Republic of Kenya

Kenya Marine Fisheries Socioeconomic
Development Project (KEMFSED)
P.O. Box 58187-00200
NAIROBI

Co

MINISTRY OF AGRICULTURE, LIVESTOCK,
FISHERIES AND COOPERATIVES

Request for Bids Works

Procurement of:

Construction of Fisheries Headquarters – " UVUVI HOUSE"

Employer: State Department for Fisheries, Aquaculture and the Blue Economy
Project: Kenya Marine Fisheries Socio-Economic Development Project (KEMFSED)
Contract Title: Construction of Fisheries Headquarters – "UVUVI HOUSE"
Country: Republic of Kenya
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VOLUME 3 OF 4: SPECIFICATIONS

SPECIFICATIONS, PREAMBLES AND PRICING NOTES

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SPECIFICATIONS, PREAMBLES AND PRICING NOTES

1.1 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 I 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.

EXPANSION JOINT FILLER

Expansion joint filler shall be "Flexcel" as manufactured by Expedite Ltd, "Resilex" as manufactured by Evo mastics Ltd or equivalent and approved filler.

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/mm2	20.00 N/mm2	16.5N/mm2	13.5 N/mm2
28 days	35.0 N/mm2	30.0 N/mm2	25.0 N/mm2	20.0 N/mm2

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 difference 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.

1.2 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.

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.

1.2.1 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 and 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.

1.2.2 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.

1.2.3 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.

1.2.4 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.

1.2.5 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.

1.2.6 FABRIC REINFORCEMENT

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

1.2.7 FIXING ROD REINFORCMENT

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.

1.2.8 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.

<u>CONCRETE WORK (CONT'D)</u>

<u>COVER TO ROD REINFORCEMENT (CON'TD)</u>

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

1.2.9 <u>FIXING FABRIC REINFORCEMENT</u>

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. appealed 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.

1.2.10 <u>FIXTURES AND INDENTATIONS IN CONCRETE</u>

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 build 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.

1.2.11 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.

1.2.12 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.

1.2.13 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".

1.2.14 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.

1.2.15 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.

1.3 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 how 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.

1.3.1 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 dying 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.

1.4 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 and waste and extra material in laps at joints, angles, etc.

B. <u>CEMENT</u>

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

C. <u>SAND</u>

All sand used for making mortar shall be clean, well graded siliceous sand of good sharp quality, equal to sample, which shall be approved by the Project Engineer. 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. <u>LIME</u>

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

(ii) 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.

<u>TRADE PREAMBLES</u>

(iii) 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.

E. <u>CEMENT MORTAR</u>

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.

1.4.1 CONCRETE <u>BLOCKS</u>

(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.

1.4.2 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 or190mm. 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.

1.4.3 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.

1.4.4 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)

1.4.5 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.

1.4.6 PROTECTION

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

1.4.7 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.

1.4.8 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.

1.4.9 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 450mm centres both vertically and 900mm centres horizontally. Wall ties shall be provided at 450 centres both vertically and 900mm centres horizontally. Wall ties shall be staggered when used to connect two leaves of unbounded walls.

1.5 ROOFING

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.

1.5.1 BITUMINOUS FELT ROOFING

A. 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.

B. STORAGE

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

C. 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.

D. SEQUENCE

(i) Jointing Compound: - One application of hot bituminous compound weighing not less than 16.3 Kgs per 10 square metres.

(ii) First Layer: (Class 1A) — One layer of self-finished felt weighing not less than 13.6 Kgs per Sq. m.

(iii) Jointing Compound: — As described in (i) above.

(iv) Second Layer: (Class 1A) — One layer of self-finished felt weighing not less than 13.6 Kgs per Sq. m.

(v) Jointing Compound: — As described in (i) above.

(vi)	Third Layer: (Class E)	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)

1.5.2 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.

1.5.3 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 timer 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: -

Standard Common Name	Botanical Names
Podocarpus	Podocarpus spp.
Cypress	Cypress
Cedar	Juniperus Procera
African Mahogany (munyama)	Khay Anthotheca

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.

1.5.4 Timber

A. **SEASONING OF TIMBER**

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

B. **PRESSURE IMPREGNTION 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 a 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 4/5th 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.

1.6 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 wrap, 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 putted. 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 planning 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%.

1.7 DIMENSION

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 145S (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.

1.8 PLASTIC SHEETING

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 mahogany 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 handling to the Project Engineer on completion.

1.9 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 noticing 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.

1.10 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 mild steel 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.

1.11 PAINTING

All steel is to be wire brushed 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.

1.12 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.

1.13 **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.

1.14 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.

1.15 PAVING

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 dump 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. **<u>CEMENT AND SAND PAVINGS</u>**

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

E. **<u>SKIRTINGS</u>**

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.

1.16 JUNCTION STRIPS

A. **<u>JUNCTION STRIPS</u>**

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. **<u>FLOOR HARDENER</u>**

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

C. **<u>P.V.C. FLOORING</u>**

Dunlop Vinylex asbestos floor tiles to B.S 3261 of thickness specified and colours selected by the Project Engineer and executed by approved sub-contractor. Upon completion the flooring is to receive two coats of approved polish.

D. **<u>GRANOLITHIC AND TERRAZZO PAVING AND WALL FINISHES</u>**

(a) <u>GENERALLY</u>

(i) Construction joints between bays of paving are to be straight and vertical and are to be 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.

E. **<u>EPOXY FLOOR PAVING:</u>**

This shall be 6 mm thick heavy-duty Industrial epoxy floor finish with four component epoxy material and colour impregnated to include skirtings, expansion and construction joints, and appropriate seal coat.

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

(a) SCREED

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

(b) 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 25mm minimum combined thickness comprising 15mm thick cement and sand (1:4) backing and 10mm. thick granolithic.

(iii) Dadoes 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.

1.18 PLASTIC DIVIDING STRIP FINISHES

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.

1.19 **A.**<u>INTERNAL</u> **<u>GAUGED</u>** <u>PLASTER</u>

Plaster described as "Internal gauged plaster in two coats" shall consist of a first or rendering coat composed or 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.

1.20 **B.**<u>GLAZED WALL TILING</u>

(i) Glazed wall tiles shall be 150 x 150 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 "Richafix" or other equal and 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.

1.21 <u>GLAZING</u>

A. **<u>GENERALLY</u>**

(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. **<u>CLEAR SHEET GLASS</u>**

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

C. **<u>POLISHED PLATE GLASS</u>**

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.

1.21.1 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.

1.21.2 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.

1.21.3 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 be 'Shellack' 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 "Ron seal" polyurethane or other equal approved by the Project Engineer.

G. **WAX POLISH**

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

1.21.4 PAINTING 2

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.

1.21.5 SAMPLES AND COLOURS

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 per cent 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.

C. **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.

D. **COVERING UP**

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

E. **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.

1.22 **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.

1.23 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 murram 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.

1.24 HANDPACKED STONE BASE

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 - 0 mm	+ 6 mm - 6 mm	+ 150 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 43ºC, 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.

1.25 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 **<u>COARSE AGGREGATE</u>**

.01 Los Angeles Abrasions – Max. 35

.02 Aggregate Crushing Value – Max 28

.03 Sodium Sulphate Soundness – Max 12

.03 **<u>FINE AGGREGATE</u>**

.01 Sand equivalent min. 40.

.02 Sodium Sulphate Soundness max 12.

.04 **<u>MINERAL FILLER</u>**

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

.05 <u>GRADING</u>

.01 Passing 0.425mm 100%

.02 Passing 0.075mm 75%

.06 <u>GRADING</u>

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.

1.26 MANUFACTURE AND LAYING

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.

1.27 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: -

1.27.1 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.

1.27.2 WORKMANSHIP

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.

1.28 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 12mm thick toughened clear structural glass fixed to 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 "ASSA ABLOY" or equal and approved ; including timber offcuts in hinge fixing points and fixing with powder coated aluminium 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

CURTAIN WALLING

Supply and fix 150 x 80 mm x 3mm thick powder coated aluminium framed curtain walling; fabricated from approved composite powder coated aluminium heavy duty hollow or angle aluminium sections of approved colour; including butt glazing with 12mm thick laminated glass with polished edges comprising of 6 mm thick reflective solar glass (approved colour) plus 1.52mm ultra-safety and security polyvinyl butyral (PVB) film plus 6mm thick self-cleaning clear glass all as manufactured by Saint Gobain – coolite series and supplied locally by Impala Glass or other equal and approved glass; glass to be butt jointed and secured to framing using approved silicon, glazing strips and beading including waterproofing all joints using approved silicon sealing compounds All fixed to aluminium framing complete with lugs for fixing framing to walls, columns or slabs

SKIN WALL

Selected approved quality natural stone fine machine dressed and cut to regular block size: stone load bearing blocks (7N/mm?): 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

ALUMINIUM COMPOSITE CEILING

Supply and fix nano self-cleansing perforated aluminium composite cladding sheets in panes sizes ranging from 400 x 400 mm - 600 x 600 mm in wet areas ; comprising of normal PE core, aluminium panel, primer paint, PVDF paint and finished in nanometer paint all as Alucobond or other equal and approved; with matching trim and associated accessories; fixed to and including aluminium sections and necessary supporting steel framework (m.s) and brackets; all to manufacturer's specifications and details

GYPSUM

GYPSUM PLASTERBOARD

12mm Thick gypsum plasterboard fixed with screws to galvanised light weight steel frame work suspended from concrete above with mild steel angle sections, perimeter channels, primary support channels, strap hangers connecting clips etc. with joints skimmed with gypsum plaster including forming and curved cuttings

ACCOUSTIC CEILING

Supply and fix approved suspended semi-recessed L.I.G. fine fissured acoustic ceiling on 24mm wide white lay-in grid complete with white perimeter and curved trims and wall angles as necessary; all to Project Engineer's details and approval. (Rate to include all necessary supports, battens and accessories)

WPC DOORS & FRAMES

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

1.29 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: -

1.30 **ALUCOBOND** / ALUMINIUM COMPOSITE PANEL:

Nano self-cleansing aluminium composite panel composed of normal PE core, aluminium pane, primer paint, PVDF paint and finished in Nanometer paint- matt grey cloud. Aluminium Panel to be 6mm thick.

