position to the approval of the Engineer, steel datum pegs which shall be securely concreted in. The level of these pegs shall be established and agreed with the Engineer and all levels used in the construction of the Works shall be referred to these established datum points. The correctness of this datum shall be checked at regular intervals during the construction period as agreed with the Engineer.

Where possible construction drawings and all levels used for construction shall be referred to the national height datum as defined by the Survey of Kenya. The

Contractor shall be responsible for obtaining the location and values of the permanent bench marks. In cases where such bench marks do not exist, the site datum shall be agreed with the Engineer.

Setting Out of the Works

The site layout drawings show indicative site layouts. Prior to commencing construction, the Engineer will agree with the Contractor the basic information supplementary to that shown on the Drawings such as the position of manholes, chambers, centre-lines and base- lines sufficient for the Contractor to locate the Works.

The Contractor shall prepare detailed setting out drawings and data sheets as necessary and submit them to the Engineer in triplicate for approval. Any modifications to the setting out drawings or data sheets required by the Engineer shall be made by the Contractor and resubmitted for final approval. Should it be necessary during setting out or during construction for the approved setting out details to be amended, the Contractor shall amend the drawings or data sheets or make new ones for approval as required by the Engineer.

For pipelines, the Contractor shall in the presence of the Engineer set-out the pipeline alignments in accordance with the indicative alignments shown on the drawings taking into account physical features on the ground, any existing services, any requirements of relevant Authorities and any changes deemed necessary by the Engineer, confirming the locations of all valves, air valves, washouts, hydrants and bends.

The Contractor shall prepare and submit to the Engineer, at an approved scale, plans of the pipeline route and profiles of ground levels after any initial clearing of the way-leave or easement showing the proposed pipe invert levels and precise

chain ages for all valves and fittings for approval. Following approval the Contractor shall submit to the Engineer two copies of the agreed alignment and profiles.

Boundaries of Works

The Employer shall provide the Site upon which the Permanent Works are to be constructed. Where a drain or pipeline is to be within an existing road or track reservation or is otherwise located in land designated Public Domain the Site width will be restricted to the limit of the public land. The existing boundary fences and walls shall not be disturbed without prior approval of the Engineer and, unless road diversions and closure notices are approved and posted, carriageways shall be left available for the safe passage of traffic.

The Employer or the Engineer will obtain the necessary permission for access to the drilling sites, but if any access road or bush clearing to provide access to the drill sites will be the responsibility of the drilling Contractor. The contractor shall make own investigation to satisfy themselves on level of scope related to site access and maintain the access throughout the contract It is a recommended to use locally available unskilled labour for this purpose. The Contractor at his own cost will repair any damage to the surface of any private roads, fences or gates by the contractor's plant and equipment. Drilling mud pits and others must be properly filled and levelled after completion of the drilling activities.

Any other damage to private property will be handled strictly according to the General Conditions of Contract.

The Contractor shall not enter upon or occupy with men, tools, equipment or materials any land other than the site without the written consent of the owner of such land.

On occupation of the Site or other land the Contractor shall provide such fencing, as required.

Work through Private Land

In order that the necessary parts of the Site which are on private land may be obtained the Contractor shall supply the Engineer with full information of his programme sufficiently in advance of the dates upon which the Contractor proposes to enter upon each area of the Site. The Contractor shall where required, in consultation with the Engineer, programme the Works to designate the areas of the Site to which the Contractor is to be given possession and the sequence of taking possession.

The Contractor shall obtain written approval before entering upon any private land or cutting through ditch, bank, hedge, wall, fence or any other form of boundary marking and he shall carry out all reasonable requirements as approved by the Engineer in the matter of reinstatement.

Public Utility Mains and Services

Where the Contract indicates the positions of existing services or apparatus the positions shown are believed to be correct but no warranty is given as to the accuracy or completeness of the information.

It shall be the responsibility of the Contractor to obtain all information available from the Public Utility Authorities regarding the position of existing mains and services and he shall copy this information to the Engineer as soon as he obtains it.

The Contractor shall carry out excavation works in a manner which safeguards any existing services, including hand excavation as necessary and shall be responsible for

the cost of any repair work necessitated by damage caused by him to any main or service and for any costs arising from the disruption.

The Contractor shall obtain all information and assistance from the Public Utility Authorities for the locating of the mains and services and shall agree with the Engineer any trial excavation which may be necessary to confirm or establish these locations.

The Contractor shall be responsible for locating all existing services, whether known to the Public Utility Authorities or not, and shall conduct his own survey as necessary to accurately locate all services. All efforts to identify these existing services shall be carried out in advance of conducting excavation for the permanent works.

Any temporary or permanent diversion of mains and services shall be agreed with the appropriate Authority.

Safeguards to Existing Pipes, Cables, Structures

It shall be the Contractor's responsibility to safeguard by means of temporary or permanent supports or otherwise all existing sewers, pipes, cables, structures or other things which would be liable to suffer damage if such precautionary measures were not taken.

Safeguards shall be to the approval of the Engineer and of the undertaker or owner concerned.

Records and Drawings

Daily drilling records must be kept in duplicate by the contractor for each borehole in progress on the form provided. In addition the contractor shall provide separate

records for each borehole upon completion (borehole completion form). The relevant information needed to be contained in these records.

The daily drilling record must be signed by both the drill operator for the contractor, and the Engineer's representative on site at the end of each daily shift. It shall be prepared in duplicate in English language. The Engineer will retain the original. The contractor for invoice completion shall use the completed daily drilling records.