1.31 **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

1.32 GRANITE **SPECIFICATIONS** (LOCAL OR EQUIVALENT)

1.32.1 GENERAL

Related Documents

Drawings and general provisions, including General and Supplementary Conditions of the Contract and Division I Specification sections, apply to this section.1.2 Applicable Publications

The following publications listed here and referred to thereafter by alphanumeric code designation only, form a part of this specification to the extent indicated by the references thereto:

1) ASTM International (ASTM):

C615-99 Standard Specification for Granite Dimension Stone

A666-00 Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar

B221-00 Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes

C97-02 Standard Test Methods for Absorption and Bulk Specific Gravity of Dimension Stone

C99-87(2000) Standard Test Method for Modulus of Rupture of Dimension Stone

C119-03 Standard Terminology Relating to Dimension Stone

C170-90(1999) Standard Test Method for Compressive Strength of

Dimension Stone
C241-90(1997) e1 Standard Test Method for Abrasion Resistance of Stone
Subjected to Foot Traffic
C270-03 Standard Specification for Mortar for Unit Masonry
C295-03 Standard Guide for Petrographic Examination of Aggregates for
Concrete
C880-98 Standard Test Method for Flexural Strength of Dimension Stone C1028-96 Standard Test Method for Determining the Static Coefficient of Friction of Ceramic Tile and Other Like Surfaces by the Horizontal Dynamometer Pull-Meter Method
C1201-91(1996) Standard Test Method for Structural Performance of Exterior Dimension Stone Cladding Systems by Uniform Static Air Pressure Difference
C1242-02a Standard Guide for Selection, Design, and Installation of
Exterior Dimension Stone Anchors and Anchoring Systems
C1352-96(2002) Standard Test Method for Flexural Modulus of Elasticity of Dimension Stone
C1353-98e1 Standard Test Method Using the Taber Abrader for Abrasion
Resistance of Dimension Stone Subjected to Foot Traffic
C1354-96 Standard Test Method for Strength of Individual Stone
Anchorages in Dimension Stone
C1515-01 Standard Guide for Cleaning of Exterior Dimension Stone, Vertical and Horizontal Surfaces, New or Existing
C1528-02 Standard Guide for Selection of Dimension Stone for Exterior
Use
2) Marble Institute of America (MIA):
Membership, Products and Services Directory, Dimension Stone Design Manual, Dimension Stones of the World, Volumes I and II (includes color plates, ASTM test data, and other technical information). Additional publications may be available from the MIA Bookstore – go online at
_ HYPERLINK "http://www.marble-institute.com" _ www.marble-institute.com_.
3) National Building Granite Quarries Association (NBGQA)Specifications for Project Engineerural Granite
Scope of Included Work
The work to be completed under this contract includes all labor and materials required for the furnishing and installation of all granite work shown or called for on the contract drawings, specifications, and addenda.
Definition of Terms
The definitions of trade terms used in this specification shall be those published by the MIA, BGQA, or ASTM International.
Source of Supply
All granite shall be obtained from quarries having adequate capacity and facilities to meet the specified requirements, and from a firm equipped to process the material promptly on order and in strict accord with specifications. The Specifying Authority (Project Engineer, designer, engineer, contracting officer, end user, etc.) reserves the right to approve the

Material Supplier prior to the award of this contract. Stone and workmanship quality shall be in accordance with Industry Standards and Practices as set forth by the MIA.

Samples

The Granite Contractor shall submit through the General Contractor, for approval by the Specifying Authority, at least two full range sets of samples of the various kinds of granite specified. Sample submittals shall represent the full range of color and markings inherent in the material proposed for fabrication of the project. Full range sample sets must be reviewed and approved as a complete set and not as individual pieces. Full range sample sets shall be indicative of the true character, including any natural variation in background and foreground color, veining or graining, of the material currently available and proposed for use on the project. The sample size shall be 1'-0" x 1'- 0" minimum, 2’-0” x 2’-0” minimum for heavily veined or varied stones, and shall represent approximately the finish, texture, and anticipated range of colors to be supplied. One set of approved samples shall be retained by the Specifying Authority, and one set shall be returned to the Granite Supplier for his record and guidance. It is noted herein that granite is a natural material and will have intrinsic variations in color, markings, and other characteristics. Depending on granite selected and quantity required, a range mockup may be used to further define the characteristics of the material. Cost of mockup, if required, shall not be included in this section. Prior to fabrication, and to assure the end user’s needs will ultimately be met and to fully understand the finish and full range of the material, an inspection and approval by the Specifying Authority and/or General Contractor and/or End User of the material is recommended. Costs for an initial inspection of the quarried blocks before slabbing, and a second inspection of the finished material slabs before fabrication shall be stipulated and included in the overall contract requirements.

Shop Drawings

The Granite Contractor shall submit through the General Contractor, for approval by the Specifying Authority, sufficient sets of shop drawings, showing general layout, jointing, anchoring, stone thickness, and other pertinent information. These drawings shall show all bedding, bonding, jointing, setting spaces and anchoring details along with the net piece dimensions of each granite unit. Due to tight fabrication tolerances of dimensional stone (see “Dimensional Tolerances” in this section) special attention must be paid to those areas where associated trade’s work abuts or is integral with the stone installation. Additional notes calling out required set backs, setting space allowances below and behind floor and wall installations, critical “hold-too” dimensions, or any other specific conditions requiring strict coordination with other trades work should be incorporated into the shop drawings. Coordination of approved shop drawings with all affected trades is the responsibility of the General Contractor. One copy of the approved shop drawings shall be retained by the Specifying Authority, one copy shall be retained by the General Contractor, and one copy returned to the Granite Contractor for fabrication. NO FABRICATION OF GRANITE SHALL BE STARTED UNTIL SUCH DRAWINGS HAVE BEEN FULLY APPROVED AND MARKED AS SUCH. The Granite Contractor shall not be responsible for determining, making, or verifying (1) design, structural, wind, seismic, or other design loads; (2) engineering estimates; (3) plans or specifications; or (4) the types, sizes, or locations of anchors, unless specifically added to the scope of work.

Defective Work

Any piece of granite showing flaws or imperfections upon receipt at the storage yard or building site shall be referred to the Specifying Authority for determination as to responsibility and decision as to whether it shall be rejected, patched, or redressed for use.

Repairing Damaged Stone

Chips at the edges or corners may be patched, provided the structural integrity of the stone is not affected and the patch matches the color and finish of the natural stone so that it does not detract from the stone's appearance.

1.32.2MATERIALS

Granite

General: All granite shall be of standard Project Engineerural grade, free of cracks, seams, starts, or other traits which may impair its structural integrity or function. Inherent color variations characteristic of the quarry from which it is obtained will be acceptable. Texture and finish shall be within the range of samples approved by the Specifying Authority. ASTM C615 [C97] [C99] [C170] [C241] [C880]. See the chart of applicable ASTM standards and tests in the Appendix.

Schedule: Granite shall be provided as follows:

1) For (state location on building) (state name and color) granite with a (type) finish, supplied by (name company or list several approved suppliers).

2) Provide information as in (1) for each different granite/finish combination in the project.

Finishes: Finishes listed in the schedule shall conform with definitions by MIA, NBGQA, or ASTM International.

Setting Mortar

Mortar for setting shall be Type N, as defined in ASTM C270-03 (Standard Specification for Mortar for Unit Masonry). All mixing, handling, and pacing procedures shall be in accordance with ASTM C270-
03.

Pointing Mortar

Mortar for pointing shall be Type N, as defined in ASTM C270-03 (Standard Specification for Mortar for Unit Masonry). All mixing, handling, and pacing procedures shall be in accordance with ASTM C270-
03.

Sealants and Backup Material (if applicable)

Where specified, (state type or name of sealant) shall be used for the pointing of joints. The backup material used with the sealant shall be (identify material).

Anchors, Cramps, and Dowels

All anchorage components shall be of 300 Series stainless steel (refer to ASTM A666) or aluminum (refer to ASTM B221) with strength and durability properties meeting or exceeding those of 6063-T6. Anchor types and assemblies shall comply with ASTM C1242-02a. Reliance on adhesives alone for material attachment will not be permitted. The granite contractor shall be responsible for all anchorage attached to the stone and directly related to stone installation. The granite contractor shall not be responsible for any additional support elements required for proper attachment of stone anchorage to the structure of the building.

1.32.3 FABRICATION

3.1 Dimensional Tolerances

Panel thickness of 3/8" or 1/2".......±1/32" Panel thickness of 3/4" to 1-5/8" ....±1/8" Panel thickness >1-5/8"................±1/4" Panel face dimension ....±1/16" Face variation from rectangular ....±1/16" (maximum out of square) (noncumulative) Heads/calibrated edges ....±1/16" Quirk miters (width of nose):

Up to 1/4"………-0; +25% of dim

Over 1/4"……………-0, +1/16"

Location of back anchors................±1/8"

Depth of back anchors…………-0, +1/16"

Location of holes for precast anchors ....±1/4" Hole depth for precast anchors ....±1/16"

Anchor Slots:

From face to C/L of slot .....±1/16" Lateral placement..............±1/4" Width ....±1/16" Depth at maximum............±1/8"

Anchor Holes:

From face to C/L of slot .....±1/16" Lateral placement..............±1/8" Diameter ....±1/16" Depth ....±1/8" Anchor Sinkages:

Depth…………………….-0, +1/8" Continuous Kerfs:

From face to C/L of kerf..... ±1/16" Maximum bow in 4'-0"....... ±1/16" Width............................ ±1/16" Depth……………...-1/16"; +1/8"

Rebated Kerf:

Elevation of bearing surface.. ±1/16" Bearing Checks:

Elevation of bearing surface . ±1/16" Bearing/Clearance Checks:

Lateral location .... ±1/2" Setback from face.............. ±1/16"

Typical Unit Sizes

Tile stock- 12” x 12”, 18” x 18”, & 24” x 24” nominal. Thickness of tile stock is typically 3/8”thick for most polished and honed surfaces (see “6.2 Protection of Finished Work” in this section), and 1/2” thick for most thermal, or pointed finishes. Large format tile stock (18” x 18” and larger) may only be available in 1/2” thickness and is dependent on the specific stone’s properties and the material supplier.

Dimension Stone Slab Stock- Industry standard slab stock available in 2 cm & 3 cm (3/4” & 1 1/4” nominal) thickness. Typical slab sizes vary by material, but average 6’-0” x 9’-0” for granite and 4’-0 x 8’- 0” for marble. For specialty thicknesses or extremely large piece size requirements, the granite contractor or granite fabricator should be consulted in the design phase to assure the design intent can be met. Typical maximum finished piece size is 4’-0” x 4’-0” +/-.

Flatness Tolerances

Variation from true plane, or flat surfaces, shall be determined by a 4' dimension in any direction on the surface. Such variations on polished, honed, and fine rubbed surfaces shall not exceed tolerances listed below, or 1/3 of the specified joint width, whichever is greater. On surfaces having other finishes, the maximum variation from true plane shall not exceed the tolerance listed below, or 1/2 of the specified joint width, whichever is greater.

Flatness Tolerances by Finish.

Polished, honed, or fine rubbed.........1/16" Sawn, 4-cut, 6-cut, and 8-cut ....1/8" Thermal and coarse stippled ....3/16" Pointed or other rough cut...............1" Split face.…dependent on piece size & stock

3.3 Beds and Joints

Bed and joint width shall be determined by analysis of anticipated building movements and designed to accommodate such movements without inducing undue stresses in the stone panels or joint filler materials. Expansion joints shall be designed and located to accommodate larger movements.

3.4 Backs of Pieces

Backs of pieces shall be sawn or roughly dressed to approximately true planes. Back surfaces shall be free of any matter that may create staining

Moldings, Washes, and Drips

Moldings, washes, and drips shall be constant in profile throughout their entire length, in strict conformity with details shown on approved shop drawings. The finish quality on these surfaces shall match the finish quality of the flat surfaces on the building.

3.6 Back-Checking and Fitting to Structure or Frame

The building design should incorporate stone installation requirements such as material thickness, setting space, and anchorage allowances. Maintain a minimum of 1 1/4” between stone backs and adjacent structure and allow for all components of the building structure (waterproofing, flashing, etc). (Note: many bolted connections will require more space than this; 2" space may be more desirable. Large-scale details should illustrate and control these conditions and be distributed by the General Contractor to the affected trades.)

3.7 Cutting for Anchoring, Supporting, and Lifting Devices

Holes and linkages shall be cut in stones for all anchors, cramps, dowels, and other tieback and support devices per industry standard practice or approved shop drawings. However, additional anchor holes may be drilled at job site by Granite Contractor to facilitate alignment.

No holes or linkages will be provided for Granite Contractor’s handling devices unless arrangement for this service is made by the Granite Contractor with the Granite Fabricator. (NOTE: It is not recommended that Lewis pins be used for stones less than 3-1/2" thick.)

3.8 Cutting and Drilling for Other Trades

Any miscellaneous cutting and drilling of stone necessary to accommodate other trades will be done by the Granite Fabricator only when necessary information is furnished in time to be shown on the shop drawings and details, and when work can be executed before fabrication. Cutting and fitting, due to job site conditions which are contrary to the dimensions and details shown on approved shop drawings are not the responsibility of the granite contractor and will be provided only by arrangement between the General Contractor and Granite Contractor.

3.9 Carving and Models

All carving shall be done by skilled Stone Carvers in a correct and artistic manner, in strict accordance with the spirit and intent of the approved shop drawing, or from models furnished or approved by the Specifying Authority.

1.32.4 SHIPPING AND HANDLING

4.1 Packing and Loading

Finished granite shall be carefully packed and loaded for shipment using all reasonable and customary precautions against damage in transit. No material which may cause staining or discoloration shall be used for blocking or packing. (See “6.2 Protection of Finished Work” in this chapter.)

4.2 Site Storage

Upon receipt at the building site, stone shall remain in the factory- prepared bundles until beginning of the installation. Bundles shall be staged in an area which is least susceptible to damage from ongoing construction activity. Once unbundled, the granite shall be stacked on timber or platforms at least 2" above the ground, and the utmost care shall be taken to prevent staining or impact damage of the granite. If storage is to be prolonged, polyethylene or other suitable, nonstaining film shall be placed between any wood and finished surfaces of the granite. Polyethylene or other suitable, nonstaining film may also be required as protective covering. Any holes or slots in the granite which are capable of collecting water shall be temporarily covered or plugged to prevent freezing of collected water. Such covers or plugs are to be removed immediately prior to installation of the piece.

1.32.5 INSTALLATION

General Installation

Installation shall be accomplished with competent, experienced Stone Setters, in accordance with the approved shop drawings. All granite pieces shall be identified with a unique piece number corresponding with the number on the shop drawings. Interchanging of numbered pieces is not permitted as the pieces are generally blended for color and characteristic markings by the granite fabricator. Granite shall be free of any ice or frost at time of installation. Salt shall not be used for the purpose of melting ice, frost, or snow on the granite pieces. Adequate protection measures shall be taken to ensure that exposed surfaces of the stone shall be kept free of mortar at all times as elements in mortar may etch the polished surfaces of some stones.

Mortar Setting of Granite

Clean base materials to remove dirt or other foreign matter. Saturate concrete substrate several hours prior to setting granite. Prepare and place mortar in accordance with ASTM C270-03. Thoroughly wet stones prior to setting in mortar bed. Apply neat cement parge of approximate 1/16" thickness to granite units prior to placing on mortar bed. Tamp stones into place using a rubber or plastic mallet to obtain full contact with the setting bed and proper stone unit alignment.

Mortar Joints

Mortar joints shall be raked out to a depth of ½" to ¾". Apply pointing mortar in layers not exceeding 3/8" and allow each layer to get hard to the touch before the next layer is applied. Tool finished joints with a concave tool having a diameter approximately 1/8" greater than the joint width. Care shall be taken to keep expansion joints free of mortar, which would compromise their function.

Anchorage

All granite shall be anchored in accordance with the approved shop drawings.

Specific anchorage design and details shall be determined by the granite contractor in conjunction with the granite fabricator. To the furthest extent possible, all anchor preparations in granite units shall be shop applied. All anchorage devices and anchor hole/slot fillers shall be in accordance with ASTM C1242-02. Care must be taken to ensure that any holes capable of retaining water are filled after use to prevent water collection and freezing.

Sealant Joints

Where so specified, joints requiring sealant shall be first filled with a closed-cell ethafoam rope backer rod. The backer rod shall be installed to a depth that provides optimum sealant profile after tooling per manufacturer recommendations. If recommended by the Sealant Manufacturer, primers shall be applied to the substrate surfaces according to the manufacturer’s directions prior to application of the joint sealant. A test should be conducted to assure that the specified sealant will not stain the stone. Typically, Sample pieces of stone with kerf cuts applied to the sample face representing the typical joint size (1/4” x 1/4”, 3/8” x 3/8”, 1/2” x 1/2” etc.) are filled with the specified sealant and allowed to cure for 24 to 48 hours. Any potential staining should be apparent at this point. Fully cured sealant samples will be submitted to demonstrate no staining to stone by the specified sealant.

Expansion Joints

It is not the intent of this specification to make control or expansion-joint recommendations for a specific project. The Specifying Authority must specify control or expansion joints and show locations and details on drawings. Typically, expansion joints are required at 20’-0” intervals and should be determined by the design professional and the granite contractor.

Caulking

Where so specified, joints shall be pointed with the sealant(s) specified in Section 2.4, after first installing the specified backup material and applying a primer if required, all in strict accordance with the printed instructions of the Sealant Manufacturer. All sealants shall be tooled to ensure maximum adhesion to the contact surfaces.

Weep Tubes

Plastic or other weep tubes shall be placed in joints where moisture may accumulate within the wall, such as at base of cavity, continuous angles, flashing, etc., or as shown on Project Engineerural drawings.

Installation Tolerances

The quality of the stone installation relies greatly on the quality and accuracy of those trades preceding stone installation. After review and approval, shop drawings shall be distributed and coordinated by the General Contractor to all trades whose work abuts, or is integral with the stone installation.

Variation in plumb:

Lines and surfaces of walls and columns:

.... ¼" in 10'-0"

.... NTE 3/8" in story height

.... ½" in 40'-0"

Exterior corners or other conspicuous lines:

.... ¼" in 10'-0"

.... NTE 1/4" in story height

.... ½" in 40'-0" Variation from level:

Lintels, parapets, rustications:

.... ½" in column bay

.... ¾" in 40'-0" Variation from linear building line:

½" in column bay .... ¾" in 40'-0"

1.32.6 CLEANING AND PROTECTION

Cleaning

All cleaning methods shall be tested on material samples prior to application to the stone installation to assure there are no adverse effects of the cleaning method or products to the stone surface. Granite shall be cleaned after installation and all pointing or caulking is complete. All dirt, excess mortar, weld splatter, stains, and other defacements shall be removed. All cleaning methods shall be in accordance with ASTM C1515-01.

Protection of Finished Work

Granite installation in progress shall be protected with film or fabric tarps secured over the work as required. After the granite is installed, it shall be the responsibility of the General Contractor to properly and adequately protect it from damage until all trades are finished. This responsibility includes the stone cleaning costs prior to the required final inspection. Where lumber is required for protection, care should be taken to protect the granite from staining by the lumber, using plastic film or other suitable materials. Any fasteners used in construction of temporary protection fixtures shall be noncorrosive.

Impact-resultant finishes, such as bush hammered (sometimes referred to as a pointed finish), require a 1¼" thick slab minimum to apply. Other finishes can usually be applied to any thickness slab, with the exception of some granites not being able to withstand thermal finishing processes in thicknesses less than 1¼". Determination of proper stone thickness must be evaluated using the following criteria:

1) Piece Size.
2) Final Face Finish.
3) Anchoring Detail.
4) Structural Design Load Requirements.
5) Flexural Strength of the Granite.