The work sheets will contain the following information:

a) Drilling Rig

- i. The location of drilling site.
- ii. Make, model, type & size of drilling rig.
- iii. Statement of each operation conducted and time taken, including breakdowns, including type of work performed and number of hours on each type of work.
- iv. Names of all crewmembers.
- v. Size of hole and meters drilled per shift.
- vi. Log of soils penetrated.
- vii. Length and size of casing installed
- viii. Length and size of screen installed.
- ix. Length and size of observation pipe installed
- x. Length and volume of gravel pack, seal or back fill emplaced
- xi. Any problems encountered.
- xii. The result of bail tests, mud monitoring or other tests carried out.
- xiii. Total standby time to the nearest minute.
- xiv. Well logging
- xv. Development method and time to the nearest minute

b) Test pump Unit

- i. Location.
- ii. Make, model & capacity of test pump.
- iii. Statement of each operation conducted and time taken, including breakdowns, including type of work performed and number of hours on each type of work.
- iv. Names of all crewmembers.
- v. Test pump setting.
- vi. Size of test pump column.
- vii. Total test-pumping time in minutes (total time must agree with pumping test data sheet).
- viii. Total standby time to the nearest ¼ hour.

For sites where the Contractor undertakes permanent works Record Drawings shall be submitted to the Engineer, for approval, in the form of As Built Drawings. Record Drawings shall be prepared to an approved format, and scale in line with the construction drawing.

Connections to Existing Pipes, Cables and Equipment

The Contractor shall be responsible for joining up and making connections between pipes and cables laid by him and existing pipes and cables. The Contractor shall submit to the Engineer a drawing showing the details of the connection, and shall state the date on which the particular connection is required, and the work shall not proceed until the Engineer's approval has been given.

The Contractor shall be responsible for ensuring the compatibility of new pipes and cables with existing pipework, cables, tubing and equipment.

Lighting, Watching and Traffic Control

Where necessary for safety of the public or where required by the Engineer, the Works shall be properly fenced and signed. In addition, the Works shall be lighted from half an hour before sunset until half-an-hour after sunrise and at other times when visibility is poor. The position and number of the lamps shall be such that the extent and position of the Works are clearly defined. Each Site shall be provided with watchmen as required.

Contractor's Offices

The Contractor shall provide and maintain offices for the use of his representative and staff to which written instructions by the Engineer can be delivered. Any instructions delivered to such offices shall be deemed to have been delivered to the Contractor.

Offices shall be located to give convenient access to the Works and shall be subject to the approval of the Engineer. The Contractor shall be responsible for obtaining the land on which to establish any temporary site offices.

The contractor shall be responsible for making all arrangements for the proper disposal of waste.

Water and Electricity Supplies

The Contractor shall make all arrangements for and provide adequate supply of potable water to each site as necessary for the execution and testing of the Works and for use by his workmen.

The Contractor shall make arrangements for and provide any electricity supply required for the execution of the Works, including the Tests on Completion.

Contractor's Staff and Workmen

The Contractor shall agree to employ Kenyan workers to the maximum extent possible. The Contractor shall provide a competent Site Agent to the approval of the Engineer to be in charge of the work who shall not be changed except with the consent of the Engineer.

The Contractor agrees that his workmen and employees shall be considered for all purposes in his direct pay and employ and under his supervision and control. He shall be directly and personally responsible for discharging all obligations, financial or other, which may be or becoming owing to any such workman or employee or to his successors, assignees or personal representatives. There shall be no contractual or legal relations of any kind whatsoever between the Employer and any such workman, employee or any person employed in the performance of the Contractor's obligations under this Contract.

The Engineer may request and the Contractor agrees to accept the request for the immediate removal from the site of any employee or worker of the Contractor adjudged by the Engineer to be incompetent, disorderly, and unreliable or of bad character. Such employee shall not again be employed on the Works.

Project Management

- **Project Control**

The Contractor shall provide within his site organization a project management capability to advise and be directly responsible to the Site Agent. (Contractor's chief site representative) The duties of the section shall include the following:

- a) Planning and programme preparation particularly in relation to the requirements of the Employer and the public authorities, and the requirements to maintain water supply and waste water disposal services where careful detailed arrangements have to be made and adhered to.
- b) Planning the execution of the Works in a manner which minimizes disruption to the water supply system and will permit the efficient and effective commissioning of the water supply system and their respective components.
- c) Ensuring adequate potable water supplies and wastewater disposal services are maintained to all consumers.
- d) Continuous surveillance of progress and anticipation of factors likely to affect the timely performance of the Contract.
- e) Making proposal for modification to forward planning and to the programme at an early stage in the light of factors resulting from (d) above.
- f) Continuous appraisal of the Contractor's methods and routines particularly as to their effect on the community and property.

- g) Forward planning for resource requirements taking due account of possible shortages and delays in the arrival on site of materials, equipment, plant and personnel and their mobilization for effective usage.
- h) Acquisition and process of up-to-date information for progress meetings with the Engineer. The preparation of monthly progress reports including an update of the detailed programme and cash flow forecast which shall include progress photographs as directed by the Engineer.

The Contractor's project management staff shall be of adequate ability and experience. Programmes shall be based upon Critical Path Management (CPM) networks in precedence format and shall be prepared using a suitable PC-based project management software package approved by the Engineer.

Reporting shall be in a manner compatible with the Employers project management procedures and shall use the Earned Value (EV) Technique and shall monitor the actual gross value of work completed against the predicted value.

- **Monthly Statements and Certificates**

Monthly statements and certificates shall be submitted in an approved manner and format. In addition to the statements submitted in hard copy the Contractor shall submit a computer copy using data base software as prescribed by the Engineer. The statements and certificates shall detail the measured value of the work completed on each item of the Works in such detail that the Engineer can identify location and measurement of each item. A location shall constitute a single structure such as a reservoir, pump station or section of a pipeline or a component of a system such as a pipeline valve complex.