Minimum safety factors of 3 to 1 minimum on granite flexural stresses and 4 to 1 minimum on anchorage components in granite are recommended. Ashlar or veneer used as a facing requires a setting space of at least 1 1/4”, as measured from the nominal thickness of the piece to the outermost layer of the building structure (including any required waterproofing, flashing, etc.).

Bed and Joint Width. The minimum recommended bed and joint width is 1/4" for exteriors and 1/8" for interiors due to the relatively tight fabrication and installation tolerances of dimension stone (see “3.1 Dimensional Tolerances” & “5.9 Installation Tolerances” in this section.), but not less than 2 times the specified tolerances for the particular application.

Sawn Backs. Because of physical characteristics, most granites cannot be split to a thickness less than 1/3 of the lesser face dimension. Consequently, sawn backs (see 3.4 in this chapter) should be specified for most veneers, and are frequently specified also for thicker ashlar, because of design considerations.

Staining. Granite should be protected from wet (green) wood, oils, mud, construction waste, and asphalt compounds. Contact Fabricator or Granite Contractor for proper remedies to staining problems that occur.

1.33 MARBLE SPECIFICATIONS

1.33.1 GENERAL

Related Documents

Drawings and general provisions, including General and Supplementary Conditions of the Contract and Division I Specification sections, apply to this section.

Applicable Publications

The following publications listed here and referred to thereafter by alphanumeric code designation only, form a part of this specification to the extent indicated by the references thereto:

1) ASTM International (ASTM):

C503-99e1 Standard Specification for Marble Dimension Stone (Exterior) C97-02 Standard Test Methods for Absorption and Bulk Specific Gravity of Dimension Stone

C99-87(2000) Standard Test Method for Modulus of Rupture of Dimension Stone

C170-90(1999) Standard Test Method for Compressive Strength of Dimension Stone

C241-90(1997) Standard Test Method for Abrasion Resistance of Stone Subjected to Foot Traffic

C880-98 Standard Test Method for Flexural Strength of Dimension Stone

2) Marble Institute of America (MIA):

Membership, Products, and Services Directory, Dimension Stone Design Manual, Dimension Stones of the World, Volumes I and II (includes color plates, ASTM test data, and other technical information). Additional publications may be available from the MIA Bookstore–go online at

_ HYPERLINK "http://www.marble-institute.com" _ www.marble-institute.com_.

Scope of Included Work

The work to be completed under this contract includes all labor and materials required for the furnishing and installation of all marble work shown or called for on the contract drawings, specifications, and addenda.

Definition of Terms

The definitions of trade terms used in this specification shall be those published by the MIA or ASTM International.

Source of Supply

All marble shall be obtained from quarries having adequate capacity and facilities to meet the specified requirements and by a firm equipped to process the material promptly on order and in strict accord with specifications. The Specifying Authority (Project Engineer, designer, engineer, contracting officer, end user etc.) reserves the right to approve the Material Supplier prior to the award of this contract. Stone and workmanship quality shall be in accordance with Industry Standards and Practices as set forth by the MIA.

Samples

The Marble Contractor shall submit through the General Contractor, for approval by the Specifying Authority, at least two full range sets of samples of the various kinds of marble specified. Sample submittals shall represent the full range of color and markings inherent in the material proposed for fabrication of the project. Full range sample sets must be reviewed and approved as a complete set and not as individual pieces. Full range sample sets shall be indicative of the true character, including any natural variation in background and foreground color, veining or graining, of the material currently available and proposed for use on the project. The sample size shall be 1'-0" x 1'-0" minimum, 2’-0” x 2’-0” minimum for heavily veined or varied stones, and shall represent approximately the finish, texture, and anticipated range of color to be supplied. Where necessary to show variations in color and markings, larger samples or range sets of samples should be submitted. If marble is to be matched, a minimum of two sets each containing four matched samples showing proposed veining and range of color in each set must be supplied. Samples designating finished face shall be clearly labeled on the back with the name of the marble, the group classification for soundness, and the use for which the marble is intended. One set of samples shall be retained by the Specifying Authority, and one set shall be returned to the Marble Supplier for his/her record and guidance. It is noted herein that marble is a natural material and will have intrinsic variations in color, markings, and other characteristics. Depending on the marble selected and quantity required, a range mockup may be used to further define the characteristics of the material. Cost of mockup, if required, shall not be included in this section. Prior to fabrication, and to assure the end user’s needs will ultimately be met and to fully understand the finish and full range of the material, an inspection and approval by the Specifying Authority and/or General Contractor and/or End User of the material is recommended. Costs for an initial inspection of the quarried blocks before slabbing, and a second inspection of the finished material slabs before fabrication shall be stipulated and included in the overall contract requirements.

Shop Drawings

The Marble Contractor shall submit through the General Contractor, for approval by the Specifying Authority, sufficient sets of shop drawings showing general layout, jointing, anchoring, stone thickness, required setting spaces and such other pertinent information. These drawings shall show all bedding, bonding, jointing, and anchoring details along with the net piece dimensions of each marble unit. Due to tight fabrication tolerances of dimensional stone (see “Dimensional Tolerances” in this section) special attention must be paid to those areas where associated trade’s work abuts or is integral with the stone installation.

Additional notes calling out required set backs, setting space allowances below and behind floor and wall installations, critical “hold-too” dimensions, or any other specific conditions requiring strict coordination with other trades work should be incorporated into the shop drawings. Coordination of approved shop drawings with all affected trades is the responsibility of the General Contractor. One copy of approved drawings shall be retained by the Specifying Authority, one copy shall be retained by
the General Contractor, and one copy returned to the Marble Contractor for fabrication. NO FABRICATION OF MARBLE SHALL BE STARTED UNTIL SUCH DRAWINGS HAVE BEEN FULLY APPROVED AND MARKED AS SUCH. The General Contractor shall

furnish all field dimensions necessary for fabrication. If measurements are not established and guaranteed in advance, the Marble Contractor shall obtain and verify measurements at the building. The General Contractor shall be responsible for all reasonable assistance to the Marble Contractor, including the services of an Engineer, if required, for the establishment of levels, bench marks, and the like. The Marble Contractor shall not be responsible for determining, making, or verifying (1) design, structural, wind, seismic, or other design loads; (2) engineering estimates; (3) plans or specifications; or (4) the types, sizes, or locations of anchors, unless specifically added to the scope of work.

Defective Work

Any piece of marble showing flaws or imperfections upon receipt at the storage yard or building site shall be referred to the Specifying Authority for determination as to responsibility and decision as to whether it shall be rejected, patched, or redressed for use.

1.9 Repairing Damaged Stone

Small chips at the edges or corners of marble may be patched provided the structural integrity of the stone is not affected and the patch matches the color and finish of the marble so that the patch does not detract from the stone's appearance. More extensive repairs may be required for certain Class C & D marbles and are acceptable pending above stipulations.

1.33.2 MATERIALS

Marble

General: All marble shall be of kind or kinds shown on the Project Engineer's drawing or as specified herein, conforming to or within the range of approved samples and in accordance with the characteristics and working qualities set forth under their respective Soundness Group Classifications, A, B, C, or D, as defined by the Marble Institute of America. Some Class C & D marbles, while prized for their vibrant colors and bold veining, are more apt to require patching and repair due to the physical limitations of these highly veined materials.

Care shall be taken in selection to produce as harmonious effects as possible. Patching and waxing, where permitted under the Marble Institute of America Group Classifications, shall be carefully done to conform to the marble's general character and finish. Texture and finish shall be within the range of sample(s) approved by the Specifying Authority. ASTM C503 [C97] [C99] [C170] [C241] [C880]. See the chart of applicable ASTM standards and tests in the Appendix. Schedule: Marble shall be provided as follows:

1) For (state location on building) (state name and color) marble with a (type) finish, supplied by (name company or list several approved suppliers). 2) Provide information as in (1) for each different marble/finish combination in the project.

Finishes: Finishes listed in the schedule shall conform with definitions by MIA or ASTM International.

Polish finish: A mirror like, glossy surface which brings out the full color and character of the marble. This finish is not recommended for exterior or commercial floor use.

Honed finish: A velvety smooth surface with little or no gloss. Abrasive finish: A flat, nonglossy surface usually recommended for exterior use.

Setting Mortar (and Adhesives)

All proposed setting materials shall be tested by the Marble Contractor to assure that there is no staining to the specified stone. Light colored and green marbles are typically more susceptible to staining and require additional consideration to avoid damage to stone during installation.

Portland cement shall conform to the requirements of the Standard Specifications for Portland Cement, ASTM C150-02a. White Portland cement is recommended for white or light-colored marble. Nonstaining cement shall conform to the requirements of the Standard Specifications for Masonry Cement, ASTM C91-03. Molding plaster (plaster of Paris) shall conform to the requirements of the Standard Specifications for Gypsum Molding Plaster, ASTM C59/C59M-00.

Sand. All sand shall be clean, free from organic and other deleterious matter likely to stain the finished work, and shall be screened as required for the desired results.

Portland cement shrinkage-reducing accelerator used with Portland cement to give it the quick-setting characteristics of plaster of Paris, shall be a nonstaining admixture that will not corrode anchors or dowels. Nonstaining adhesive shall be of a type that will not stain the marble, that is not affected by temperature changes or moisture, and that adheres with strong suction to all clean surfaces.

Pointing Mortar

Mortar for pointing shall be Type N, as defined in ASTM C270-03 (Standard Specification for Mortar for Unit Masonry). All mixing, handling, and pacing procedures shall be in accordance with ASTM C270-
03.

Sealants and Backup Material (if applicable)

Where specified (state type or name of sealant) shall be used for the pointing of joints. The backup material used with the sealant shall be (identify material). Sealants, used for pointing to exclude moisture and provide a joint that will remain plastic for many years, shall be nonstaining.

Anchors, Cramps, and Dowels

Anchors, cramps, and dowels shall be made of corrosion-resistant metals. Special cramps, dowels, and the like shall be used where shown on shop drawings, but elsewhere, #8 copper or stainless-steel wire anchors shall be used. It shall be the responsibility of the Marble Contractor to anchor all marble securely. For standing marble, the following practices usually prevail:

A minimum of four anchors should be provided for pieces up to 12 square feet, with two additional anchors for each additional 8 square feet of surface area. Shims used to maintain joints shall be plastic. Use of copper wire for anchors to be installed over 12' off the ground is not recommended.

1.33.3 FABRICATION

Dimensional Tolerances

Panel thickness of 3/8" or 1/2".......±1/32"

Panel thickness of 3/4" to 1-5/8" ....±1/8" Panel thickness >1-5/8"................±1/4" Panel face dimension ....±1/16" Face variation from rectangular

.......±1/16" (maximum out of square) (noncumulative) Heads/calibrated edges ....±1/16" Quirk miters (width of nose):
Up to 1/4"………-0; +25% of dim
Over 1/4"……………-0, +1/16"
Location of back anchors................±1/8"
Depth of back anchors…………-0, +1/16"
Location of holes for precast anchors. ..... ±1/4" Hole depth for precast anchors........ ±1/16" Anchor Slots:
From face to C/L of slot ..... ±1/16" Lateral placement.............. ±1/4" Width............................ ±1/16" Depth at maximum............ ±1/8"
Anchor Holes:
From face to C/L of slot ..... ±1/16" Lateral placement.............. ±1/8" Diameter .... ±1/16" Depth .... ±1/8" Anchor Sinkages:
Depth……………………-0, +1/8"
Continuous Kerfs:
From face to C/L of kerf..... ±1/16" Maximum bow in 4'-0"....... ±1/16" Width............................ ±1/16"
Depth……………...-1/16"; +1/8"
Rebated Kerf:
Elevation of bearing surface. ±1/16"
Bearing Checks:
Elevation of bearing surface. ±1/16"
Bearing/Clearance Checks:
Lateral location .... ±1/2" Setback from face.............. ±1/16"

Typical Unit Sizes

Tile stock- 12” x 12”, 16” x 16”, & 18” x 18” nominal. Thickness of tile stock is typically 3/8” thick for most polished and honed surfaces. Large format tile stock (16” x 16” and larger) may only be available in 1/2” thickness and is dependent on the specific stone’s properties and the material supplier.

Dimension Stone Slab Stock- Industry standard slab stock available in 2 cm & 3 cm (3/4” & 1 1/4” nominal) thickness. Typical slab sizes vary by material, but average 4’-0 x 8’-0” for marble. For specialty thicknesses or extremely large piece size requirements, the Marble Contractor should be consulted in the design phase to assure the design intent can be met. Typical maximum finished piece size is 3’- 0” x 3’-0” +/-.

Flatness Tolerances

Variation from true plane, or flat surfaces, shall be determined by a 4' dimension in any direction on the surface. Such variations on polished, honed, and fine rubbed surfaces shall not exceed tolerances listed below, or 1/3 of the specified joint width, whichever is greater. On surfaces having other finishes, the maximum variation from true plane shall not exceed the tolerance listed below, or 1/2 of the specified joint width, whichever is greater.

Flatness Tolerances by Finish.

Polished, honed, or fine rubbed.........1/16"

Sawn, 4-cut, 6-cut, and 8-cut ....1/8" Thermal and coarse stippled ....3/16" Pointed or other rough cut ....1" Split face.…dependent on piece size & stock

Beds and Joints

Bed and joint width shall be determined by analysis of anticipated building movements and designed to accommodate such movements without inducing undue stresses in the stone panels or joint filler materials. Expansion joints shall be designed and located to accommodate larger movements.

Backs of Pieces

Backs of pieces shall be sawn or roughly dressed to approximately true planes. Back surfaces shall be free of any matter that may create staining.

Moldings, Washes, and Drips

Moldings, washes, and drips shall be constant in profile throughout their entire length, in strict conformity with details shown on approved shop drawings. The finish quality on these surfaces shall match the finish quality of the flat surfaces on the building.

Back-Checking and Fitting to Structure or Frame

The building design should incorporate stone installation requirements such as material thickness, setting space, and anchorage allowances. Maintain a minimum of 1 1/4” between stone backs and adjacent structure and allow for all components of the building structure (waterproofing, flashing, etc). (Note: many bolted connections will require more space than this; 2" space may be more desirable. Large- scale details should illustrate and control these conditions and be distributed by the General Contractor to the affected trades.)

Cutting for Anchoring, Supporting, and Lifting Devices

Holes and linkages shall be cut in stones for all anchors, cramps, dowels, and other tieback and support devices per industry standard practice or approved shop drawings. However, additional anchor holes may be drilled at job site by Marble Contractor to facilitate alignment. No holes or linkages will be provided for Marble Contractor’s handling devices unless arrangement for this service is made by the Marble Contractor with the Marble Fabricator. (NOTE: It is not recommended that Lewis pins be used for stones less than 3-1/2" thick.)

Cutting and Drilling for Other Trades

Any miscellaneous cutting and drilling of stone necessary toaccommodate other trades will be done by the Granite Fabricator only when necessary information is furnished in time to be shown on the shop drawings and details, and when work can be executed before fabrication. Cutting and fitting, due to job site conditions which are contrary to the dimensions and details shown on approved shop drawings are not the responsibility of the Marble Contractor and will be provided only by arrangement between the General Contractor and Marble Contractor.

Carving and Models

All carving shall be done by skilled Stone Carvers in a correct and artistic manner, in strict accordance with the spirit and intent ofthe approved shop drawing, or from models furnished or approved by the Specifying Authority.

1.33.4 SHIPPING AND HANDLING

4.1 Packing and Loading

Finished marble shall be carefully packed and loaded for shipment using all reasonable and customary precautions against damage in transit. No material which may cause staining or discoloration shall be used for blocking or packing.

4.2 Site Storage

It shall be the responsibility of the Marble Contractor to receive, store, and protect the marble from damage by others after it is delivered to the job site and prior to its erection in the building. All marble shall be received and unloaded at the site with care in handling to avoid damage or soiling. If marble is stored outside, it shall be covered with nonstaining waterproof paper, clean canvas, or polyethylene.

1.33.5 INSTALLATION

General Installation

Installation shall be accomplished with competent, experienced Stone Setters, in accordance with the approved shop drawings. All marble pieces shall be identified with a unique piece number corresponding with the number on the shop drawings. Interchanging of numbered pieces is not permitted as the pieces are generally blended for color and characteristic markings by the Marble Fabricator. Marble shall be free of any ice or frost at time of installation. Salt shall not be used for the purpose of melting ice, frost, or snow on the stone pieces. Adequate protection measures shall be taken to ensure that exposed surfaces of the stone shall be kept free of mortar at all times as elements in mortar may etch the polished surfaces of some stones. All setting materials shall be tested on the specified stone to assure there is no staining.

Mortar Setting of Marble

A. Floor Marble

Floor Preparation. It is the General Contractor’s responsibility to
clean all sub floor surfaces to remove dirt, dust, debris, and loose particles immediately prior to setting marble floor and to ensure that the area to receive the stone flooring meets the deflection standards of the industry.

Curing Compounds. Curing compounds of any kind shall not be used on the slab on which floor marble is to be directly set. If a curing compound is present, it is the General Contractor’s responsibility to remove it by scarifying the slab. Before being set, all marble shall be clean and free of foreign matter of any kind.

Cement Bed. The cement bed to receive the marble tile shall consist of 1-part Portland Cement to not more than 3 to 5 parts of clean, sharp sand mixed quite dry for tamping. White Portland cement is recommended for light- colored marbles.

Marble Tamped. The marble shall be stamped with a suitable mallet until firmly bedded to the proper level of the floor.

Marble Removed. The marble shall then be removed and the back parged with wet cement or the bed sprinkled with water and cement. In the latter procedure, the back of the marble shall be wet. The method of fully buttering edges of the marble as it is laid is equally approved.

Joints. Joints between the marble pieces shall show an even width when laid and finished.

Traffic After Installation. The floor shall be roped off for 24 hours after installation and then grouted with water and white Portland cement grout or nonstaining dry-set Portland cement grout.

Time-Line for Additional Cleaning.

Cleaning or additional surfacing, if required, shall not be undertaken until the new floor is at least seven days old.

Thin-Set Method. The thin-set method of installing marble tile employing the use of dry-set Portland cement mortars is recommended for thin marble tiles (nominal 3/8" thick) where optimum setting space is not available. Sub floor shall be clean, smooth finished, and level.

Stone dust must be washed off the back face of stone pavers prior to installation. Apply mortar with flat side of trowel over an area that can be covered with tile while mortar remains plastic. Within ten minutes, and using a notched trowel sized to facilitate the proper coverage, comb mortar to obtain an even-setting bed without scraping the backing material. Key the mortar into the substrate with the flat side of the trowel. Comb with the notched side of the trowel in one direction. Firmly press stone tiles into the mortar and move them perpendicularly across the ridges, forward and back approximately 1/8"to ¼" to flatten the ridges and fill the valleys. Ensure a maximum mortar thickness of 3/32" between stone tile and backing after stone tile has been tamped into place.

Stone tile shall not be applied to skinned-over mortar. Alternatively, back butter the stone tiles to ensure 100% contact. In either method, ensure 100% contact on 3/8" tile; not less than 80% contact on ¾" or thicker material, noting that all corners and edges of stone tiles must always be fully supported, and contact shall always be 100% in exterior and/or water-susceptible conditions.

B. Interior Veneer Marble

The marble shall be set by spotting with gypsum molding plaster or cement mortar and the use of concealed anchors secured in the wall backing. Special consideration may be required for penetrations to fire rated walls.

C. Marble Wall Tile

Individually set thin tile (nominal 3/8" thick) on vertical surfaces exceeding 8' is not recommended. Where thin marble tile is installed, nonstaining adhesives or dry-set mortars may be used as setting beds.