Each item shall be uniquely identified in accordance with the numbering system as instructed by the Engineer.

- **Progress Meetings**

The Contractor shall provide a suitable venue, near the vicinity of the Site, and arrange progress review meetings to be chaired by the Engineer at monthly intervals to coincide with submission of monthly progress submissions. The Contractor shall allow for attendance by the Engineer and up to 4 representatives of the Engineer's or Employer. The meetings shall be attended by the Contractor's senior representatives, Site Agent and other members of his senior staff as may be deemed necessary.

Equipment for the Employer

The Contractor shall hand over to the Employer on completion of the Works a complete set of tools and equipment together with spare parts and fittings to facilitate the maintenance and operation of the installed works.

Facilities for Survey and Inspection by the Engineer

The Contractor shall make available technicians and such labour, materials and safety equipment as the Engineer may require for inspections and survey work in connection with the Works. The Contractor shall provide all necessary tackle, test equipment, access, labour, staff and any other thing the Engineer may reasonably require in order that he may safely, conveniently and quickly carry out such inspections as he deems necessary at any time during the execution of the Works and during the Defects Liability Period. The Engineer, his representative and assistants, shall not inspect any area of the Works where they deem the safety

provision to be inadequate and the Contractor shall undertake any work required by the Engineer in order to make it safe.

Inspections by the Engineer during Defects Liability Period

The Engineer will give the Contractor due notice of his intention to carry out any inspections during the Defects Liability Period and the Contractor shall thereupon arrange for a responsible representative to be present at the times and dates named by the Engineer. This representative shall render all necessary assistance and shall record all matters and things to which his attention is directed by the Engineer.

Protective Clothing and Safety Equipment

The Contractor shall provide for the Engineer, his Representative and assistants any additional protective clothing and safety equipment necessary for the proper discharge of their duties on the Site.

The Contractor shall provide any necessary protective clothing and safety equipment for the use of authorized visitors to the site including the Employer and his staff and representatives and those of any relevant authority who have reason to visit the Site.

Language of Correspondence and Records

All communications from the Contractor to the Engineer shall be in the English language. All books, timesheets, records, notes, drawings, documents, specifications and manufacturers' literature shall be in the English language. If any of the aforementioned is in another language a certified translation in English shall be submitted to the Engineer.

Standards and Regulations

Each and every part of the Works shall be designed, constructed, manufactured, tested and installed in accordance with an internationally recognized standard, Code of Practice, or Regulation applicable to that part of the Works.

Such standards and codes shall include:

- i. British Standard Specification last published.
- ii. International Electromechanical Commission, where available (IEC).
- iii. International Organization for Standardization (ISO).

The Contractor shall provide and keep permanently on site copies of such standards as may be directed by the Engineer and shall make them available to the Engineer as required.

Equivalency of Standards and Codes

Wherever reference is made in the Contract, including Specifications, Drawings and Bill of Quantities, to specific standards and codes to be met by the goods and materials to be furnished, and work performed or tested, the provisions of the latest current edition or revision of the relevant standards and codes in effect shall apply, unless otherwise stated in the Contract. Where such standards and codes are national, or relate to a particular country or region, other authoritative standards that ensure a substantially equal or higher quality than the standards and codes specified will be accepted subject to the Engineer's prior review and written consent. In the event the Engineer determines that such proposed deviations do not ensure substantially equal or higher quality, the Contractor shall comply with the standards specified in the Contract.

Quality Control

The Contractor shall be responsible for his own quality control and shall provide sufficient competent personnel for supervising the Works, taking and preparing samples and for carrying out all necessary tests.

Units

The International System of (metric) Units as set out in ASTM E380 shall be used throughout the Contract except where otherwise provided.

Inspection and Testing during Manufacture

The performance of each item of Plant or Pipe shall be tested in accordance with the specification to the requirements of the Engineer.

Test certificates in triplicate shall be submitted by the Contractor to the Engineer within 2 weeks of the date of the tests. Type tests are not acceptable. Test certificates shall be supplied for tests carried out on the actual Plant being supplied.

Plant shall not be dispatched from the manufacturer's works until it has passed the specified tests and approval been given by the Engineer.

The Engineer shall at his discretion witness tests of individual items of Plant at the manufacturer's works. The Engineer shall be given three weeks' notice in writing before such tests are to take place.

The acceptance by the Engineer of any item of Plant or equipment after testing at the manufacturer's works shall in no way relieve the Contractor of his responsibility for the correct performance.

CONFORMITY VISIT FOR DRILLING RIGS AND CONTRACTOR'S EQUIPMENT

Before erection of the drilling rig at the first borehole location, the Engineer will verify that the Contractor's has mobilized the equipment listed in the Contract. No authorization to start the drilling works will be given if equipment is not mobilized as listed.

At any moment during drilling operations, the Engineer may interruption works operations if the equipment mobilized by the Contractor differs from those listed in the Contract.

24.1.2 METHOD FOR BOREHOLES CONSTRUCTION

1.1.1.1 Location of boreholes

The final locations of boreholes will be given by the Engineer, with a minimum 5 days' notice before erection of rig at site.

1.1.1.2 Drilling techniques

- **Depth and boreholes design**

The boreholes to be drilled will be required to penetrate thickness up to 10 m to 20 m soil or poorly consolidated sediments. The contractor should indicate clearly in

his proposal the drilling technique he will operate for drilling the first poorly consolidated levels.

The required drilling technique is rotary drilling with bentonite accepted in the drilling fluid (see for characteristics of the drilling fluid)

- **Centralisers and end plug**

In order to achieve the required borehole linearity, all casing permanently installed in wells should be fitted with centralisers at 6 meter intervals or as otherwise directed by the Engineer. The centralisers should be factory manufactured from spring steel straps welded to hinged steel collars to the approval and direction of the Engineer.

A factory manufactured stainless steel end plug will be installed at the bottom of the screen and tubes.

- **Gravel pack installation**

A special attention will be paid to quality of gravel pack installation. The mud circulation should be maintained during gravel pack installation.

No gravel pack could be installed in the well without use of a cross-over tool. With this tool, the fluid and filter pack pumped down through the drill pipe will discharge bellow the packed associated to the cross-over tool while the return flow will be conducted up through the packer into the annular space around the drill pipe. The stinger pipe below cross-over tool will extend to some 1 m of the bottom of the screen.

In order to prevent undesirable separation of coarse and fine fraction of the gravel pack, the uniformity coefficient of the mixture will be lower than 2.5 (see § 5.6. Characteristics of the gravel pack). In order to check the perfect installation of the

gravel pack, a 3m piece of tell-tale screen will be installed above the production screen, inside the telescoped section

- **Partial backfilling of wells**

The Contractor may be required to backfill an existing well to a depth specified by the Engineer. The backfill material will consist of sand and ten millimetres by twenty millimetres crushed or graded gravel or other sized gravel. All such backfill material must be approved by the Engineer before being used in the well.

- **Cementation under pressure**

The Cementation under pressure should be done from the bottom through a cementing shoe: the annular space shall be filled in by cement up to cement appears at the surface. If cement fail to reach the surface, the Contractor, should at his own cost and to the satisfaction of the Engineer, demonstrate that the cement is continuously sealing the casing from the bottom to half of the cemented depth. It should then continue the cementation from the surface and finally demonstrate at his own cost and to the satisfaction of the Engineer, that cement is continuously sealing the whole casing.

Should the Contractor fail to conduct these operations to the satisfaction of the Engineer, the borehole may be declared lost.

- **Failure of casing strings to enter well**

In the event that any string of casing will not enter the well, the casing will be removed and the well will be reamed or re-drilled. If the string of casing still does not enter the well, the well will be declared lost.

Drilling Sequence

- Drilling of the poorly unconsolidated levels, up to 10 to 20 m
- Installing of a surface casing from the bottom of the hole to the surface
- The surface casing will be fixed in position by cement being placed in the bottom half meter of the hole by tremmie pipe installed inside the casing, to ensure that the surface pipe remains plumb, and that there is an annular seal for the cement. The annular space between the well and the surface casing will then be filled with cement up to 1 m below ground surface. Once in place the cement will be allowed to set for a period of 12 hours
- Drilling the borehole down to a depth of about 230 m (diam. 20 or 22") below the ground.
- An electrical well logging shall be performed and decision can be taken to continue drilling (come back to previous indented line)
- The extrados of the casing is cemented under pressure from the bottom up to the surface. The Contractor will provide all necessary equipment to ensure the correct and successful displacement of the cement. Before proceeding with the cementing of the casing, circulation should be established around the casing without any loss and on completion of the cementing some cement should return to the surface.
- The cement is allowed to set for 24 hours minimum

- Gravel pack shall be installed beneath the screens and tubes using a cross-over tool.
- The borehole is then developed
- A full pumping test is completed
- The well head is constructed

Sampling and logging

- **Formation Sampling**

Representative samples of the strata penetrated will be collected every meter (or as otherwise directed and approved by the Engineer), by whatever method is standard for the drilling technique in use.

A sample of the formation cuttings will be removed from the drilling medium by collecting the sample in a screen, or by collecting a large sample of the drilling fluid and allowing the cuttings to settle out. Care will be taken to ensure that the sample is representative of the material being drilled and not contaminated by hole erosion or cavings.

The samples will be placed in approved and appropriately marked heavy plastic sample bags and handed over in a sturdy box to the Engineer. The sample box will be a container fitted with individual compartments for the samples. A card will be inserted into each compartment along with the sample, indicating, in water-proof ink, the depth from which the sample was recovered.

When requested by the Engineer, the samples will be displayed in a neat and organized manner so that the entire geologic section is clearly represented.

- **Well head logging**

Penetration rates, measured as minutes per meter drilled, must be recorded for every meter in the drillers log in regard with the pressure on the tool. The Contractor must report immediately to the Engineer's representative on site any changes in the penetration rate. The penetration rate report must include the method of drilling used and if any changes in the drilling method must be recorded its depth and time of change. Drilling interruption for flushing without drilling, stoppage during installation of additional drill pipes; breakdowns, etc. must be properly recorded so that the drilling rates can be properly interpreted purely based on time taken for drilling.

The contractor shall endeavour to operation in such a way as to detect water strikes by noting increases in flow rates. For this purpose marsh funnel and stopwatch must be available. In order to measure yield rates during drilling and so to obtain an indication of water strikes, the return water must be directed through a gauging weir consisting of a 90o weir plate (V – Notch) installed at a suitable point in the return water circulation system. The dimension of the V-Notch should be at least 800mm wide across the top and the V and 400 mm vertical depth.

Borehole development and clean-up

Well development will be conducted with successively both airlift pump system and interrupted over-pumping. All well development methods and chemicals must be approved by the Engineer.

For airlift pump system, it is a requirement that the double-tube airlift method to be used by the drilling contractor for the development of boreholes. Development must begin from the bottom of the borehole, the apparatus being placed about 1 m above the base of the borehole. The air is turned on and off repeatedly to agitate

the fine material within the gravel pack and the surrounding formation. This process continued every two meters upward within the borehole until the static water level is reached. Once this is completed the apparatus is lowered to the bottom of the borehole to remove sand and gravel and the borehole is then further airlifted until the water is totally clean to the satisfaction of the Engineer.