D. Toilet and Shower Compartments

Stiles and partitions shall be assembled with concealed dowel fastenings or corrosion resistant angles, three in height of stall. For ceiling-hung units, metal supporting members in ceiling are to be furnished and installed by the General Contractor.

Mortar Joints

Mortar joints shall be raked out to a depth of ½" to ¾". Apply pointing mortar in layers not exceeding 3/8" and allow each layer to get hard to the touch before the next layer is applied. Tool finished joints with a concave tool having a diameter approximately 1/8" greater than the joint width. Care shall be taken to keep expansion joints free of mortar, which would compromise their function.

Anchorage

All marble shall be anchored or doweled in accordance with the approved shop drawings. To the furthest extent possible, all anchor preparations in the marble units shall be shop applied. All anchorage devices and anchor hole/slot fillers shall be in accordance with ASTM C1242-02. Care must be taken to ensure that any holes capable of retaining water are filled after use to prevent water collection and freezing.

Sealant Joints

Where so specified, joints requiring sealant shall be first filled with a closed-cell ethafoam rope backer rod. The backer rod shall be installed to a depth that provides optimum sealant profile after tooling per manufacturer recommendations. If recommended by the Sealant Manufacturer, primers shall be applied to the substrate surfaces according to the manufacturer's directions prior to application of the joint sealant. A test should be conducted to assure that the specified sealant will not stain the stone. Typically, Sample pieces of stone with kerf cuts applied to the sample face representing the typical joint size (1/4" x 1/4", 3/8" x 3/8", 1/2" x 1/2" etc.) are filled with the specified sealant and allowed to cure for 24 to 48 hours. Any potential staining should be apparent at this point. Fully cured sealant samples will be submitted to demonstrate no staining to stone by the specified sealant.

Expansion Joints

It is not the intent of this specification to make control or expansion-joint recommendations for a specific project. The Specifying Authority must specify control or expansion joints and show locations and details on drawings. Typically, expansion joints are required at 20'-0" intervals and should be determined by the design professional and the Marble Contractor.

Caulking

Where so specified, joints shall be pointed with the sealant(s) specified in Section 2.4, after first installing the specified backup material and applying a primer if required, all in strict accordance with the printed instructions of the Sealant Manufacturer. All sealants shall be tooled to ensure maximum adhesion to the contact surfaces.

Weep Tubes

Plastic or other weep tubes shall be placed in joints where moisture may accumulate within the wall, such as at base of cavity, continuous angles, flashing, etc., or as shown on Project Engineerural drawings.

Installation Tolerances

The quality of the stone installation relies greatly on the quality and accuracy of those trades preceding stone installation.

After review and approval, shop drawings shall be distributed and coordinated by the General Contractor to all trades whose work abuts, or is integral with the stone installation.

Variation in plumb:
Lines and surfaces of walls and columns:
.... ¼" in 10'-0"
.... NTE 3/8" in story height
.... ½" in 40'-0" Exterior corners or other
conspicuous lines:
.... ¼" in 10'-0"
.... NTE 1/4" in story height
.... ½" in 40'-0" Variation from level:
Lintels, parapets, rustications:
.... ½" in column bay
.... ¾" in 40'-0"
Variation from linear building line:
½" in column bay
.... ¾" in 40'-0"

1.33.6 CLEANING AND PROTECTION

Cleaning

All cleaning methods shall be tested on material samples prior to application to the stone installation to assure there are no adverse effects of the cleaning method or products to the stone surface. Marble shall be cleaned after installation and all pointing or caulking is complete. All dirt, excess mortar, weld splatter, stains, and other defacements shall be removed. All cleaning methods shall be in accordance with ASTM C1515-01.

Marble Contractor should be contacted before cleaners other than neutral detergents are used.

Protection of Finished Work

After the marble work is installed, it shall be the responsibility of the General Contractor to see that it is properly and adequately protected from damage or stains until all trades are finished. This responsibility includes the stone cleaning costs prior to the required final inspection. The Marble Contractor will outline the needs for protection, in writing, to the General Contractor. For the protection of projecting members, corners, window stools, and saddles, wood guards using lumber that will not stain or deface with marble shall be supplied, installed, and maintained by the General Contractor.

All nails used shall be galvanized or nonrusting. Damage to finished marble by other trades shall be repaired or replaced at the expense of the General Contractor. Marble flooring shall be adequately protected by the General Contractor against traffic and other damage with nonstaining materials, without cost to the Marble Contractor. All marble work in progress shall be protected at all times during construction by use of a strong, impervious film or fabric securely held in place as required.

1.34 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 materialsforming 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 SupplyAuthority. The Sub-Contract Works shall also comply where applicable to Kenya Standards as published by Kenya Bureau of Standards or current editionIEC (International Electro Technical Commission) and British Standards Codesof 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 theSub-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 bereplaced 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 bearthe cost of any associates 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 theSpecification shall be limited so as not to exceed the maximum permissible starting currents described in the Electricity Supply Authority's (KPLC)Bye- Laws.
Attention is drawn to the fact that all the Sub-Contractor's work is subject tothe 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 staffavailable 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 inaccordance 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 withthe appropriate British Standards. The switchboards shall be flush fronted inappearance 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 RecordDrawings relating to the switchboard, made in ink on tracing cloth.

Four sets of instruction manuals are to be provided describing the method ofoperating 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 fittedwith 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 EpoxyResin.

Bus-bars and current transformer joints and connections are to be insulated byepoxy 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 connectionsshall be constructed from high conductivity solid copper.
The bus-bars and bus-bar supports shall be arranged to withstand, withoutdamage, 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 forphase identification.

3.1.5 Extensibility

All units shall be so designed and the bus-bars drilled so that further extensionunits 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 thereception of the cable specified.

3.1.7 Special Tropical Finish

The switchgear shall be designed for use in the tropics and the followingrequirements 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 resign bond and finished with two coats of paint.

2.1.3 The interior of all gear not having oil, compound or other insulation, andall 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. 4800to be chosen by the Engineer.

3.1.8 Labels

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

3.1.9 Relays

Protection relays shall be of the type and number listed in the schedule ofrequirements for HV switchgear in the Particular Specification.
All relays shall be flush mounted, and where required, shall be provided withadditional contacts for remote indication etc., Bezels shall be finished in blackgloss.
The relays shall have their secondary connections brought out to studs on therear 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 andin the schedules of requirements for HV switchgear in the Particular Specification.
Ammeters shall be MICS 100mm square dial flush mounting pattern withrotary selection switch.
Voltmeters shall be MICS 100mm square dial flush mounting pattern withrotary selector switch.
The construction of the instruments shall be in accordance with B.S. 89 andshall be of industrial grade.

3.2 Instrument Panels

Instrument panels shall be mounted at the same height on each unit and havesuitably 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 otherdevices 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 anapproved type at each end.
All wiring within each switchboard, not installed in conduits, shall be neatlylaced and cleated to the panel structure of each switchboard and its auxiliaryequipment. Where wiring passes through a hole in the metal work, thermoplastic grommets shall be used and in no case shall cables be unprotected where theycome into contact with the edge of a piece of metal work.

3.5 Current Transformers

Separate current transformers shall be provided for protection andinstrumentation.
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, besuitable 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 bestated. Cartridge type fuses shall be provided for protection of both primaryand secondary windings.

3.7 Drawings for Approval

The following drawings shall be submitted for each switchboard for approvalas 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 theEngineer. In addition, the Sub-Contractor shall provide any other drawings or information required by the Engineer in order that the Engineer may satisfyhimself 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 theswitchboard to which each unit shall be bonded.
A wall chart mounted on metal, with instructions for the treatment of electricshock, 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 eachwith two keys.
A framed diagram showing clearly the layout of the high voltage distributionsystem 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. trippingcircuit 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 tripterminals 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 forin 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 groupDY.11, insulation Class `C'. The arrangements and connection of windings,tap-changing, loading and terminal boxes shall be as previously detailed inClause

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 describedin 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'sworks 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 testsshall 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 thetransformers. Certificates of type tests (B.S. 171, Clause 1802 (b)) will be acceptable subject to the Engineer's approval except where specified elsewherein 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 isready 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 tominimize 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 appropriateBritish 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 approvedmeans 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. Modula 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 doorsand 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 cementedresilient gasket seals to provide a dust proof enclosure. All hardware and fastening shall be heavily cadmium plated. No self-tapping screws shall beused.

All steelwork shall be clean and free of burrs, scale and blemishes, with all rawedges hidden and shall be finished with a rust inhibiting treatment one primeror 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 andinterlocks 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 andother 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 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 and2No. 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 providedand installed so that future components may be installed and connected in theleast 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 thatany 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 manufacturedand 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 bewithin the bus-bar chamber.

Bus-bars shall be sheathed in approved insulating material, in their respectivephase 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 andconnections, with variations in temperature.

Interconnections between bus-bars and switchgear shall be of minimumlength, 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 accessto all joints and connections shall be provided.

5.4 Circuit Breakers

Where oil circuit breakers are called for on the drawings, they shall be suitablefor 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 26MVA 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 suitablefor 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 and2No. spare spaces

Each circuit breaker shall be fitted with telescopic rails to allow the breaker tobe 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 racket 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, closingmechanism.

Inverse definite minimum time lag over current relay protection shall beprovided 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 andits 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 shallalso be provided.

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

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

Each circuit breaker shall be provided with the facility of locking the breakerin the ’OFF’ position.

5.5 Oil Switches

Oil switches shall be identical to the oil circuit breakers, B.S. 5311 except thattripping 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 shallbe 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 shallbe 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 ofthe 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 thefuse links.
The switch contacts shall be separately and fully shrouded and shall berenewable.

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 thefull 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 hightensile 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 theswitchboard enclosure. This bar shall be mounted on insulators and shall be divided into sections according to the design of the switchboard. The sectionsshall be connected by copper links double bolted to each section.

Voltmeters shall be MICS 150mm square dial, flush mounting pattern with rotaryselector 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 theswitchboard.

5.10 Phase Failure Relays

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

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

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

In addition, test buttons shall be provided. The test buttons shall be connectedin 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 theswitchboard.

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 accordancewith 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 interlockinghandles 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-hygroscopictype and to the Engineer's approval.

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

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

ii) Units rated in excess of 100 amps and for a system voltage not in excess of380 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 unlessotherwise 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 orcircuit breakers. The cabling zone shall be fully insulated from any live metal partso that future cabling and alterations can be carried out in complete safety withoutthe 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 thedrawings. Cases shall be zinc coated sheet steel of substantial construction withhinged lids fitted with foam rubber gasket, enamelled finish. Where called forin the specification the cases shall be provided with locks. For ratings of 60 amp. and over detachable drilling plates and soldering lugs for incoming cableterminations 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 carriersand bases, removable insulated shields to provide adequate protection againstaccidental contact with live metal, and circuit indicating labels fixed inside thecover.

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 minimumshort 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 ofminiature 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 orequal 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 acard or identification plate fixed to the inside of the Board or were providedfor. This information must include the outlets (with cross reference to the reference numbers on Contract Drawings) fed from each fuse way or MCB andthe 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

Lifts Distribution 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 communicating module

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 forcables with copper conductors.

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

Multi core cables shall be paper insulated, lead sheathed, single wire armouredand served with hesian 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 ContractDrawings.

6.1.1 Jointing

Where possible the core of the paper insulated cable shall be taken direct tothe 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 andsealing 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 mustnot be removed until all preparations for jointing are complete and adequate protection from the weather arranged by the Sub-Contractor.

Before rejointing cable ends shall be tested from moisture content in an approved manner. If any moisture is discovered the wet cable or cables shall becut out.

Care shall be taken when making off cable ends to phase out the cores to agreewith 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 Zend. 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 be660/1000-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 ContractDrawings 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 shallbe 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 ContractDrawings 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 byindentation 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 shapeof 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 eachcore adjacent to the terminal.

Aluminium armour may be used as the earth continuity conductor where the Crosssection 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 shallbe 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 shallinclude for the supply and installation of all jointing material, cable supports, steelracking 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 thetop 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 notbe fragged 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 mayrun adjacent to or across the route of the cable being installed.

Cables shall be installed with a minimum of 300mm clearance form 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 tapeand grouted in. A hard wood surround below shaped to suite 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 orto a height of 1.5m above floor level.

Detailed drawings showing dimensions and method of manufacture of the cableguards 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 testsshall 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 betreated with one coat of zinc primer and two coats of anti-corrosive paint and shallbe 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 toavoid 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 withoutexerting undue pressure or strain on the cables.

In the case of vertical cables, the cleats shall be so designed and of sufficient numberto 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 atall 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 notbe 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 ductsunder roadways or concrete walkways under which cables are to be routed.
The Main Contractor will supply and install ducts where required in the footings ofbuildings, 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 ateach 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 ofthe 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 aneffective seal.

The box shall be provided with an external armour clamp. The lead sheathing of thecable 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 armouringneatly fixed by means of binding wire and the external clamp. The Sub-Contractorshall 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 bondshall be fitted at the time the joint is made.
An adequate compound filling gland shall be provided on each box and shall be soplaced 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 tarderivatives of any kind and having no deleterious action whatever on the materialsused 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 inthis 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 otherapproved cable covers indelibly marked "DANGER, HATARI".

Cable marker posts fabricated in precast concrete, shall be installed at each cableentry into the building, each change of direction, each road or pathway crossingand 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 teejoints 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 coresand to earth and the results of these tests shall be recorded and communicated to theEngineer.

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 andfor 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 accordancewith B.S. 6207 by an approved manufacturer. Where installed in corrosive situations, they shall be PVC sheathed. No cable shall have conductors less than1.5mm² 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 ContractDrawings or the Specification.
All mineral insulated copper sheathed cable glands shall be of the samemanufacture as the cable and shall be of the compression type.
The choice of cable seal type shall be based on the manufacturer recommendationfor the particular application.
In areas where a flameproof installation is specified, the glands shall be of flameproof 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. Theyshall, however, be fitted with rigid impact resistant hoods and shall be filled withplastic compound as used for sealing the 44^{0}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 atermination, 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 fixingsshall 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 andbrackets 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 ofthe 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 andinsulation tests shall be performed 24 hours after the cable has been sealed.
Where single core MICS cables are used, all necessary precautions shall be takento prevent hysteresis and eddy currents.

Ferrous plates or structures through which the cables pass shall be slotted andbrass 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 ofthe 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 insulatedcable, enclosed in steel screwed conduit or trunking mechanically and electricallycontinuous throughout.

Conduit shall be buried in the wall and floors of the building, and either run inroof 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 insulatedcable enclosed in steel screwed conduit or trunking, mechanically and electricallycontinuous throughout.

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

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

Wiring shall be carried out in an approved type single core, plastic insulated cablewith 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 roofspace or buried in structural slabs.

7.1.4 System D - PVC Insulated Cables with Insulated Earth Continuity Conductorenclosed in Non-Metallic Conduit or Trunking fixed to the Surfaces of Wallsand 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 conduitor 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 inwalls and floors.

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

The installation shall be carried out in an approved type twin or three-core PVC insulatedand sheathed cable. Cables shall be securely fixed to the surface of the walls and in theroof spaces, and shall be fixed to the underside of ceilings, only when three is no reasonable access from above. They shall be fixed to walls and the sides of roof membersor 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. Wherecables 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 jointsbe 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 sideof wooden joints or otherwise protected from radiant heat.

7.1.7 System G - PVC Insulated and Sheathed Cables Clipped to Roof Members andRun 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 PaperInsulated 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 ductsor laid in trenches. Cables suspended on multiple hangers shall be so arranged that onecable 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 metalswith which they are liable to set up electrolytic action. All spacings of cable hangers andsupports shall not exceed those laid down for the relevant size and type of cable in thecurrent 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 patternto 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 ofobstruction 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 tieoff 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 bedeemed to be galvanised unless specified otherwise.

The number of cables to be installed in trunking shall be such as to permit easy drawing inwithout damage to the cables, and shall in no circumstances be such that a space factor of45% is exceeded.

Conduit and trunking shall be mechanically and electrically continuous. Conduit shall betightly 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 bymeans of smooth bore male brass bushes, compression washers and sockets. All exposedthreads and abrasions shall be painted (using an oil paint for black enamelled tubing andgalvanising 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 2½ 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, andthey 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 atnot 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 conduitinstalled 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 complywith 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 junctionbox, 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 ofany 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 fillingin 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 ofoil 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 300mmwaterproof 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 forconduit connection and a thread for conduit connection and a thread to receive the flexibleconduit. The adaptor shall be sweated solid to the flexible conduit and the rub screw fullytightened.

8.3 Plastic Compound

All galvanised boxes and boxes in a situation where the air flow is likely to cause excessivecondensation 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-inboxes shall be provided in telephone conduit on the same basis as laid down for powerand 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 otherservices.

8.5 Television Conduit

Television conduit shall be 19mm diameter thermo-plastic type installed vertically fromeach outlet point terminating 300mm above finished roof surface. A purpose made bendshall 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 completewith plug type L734/PAl, 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 widthand 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. 7type.

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

Cable tray shall be appropriately fixed on robust and substantial brackets fixed into thewalls 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 shallbe minimum 10mm. dia. mild steel, Brackets or suspension supports shall be provided asnecessary, 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 radiusof 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 copperbus-bars rising through the building via the riser duct, and supplying the distributionsystem 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 bein 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 theContract 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 50oC.

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 takingup the maximum expansion and contraction likely to occur in the bars under normal conditions shall be incorporated. The recommendations of the manufacturers in thisrespect 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 lowerend 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 toensure 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-bartrunking. The tape shall be bonded to each section at intervals not exceeding 1200mm, bymeans 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 togetherto make a single unit. The capacity of each section shall be adequate for the number ofconductors 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 topoint and no tee or other joint will be permitted. Conductors of the same circuit shall becontained in the same conduit or trunking. At distribution boards, the neutral bar in thesame sequence as the live conductors are connected to the fuses or circuit breakers so thatthey 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-voltgrade, single-core. No cable smaller than 1/1.38mm (1.5^2) shall be used. Cable size shallcomply with circuit details as indicated on the Contract Drawings. Slack cable shall beleft at all points of connection.

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

i) 1/1.38mm. ($1.5mm^2$) and 1/1.78mm. ($2.5mm^2$) - the conductor doubled backon itself to present a double thickness.

ii) 7/0.85mm ($4.0mm^2$) to 7/1.70mm. ($15mm^2$) - the strands well twisted togetherto make as solid a conductor as possible.

iii) 7/2.14mm. ($70mm^2$) and above - the strands sweated solid or fitted withpurpose 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, orcompleted 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 trunkingbeing 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 beof 300/500-volt grade VR or PVC insulated and shall comply with B.S. 6500. No flexiblecord smaller than $0.75mm^2$ 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 installationand 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 bythe Sub-Contractor at his own expense.

10.2 Testing Equipment

The Sub-Contractor shall provide accurate instruments and apparatus and all labourrequired 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 Worksand 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 primarilyof 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 shallbe 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:

Maximum Prospective Fault Current	Insulated Stranded Conductor	Bare Copper Conductor
14 KA	19/2.52 (95mm²)	25mm x 9mm
9 KA	19/2.14 (70mm²)	25mm x 3mm

Where necessary, earthing connections shall be protected against mechanical damage andcorrosion.
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 connectedtogether and to the earth bus-bar by an insulated stranded conductor. The earth rods shallbe 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 lessthan 3m. from the building. The head of the earth rods shall be driven to 300mm belowthe 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 isolatedswitchgear, connected to the earth busbar.

   A complete earth electrodes system, installed as specified in Clause 10.01, connectedby 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, theearth electrodes and earth continuity conductors, described in (1) and (2) above, shallbe 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 withthe 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, describedin 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 themain 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 shallbe 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 ofthe electrical installation so as to ensure that no difference in electrical potential can arisebetween 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 inPart 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 betweenrecessed point boxes and finished ceiling levels.