For interrupted pumping, the pumping shall be done at rates up to 2 times the design capacity. The pumping should be carried out in at least 5 steps, which should include pumping rates of 0.25, 0.5, 1, 1.5 and 2 times the design capacity, with no check valve nor foot valve present. Pumping shall be conducted in 5 minute cycles.

Development shall continue for a minimum of 6 hours air-lift development plus 3 hours interrupted pumping development and until the discharge water is clean and free of sand (i.e. no more than 1 cm diam. sand stain test) or until such time as the Engineer finds acceptable. No payment shall be made for the extra hours necessary after 15 hours of development

Borehole Disinfection

The Contractor shall at all times take every precaution to ensure that the borehole is kept free of contamination. The Contractor will ensure that formation stabilizer material is disinfected prior to installation.

Disinfection of the borehole shall be undertaken immediately after the borehole development process has been completed. The Contractor will devise a method for the disinfection procedure that meets the approval of the Engineer. The Contractor will include the cost of the disinfection process in his unit process for borehole construction.

The Contractor shall ensure that the disinfecting agent is uniformly applied throughout the entire water depth of the borehole. The disinfecting agent may be placed by a tremie pipe of sufficient length to extend to the bottom of the borehole. The disinfecting agent shall be applied through the hose that shall be raised and lowered to achieve uniform distribution of the solution throughout the borehole.

Concrete slab, well heads and capping of boreholes

- **Sanitary seal**

The annular space between the borehole and wall of the surface casing shall be grouted for sanitary seal for a depth not less than 2 m below ground surface with mixture of cement and water slurry by a pour-in method from the top.

Cement grouting shall be carried out in one continuous operation before initial setting of the cement occurs. Regardless of the method used, the grout shall be introduced at the bottom of the space to be grouted. In no circumstance will this be less than 2 m below the wellhead. The method proposed by the Contractor will be changed or modified if and required to suit the local conditions

- **Construction of concrete slab**

After the completion of the borehole to the satisfaction of the Project Manager, the Contractor if must excavate around the sanitary seal until reasonably firm formation is reached.

The ends of the surface casing shall be cut off 0.5 m below the surface level.

The Contractor shall construct a reinforced concrete block (with 12 mm steel reinforcing rods at equal spacing) with the surface dimension of 1 m width, 1 m

length and 1.5 m high (1 m below the surface level, 0.5 m above the surface level). Surface of the concrete block will have a divergent slope.

The well casing must protrude 0.2 m above the concrete block unless otherwise specified by the Engineer.

The wellhead block shall be cast around the surface casing in accordance with the Contract drawings, with 0.5 m inside the concrete slab.

- **Wellhead block and capping**

The wellhead block without artesian pressure is detailed in the drawings section. The Contractor shall supply all materials and carry out the construction of the wellhead according to the following instructions:

- ❖ on the top of this casing, a welded flange (stainless steel, 10 mm tick);
- ❖ Over the flange, a capping plate (stainless steel, 10 mm tick) bolted together with the coupling in 8 points and welded in 10 points.

The wellhead block with artesian pressure will be equivalent to the above, but should stand up to 3 bars pressure.

The well head shall be marked with the well number, in a manner approved by the Engineer.

Lost boreholes and abandonment

- **Failure to complete wells**

Should any accident to the plant, jamming of the tools or casing, collapse of the borehole, or any other causes due to the Contractor's negligence, prevent the satisfactory completion of the works, the borehole shall be deemed to be lost and

no payment shall be made for that borehole or for any material not recovered there from, nor for any time spent during operations or while attempting to overcome the problems. The option of declaring such lost well shall rest with the Contractor.

In the event of a well potentially being deemed lost, the Engineer may where possible redesign the well so that it is of use to the Employer and payment will be made in accordance with quantities and rates written in the Contract document. Should it not be possible to do this, the well shall be declared 'lost'.

A well may also be declared lost by the Engineer if it is not completed as required due to uncontrolled caving, lost tools down-hole which cannot be recovered, lost circulation zones, unsuccessful cementing or any other reason which leads to failure of completion and which renders the well useless or of little value to the Employer. A lost hole should be neutralised by a full cementation at the satisfaction of the Engineer.

No payment shall be made for a lost well and its neutralisation.

In the event of lost well the Contractor shall drill a new well at a site indicated by the Project Engineer.

- **Fishing**

Under no circumstances will the Employer pay any charge for time spent on fishing operations due to the Contractor's negligence, broken drill string components, stuck pipe, junk in the hole or any other reason. Contractors are advised to assure themselves of the good condition of all drill string components and maintain adequate wellhead security at all times.

- **Abandonment**

The Engineer shall have the right at any time during the progress of the work to order the abandonment of a borehole.

The Contractor thereupon shall withdraw the casing from the borehole, if applicable, and salvage or attempt to salvage all such materials as the Engineer shall direct and/or up until the Engineer revokes such direction and shall fill in or leave the borehole to the satisfaction of the Engineer. Aquifers may be sealed by cement.

Payment shall be made for such abandoned boreholes at the rates and tariffs shown in the Bill of Quantities.

24.1.3 AQUIFER TESTING AND WATER QUALITY

Introduction

The aquifer pumping test is a thorough and precise test of the characteristics of the water bearing formation in the vicinity of the well. It is of prime importance that the Contractor correctly monitors test pumping operations to ensure that accurate data is obtained. Testing work will be carried out with the intent of maximising the chances of success in completing tests within the allocated period of time.

For testing operations, the pump test will be installed at the bottom of the pump house, i.e. the bottom of the casing.

Calibration test

Before beginning the actual tests on each well, a calibration test must be undertaken. This involves checking that all equipment including the pump, generator, manometer and pipes are working satisfactorily. The discharge pipeline shall be checked for leaks. The gate valve shall be graduated and relative discharge positions marked in preparation for the step test. Once the calibration test has been completed the well must be allowed to recover to the satisfaction of the Engineer, before the actual test pumping operations can begin.

The cost of the calibration test shall be uniformly spread over the pump test items of the Bill of Quantities.

Tests sequence and duration

If calibration test shows that a well has sufficient capacity to be interest, pump testing shall be carried out. The following two types of test may be conducted according to the instruction of the Engineer.

- Continuous Step Draw-Down test: The Step Draw-Down test shall have six (6) steps of one (1) hour each, without rest period. The test shall begin with the lowest discharge rate (about 1/5 of the pump capacity) and increase consecutively until the maximum discharge rate is reached. (About 150% of the planned well yield). Upon completion of the step drawdown test, a step recovery test shall be undertaken, which should normally last for at least two (2) hours or as otherwise directed by the Engineer.
- Constant discharge test. Constant discharge tests will be hundred twenty (120) hours in length followed by a twenty four (24) hours recovery period, at a pumping rate close to the planned well yield (70

l/s or 115 l/s). The Engineer or his representative during the test on the basis of the measurements made and his analysis may increase or reduce both periods thereof.

The pump test shall be terminated only upon the written notice of the Engineer or his representative.

The test pump cannot be removed from the well during the recovery periods.

The pumped water during pumping test should not be allowed to from pools to avoid re- infiltration in the vicinity of the wells. If the Engineer feels that infiltration would take place around the well he can order the Contractor to dispose the water by means of discharge pipes toward a nearby natural drain over a distance where infiltration in to the aquifer during testing is negligible.

Water level measurements

During the period of the tests, the Contractor shall measure and record water levels in the pumped well. For measurement of water levels in wells, pressure meter or electric water level indicators shall be used.

If water level indicator is used, the Contractor shall have at least two water level indicators on each site. In the tested well, the measurement will be done through a temporary measurement pipe which shall be deep enough to reach the top of the pump.

The water level measurement will also be done in up to 2 neighbour wells designated by the Engineer.

For the tested borehole, the following time intervals are recommended:

Every	1	minutes	0	to	10	minutes of pumping
Every	2	minutes	10	to	30	minutes of pumping
Every	5	minutes	30	to	60	minutes of pumping
Every	10	minutes	60	to	360	minutes of pumping
Every	15	minutes	360	to	600	minutes of pumping
Every	30	minutes	10	to	24	Hours of pumping
Every	60	minutes	24	to	72	hours of pumping

Flow measurements

Flow measurements shall be made by means of a gauging weir consisting of a 90o weir plate (V – Notch) as described in the drawing section.

Flow measurements will be made for any water level measurement.

The contractor is responsible with mobilising testing pump with sufficient capacity to meet the planned well yield.

Interruption of the test pumping

The discharge rate during the pumping shall be maintained within five per cent of the rate established by the Engineer and the Contractor shall maintain uninterrupted pumping during the period of all tests. If not so, the Engineer may declare the test interrupted. Shall the Contractor fail to provide accurate water level and flow measurement with the recommended frequency, the Engineer may also declare the test interrupted.

No payment will be made for the elapsed time of the test prior to the interruption. Unless otherwise directed by the Engineer, interrupted tests shall not be restarted until sufficient time has elapsed for complete recovery of the water levels in the pump or observation well and shall not be considered to be a part of the pumping

test for purposes of payment even though water level measurements shall be made during that period by the Contractor if so directed by the Engineer.

Reporting

The contractor shall record test-pumping data on prepared sheets after the approval of the Engineer. The data sheet shall be filled in the English language. The data sheets prepared in triplicate shall include the following information:

- i. The location of the well being tested.
- ii. The physical characteristic of the well including depth, diameter, size length of casing screen setting and length of screen.
- iii. Characteristics of the test pump
- iv. Depth of setting of the test pump in meters.
- v. Date and time of start and finish of pumping test.
- vi. Static water level at commencement of test, dynamic water levels and discharge rates at prescribed time intervals.
- vii. Draw -down recovery after pumping is completed.
- viii. Date and time of start of removal of test pump from the borehole.

Water samples and analysis

Water samples for water quality analysis must be collected during the pumping test as directed by the Engineer. Each sample consists of 4 containers as in a glass or suitable plastic container of 1-liter capacity each.

Water samples should be clearly marked showing name of well, date of sampling, hour of sampling, temperature and conductivity of water during sampling and signature of person taking the sample.

2 sets of samples are dedicated for future ICP-MS analyses and will be stored.

1 set will be stored for cross-check analysis if required.

One sample shall be sent to a Laboratory approved by the Engineer within 12 hours after sampling. During transportation, the sample shall be kept in an isotherm box.

The contractor shall carry out water analysis for at least the following:

- Temperature
- Electrical conductivity at 25°C
- pH at 20°C
- Cations: Ca⁺⁺ Mg⁺⁺ Na⁺ K⁺ and total Fe
- Anions: Cl⁻, NO₃⁻, SO₄⁻⁻ and HCO₃⁻

Note:

- i. The Project Manager may order additional analyses if deemed necessary to achieve project objectives
- ii. Contractor is responsible in ensuring that the samples are stored in correct temperature condition throughout the contract, if deemed necessary the contractor shall provide air-conditioned room exclusively for storing the samples.
- iii. Time of storing: till the demobilization.

24.1.4 QUALITY OF MATERIALS AND WORKS

Erection of drilling machine at borehole site

The drilling machine must be erected at the borehole site in such a way that the hole will be drilled within 1 m of the marks which is shown to the contractor by the Engineer. No payment will be made for a well not located at the designed site

Verticality and alignment of boreholes

The wells will be drilled and cased straight and vertical, and all casing, screen or liners will be set plumb and true to line.

Upon completion of drilling or at any other time, the borehole shall be tested for verticality and straightness using deviation-measuring instruments like Inclinator, Draft Indicator etc., provided and operated by the Contractor at the Contractor's own expenses. Readings of deviation and direction will be taken at three meters depth intervals. Deviation shall be no more than 10%.

After pump house casing installation, verticality will be tested by the plumb-bob method. The dummy will consist of an axially suspended cylinder (or cage-ring) at least 7 m long with an external diameter as specified in the Conventional Code of Testing Boreholes. The suspending wire should be less than 5 millimetres diameter of uniform cross section with no kinks. Dummy should freely be passed down the borehole without force. Dummy is provided and operated by the Contractor at the Contractor's own expenses.

Should the plumb or dummy fail to move freely throughout the length of the casing or hole to the bottom of the housing line or should the borehole vary from the vertical in excess of above specified value, or beyond limitations of this test, the plumb ness and alignment of the borehole shall be corrected by the contractor at his own expense. Should the contractor fail to correct such faulty alignment or verticality, the well may be deemed lost. The Engineer may waive the requirements of this paragraph for verticality if in his judgment he establish that:-

- The Contractor has exercised all possible care in constructing the borehole and the defect is due to circumstances beyond his control.
- The usefulness of the completed borehole will not be materially affected.
- The cost of necessary remedial measures will be excessive.

In no event will the provisions of this paragraph with respect to alignment be waived.

Assembling of casing, tubes and screens

The assembling methodology for casing, tubes and screen will be submitted to and approved by the Engineer before operation. A particular attention will be paid to the external diameter of tubes and screens, and his compatibility with cementing or gravel pack installation.

The 18”5/8 casing may be coupled to each other either with welds. In order to secure mechanical and corrosion resistances, the Contractor should submit the certificates and qualifications of the welding operator as well as the welding procedures to the Engineer and get his approval before starting operations. All

welding electrodes must comply with the Standard Specifications DIN 1913 or AWS (American Welding Society) standards.

The 13”3/8 tubes and screens may be coupled to each other either with tight sleeve connection (ZSM connection 2 rods version).

The 8”5/8 and 10”3/4 (type 2) tubes and screens may be coupled to each other either with tight sleeve connection (ZSM connection 2 rods version) or with API round threaded connection.

The 10”3/4 (type 1) tubes and screens may be coupled to each other either with API round threaded connection.

In case of threaded connections, the lubricating compound shall not contain any heavy metal or hydrocarbon

Characteristics of the drilling fluid and additives

In order to limit the environmental impact and to improve the mud quality, the contractor should use mud tanks. Hand dug pits for mud are forbidden.

Drilling mud should be of biodegradable type and non-toxic and amenable to degradation by an appropriate chemical agent. The use of bentonite mud is only authorized for drilling of the sealed terrain, i.e. less than about 230 m.

The Contractor must ensure that if the Employer or Engineer specifies mud drilling, he has the necessary equipment including mud pumps, viscosity-measuring apparatus, water tanks etc., to enable him successfully complete the works.

The Contractor shall specify the brand name and manufacturer of any mud or chemicals or additives proposed to be used and include technical specifications or

any other relevant data. Readings of the mud condition (pH, viscosity, density and sand content) will be collected and recorded as directed by the Engineer. Steps will be taken immediately to correct any variations of the preferred values.

A special and permanent attention should be paid to the density of the drilling mud, in regard to the expected high artesianism of the aquifer. Balanced mud weights will be used for control of the artesian conditions. Barite may be used for mud weight control.

Where applicable and required, mud dispersing agents (such as glassy phosphate), acids for washing limestone, and other chemicals applicable to standard procedures may be used as. If polyphosphates are used, it must be followed by well disinfection. It is recommended, however, to provide a polyphosphate product that already contains disinfecting agents (i.e. Weltone or equivalent)

Characteristics of the casings and screens

Surface casing can be standard black steel casing. All other casing, plain tubes and screens will be made of 304L stainless steel or equivalent.

The 10 ¾” tubes and screens characteristics should be:

- Tubes: Internal and external longitudinally welded pipe AISI 304L according to ASTM A312 or DIN 4922 with ferrite content <5% and OD 273 mm
- Tubes and screens: the minimum collapse resistance will be 65 bars for the type 1 (the standard pipe 273 x 9.27 mm should meet this requirement) and 50 bars for the type 2.

- Before shipment material will be picked and passivated according to ASTM A380

The 8 5/8” tubes and screens characteristics should be:

- Tubes: Internal and external longitudinally welded pipe AISI 304L according to ASTM A312 or DIN 4922 with ferrite content <5% and OD 219 mm
- Tubes and screens: the minimum collapse Strength will be 70 bars (the standard pipe 219 x 8,18 mm (Sch 40) should meet this requirement).
- Tubes and screens: the minimum collapse Strength will be 70 bars (the standard pipe 219 x 8,18 mm (Sch 40) should meet this requirement).

All screens to be installed into the boreholes would be with 0.75 mm slot (tolerance 0.2 mm). This slot might be modified to 1 mm (tolerance 0.2 mm) slot after the first series of tests. The authorized open area will range from 6.5% to 9.5%, in order to maintain an entry velocity from 2 to 3 cm/s. In case of use of pipe base wire wound screens, the pipe has to offer an open area significantly higher than the continuous wire open area, and 13% minimum.

All casing and tubes supplied by the Contractor and which will be installed permanently in the boreholes must be with no circular welding; only longitudinally welding is allowed except to connect the fittings. None of the pipes will be made of short pieces welded together.

All casing and tubes supplied by the Contractor and which will be installed permanently in the boreholes must be new and must comply with the ASTM standards. The appropriate manufacturer's product information pamphlets with full details of the offered casing, tubes and screens, including method of joining must

be provided to the Engineer and accepted before installation in the hole. The following information should be engraved on equipment:

- Customer project name
- Supplier name
- Material
- OD and slot for screens, OD and nominal thickness for tubes

The Contractor will organize at his own costs a qualitative inspection, carried out by a recognized international certification company (third part inspection – choice of the third party to be given to Engineer). It must be held for the release of the equipment at supplier site to check conformity of:

- Origin of stainless steel, traceability during manufacturing process to avoid mix of different stainless steel.
- Quality plan, quality certificate and qualification of manufacturer, welding operators qualifications, welding procedures

Material manufacturer certificates according to EN 10204 / 3.1

- Dimensional results (slot measurements, tally list)
- X-Ray control of the longitudinal welded joint (for 2% of length over 10% of the pipes number randomly selected)
- Before shipment material will be picked and passivized according to ASTM A380
- Destructive tensile test (on a partial length of 13"3/8, 10 3/4 and 85/8"screen).
The Contractor should demonstrate that these figures are compatible with the weight of columns of screen and tubes.

- Full length destructive collapse test (on pipes and screens 13”3/8 , 10 3/4 and 85/8”)
- Internal pickling report and internal acceptance report of the production, as well as environmental report on passivation plan

The Contractor will organise at his own costs (covering travel, accommodation for a minimum of 3 days, subsidence) the participation of two (2) representatives of the Client to the qualitative inspection.

Characteristics of the gravel pack

The gravel pack will consist of quartz sand and gravel will not contain any carbonate calcium. The material must be clean well-rounded 90 % composed of quartz. The use angular crushed material is not acceptable. Considering the nature of the aquifer material and the specified screen aperture, the required grain size for 95% of the gravel pack material should be 1.0 mm to 2, 5 mm.

5 kg sample of the gravel pack material must be submitted to the Engineer for approval before use. Such approval shall be issued in writing and under no circumstances is the contractor to produce gravel for the work until such approval has been received.

Characteristics of the cement

- **Cement**

All cement, which is used, must comply with the Standard Specification DIN 1164, EN 197,

DIN 18555 and must not be older than three months. Unless otherwise instructed by the Engineer or the Employer, a hardening agent such as calcium chloride

should not be used to accelerate the cement setting process. The normal aggregate size for use with the cement may not exceed 19 mm unless otherwise stated.

- **Cement slurry**

The cement used for cement slurry will be PORTLAND artificial CPA325 type.

The water used shall be potable water. No less than 800 kg of cement will be used per cubic meter of water

- **Cement mortar**

The cement used for cement slurry will be PORTLAND artificial CPA325 type.

The water used shall be potable water. No less than 50 kg of cement will be used for 100 l of water. A minimum of 600 kg of cement shall be used per cubic meter of sand.

- **Tools and accessories**

For accessories listed below, the contractor should provide and get approved drawings including all technical details, quality plan, reference and origin:

Production well head with and without artesian pressure.

- ❖ Bottom plug;
- ❖ Centralizers;
- ❖ Handling tools and clamps for pipes and screens (according to EEC safety rules), and;

- ❖ Cross-over tool.
 - ❖ Cross-over tool
-

25 STANDARDS

1. ISO/IEC 17020:2012 – Conformity Assessment Requirements for the operation of various types of bodies performing inspection.
2. ILAC P15:06/2014 – Application of ISO/IEC 17020:2012 for the Accreditation of Inspection Bodies
3. SAC-SINGLAS 006 - Traceability of Measurement
4. BS 5930:2015 – Code of practice for site investigations
5. BSISO 14686: 2003 – Hydrometric Determination Plumbing tests for Wells. Considerations and guidelines for design, performance and use.
6. BS EN ISO 14688-1:2002+A1:2013 – Geotechnical investigation and testing.
7. BS EN ISO 14689 Part1:2003 – Geotechnical investigation and testing.
8. BS EN ISO 22282-1:2012 – Geotechnical investigation and testing – Geohydraulic testing: Part 1- General rules
9. BS EN ISO 22282-2:2012 – Geotechnical investigation and testing – Geohydraulic testing: Part 2 – Water permeability tests in a borehole using open systems

10. BS EN ISO 22282-3:2012 – Geotechnical investigation and testing – Geohydraulic testing: Part 3 – Water pressure tests in rock
11. BS EN ISO 22282-4:2012 – Geotechnical investigation and testing – Geohydraulic testing: Part 4 – Pumping tests
12. BS EN ISO 22282-6:2012 – Geotechnical investigation and testing – Geohydraulic testing: Part 6 - Water permeability tests in a borehole using closed systems
13. BS EN ISO 22475 Part1:2006 – Geotechnical investigation and testing. Sampling methods and groundwater measurements. Technical principles for execution.
14. BS EN ISO 22476 Part1:2012 – Geotechnical investigation and testing. Field testing. Electrical cone and piezocone penetration test
15. BS EN ISO 22476 Part 3:2005+A1:2011 – Geotechnical investigation and testing – Standard Penetration Test.
16. BS EN ISO 2274 Part 4:2012 – Geotechnical investigation and testing – Menard Pressure meter Test
17. BS EN ISO 22476 :Part 5 :2012 – Geotechnical investigation and testing – Flexible Dilatometer Test
18. BS EN ISO 22476: Part 11:2006 – Geotechnical investigation and testing – Flat Dilatometer Test

19. ASTM D6274 Part 18 – Standard Guide for conducting Borehole Geophysical Logging – Gamma

20. BS 7022:1988 – Guide for geophysical logging of boreholes for hydrogeological purposes.