12.3 Enclosures

In situations where a lighting fitting is fitted to a ceiling of combustible material, the backplate or other accessory shall be so designed that the connecting cables are completelyenclosed.

12.4 Earthing of Lighting Fittings

At every lighting point an earthing terminal shall be provided and connected to the earthcontinuity 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 canbe 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 anyother services in the ceiling void at that point.

No. claims will be considered for costs of extra works or damages which arise out of theSub-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 asspecified. The type of accessory to be used in each location is related to the type of wiringsystem in that area,

In all cases where switches are grouped together, and are connected to the same phasethey 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 platesshall 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 haveintegral 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 aresupplied as part of the Sub-Contract Works, they shall have a finish to match the otheraccessories installed in the same area.

14 SECTION 14- PLANT POWER WIRING

14.1 General

Wiring to motor outlets and control outlets in Plant Rooms, Boiler Houses, etc., and to remote motor and control outlets forming part of the Mechanical Engineering Servicesinstallation, 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 ofequipment 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.

14.2 Power Outlets for Lifts

The outlet for each lift shall terminate on an isolator located at the position shown on theContract Drawings. The rating of the isolator and the size and type of cables are shownon the diagram of connections. Each outlet shall be wired on a separate circuit using butylrubber cables in conduit or MICS cables, as indicated on the diagram of connections.

The switch fuse controlling a Firemen's Lift shall be located on the main switchboard, andshall be provided with means for padlocking in the `ON' position.

Where the installation includes a mains failure generator, the supply to the Firemen's Liftshall be connected to the `essential services' section of the main switchboard.

The isolating switch controlling each lift shall disconnect all supplies to the lift hoist andcontrol equipment

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., suitablefor plain connections.

15.2 Manipulation

The conduit shall be bent and formed strictly in accordance with the manufacturer'sinstructions.

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 isbent past 90^{o} 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, sh all 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 orrag. `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 shallbe 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 pushsocket 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 mainconcrete 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 floorscreed, whichever shall prove to be the most suitable method of installation for use in thebuilding under construction. Unless it is clearly specified or shown on the drawing, themethod 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 fixednot more than 900mm apart.

Surface conduit shall also be fixed 125mm. on both sides of all boxes, the box itself beingsecurely fixed. Where such an arrangement of boxes and saddles would prove to be bothunsightly 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. Insuch 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 servicesand 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 thepouring and vibrating of the concrete. Outlet boxes shall be filled with paper to preventingress of concrete, and all boxes shall be securely fixed to the shuttering with nails, or bymeans which shall be visible as a marked-on removal or the shuttering only where thesemarks 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 bycouplings plugged with a suitable non-metallic stopping plug. The number of right anglebends in conduit cast in-situ shall not exceed two between boxes. Immediately prior toinstalling the wiring all conduit and fittings shall be dried and cleaned out by drawingthrough 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'sinstructions 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 beprovided and fixed at all junctions.

The above circular boxes or equivalent looping boxes shall be provided and securely fixedfor all ceiling points. When the conduit is run on the surface, all circular boxes for ceilingpoints shall be fixed with screws.

Where ceiling roses occur and the ceiling box is recessed below the finished level of theceiling, 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 thebox does not exceed 60^{o}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 withstopping plugs.

15.8 Continuity

Where fittings and accessories require earthing, an earth continuity conductor shall berun through the conduit. The earth continuity conductor shall be of copper minimumsize 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 barin 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 Nairobi, Kenya.

16.2 Description of Project

The project shall comprise the development of an office block.

16.3 Commencement of Works

The Sub-Contractor in submitting his tender shall be deemed to have included forcommencing any necessary work on site at such time as will comply with the MainContractor'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-	31°C
Minimum temperature-	17°C
Average temperature range-	24°C
Relative humidity range-	50% - 85%
Altitude-	1350 M above sea level
Latitude-	0° 10′03S
Longitude-	34° 27′55E

Rainfall- Extremely heavy at certain periods of the year

The Sub-Contractor shall be deemed to have taken account of the above details inhis prices and his planning of the execution of the works.

Unless otherwise stated, all ratings of plant, equipment and apparatus shall beinterpreted 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 particularlycalled 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 hisfailure 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 notrestricted 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.
9. Surveillance system

16.6 Ordering

The Sub-Contractor shall order materials from the quantities taken from his ownapproved working drawings and not from the quantities shown on the ContractDrawings 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 acontrasting 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 compliancein which he shall clearly declare any items of the Specification to which his offerdoes 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 MainContractor, he may, at the Engineer's discretion, be allowed to store these in hispremises. In this case, the Sub-Contractor shall be required to provide a securitybond specifically covering these materials intended for use on the Sub-ContractWorks.

16.10 Labour Camps

Labour camps will not be permitted on the site and the Sub-Contractor shall allowfor 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 satisfiedhimself 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 besupplied, 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 ensurethat the correct glands and terminations for the service cables entries into the MainLow 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 theKenya 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 anyadditional 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 boardswith 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 Powerand 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 onthe contract Drawings.

The Sub-Contractor shall be deemed to have studied all the Contract Drawingsand 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 onthe 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 forthe 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 busbarsection shall allow for this provision. The Engineer reserves the right to make such variations to the layout and dimensions of the switchboards as are deemednecessary to suit site conditions.
The arrangement of these switchboards shall be capable of accommodating powersupply 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 fuseswitched 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 timesthe 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 equaland 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 singlephase and three phase sub-circuits ways.

All neutral conductors in a single-phase distribution board shall be connected inthe same circuit sequence as its phase conductor, i.e., phase wire No. 1 connectedto 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 manufactured 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, wiringto 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 beby 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 control panel.
b) Rainwater pumps (duty and Standby) and the associated control panel.
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) and associated 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 supplyup 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 forload making/load breaking duties.

19.7 Cable Tray

Sizes, proposed fixing arrangements and routes of the galvanised cable tray havebeen 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 majorLow 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 mechanicalloads.

Phase colours of the incoming cables to each board shall clearly be marked andthe current ratings shall comply with B.S. 159 for a temperature rise of 50^0C.
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 inthe boards shall never be permitted.

19.10 Fire Barriers

Where the rising bus bar systems, vertical cable tray installations, vertical trunkinginstallations pass through floors, a barrier of fire resisting materials shall be incorporated around the installations at each floor level to prevent the possiblespread 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 ratingof 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 havelow 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 inaccordance 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. Theconduits 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 thisSpecification.

All luminaries shall be supplied and installed complete with lamps and tubes ofthe wattage specified. All fluorescent tubes shall be warm white as manufactured by Thorn Lighting orother 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 rockeroperated switches and ivory plastic moulded cover plates.

All lighting switches and socket outlets shall be as manufactured by M/S CrabtreeLtd., 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 Ampswitched socket and neon indicators. An appropriate connector block shall be installed at low level. The cooker control units shall comply fully with B.S 4177and 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 up2 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 thecontract 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 externalsecurity 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. The security luminaries shall be controlled via photoelectric cell mounted on roof. Thephoto 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 tothe 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 forsockets, telephone outlets, television outlets, camera boxes etc. shall form part ofconduit 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 tapesnetwork, all bonding to down conductors and other metal works and earthing asindicated on the appropriate drawings.

21.2 Description of Installation

The installation is based on the recommendation of Kenya Bureau of Standardsand I.E.C 62561 and shall comprise a network of 25mm x 3mm flat copper rooftapes running on the ridges and parapet wall and bonded to a selected 20mm diameter reinforced steel (lengths welded to form a sound and effective electricalcontinuity down to the concrete foundation bases). At the basement level, the down conductors shall be bonded to a system of effective earthing comprising ofearth 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 tothe roof copper tapes.

21.4 Earthing of Lightning Protection System

Earthing of the lightning protection system shall be effected by bonding 20mmdiameter reinforced steel down conductor to 25mm x 3mm earth matt constructedfrom 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 of3:1. 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 shownon 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 pouringto the columns with lightning protection down conductors does not affect the welded points.

22 SECTION 22- TELEPHONE/COMMUNICATION DISTRIBUTION SYSTEM

22.1 Scope of Works

This section of the specification covers the supply and installation of trunkings, conduits and cable trays for the distribution of telephone system, communicationsystem like Television network via satellite dish on roof all in accordance with theContract Drawings and specification.

The supply and installation of the telephone equipment, communication equipment
- T.V. and C.C.T.V. does not form part of this sub-contract.

22.2 Distribution System

At the ground floor level, the sub-contractor shall supply and install a cable tray forthe installation of the main incoming line from the main point of entry into the building to the proposed server room.

The sub-contractor shall also provide and install cable tray from telecom closets toriser duct and all the length of riser duct up to highest floor ceiling.

The electrical sub-contractor shall provide conduit interconnections between eachcabinet box and office floor trunkings. Details of the office floor trunkings are shownon the Drawings and the trunking shall be 3-compartment with a separate compartment for telephone cables. The electrical sub-contractor shall provide andinstall an accessory box and data outlet plates (plug-in type as specified) for connection by other. Outlet plates shall be as manufactured by M/s. Crabtree Ltd,MK Electric Ltd or other equal and approved. Draw wires shall be installed in all conduits to facilitate wiring by others.

A metallic trunking 200mm x 50mm 3 - compartment shall be provided and installedby electrical sub-contractor in the same ICT riser duct from ground floor to highestfloor for the accommodation of communication cables, T.V. cables and Fire Alarmand Detection system cables.

22.3 Wiring System

The Sub-Contractor shall supply and install lead-in pipe of diameter 100mm for themain incoming last mile cables

The Sub-Contractor shall allow for all conduit installation from the cabinet to the data outlet position. The final wiring from the distribution case to each telephoneoutlet shall be carried out by others.

The minimum size of conduit shall be 25mm diameter and not more than 3 data outlets shall be fed by each 25mm diameter conduit.

At each telephone outlet position the sub-contractor shall supply and install an accessory box and outlet plate for connection by others. Each outlet plate shall comprise of jack plug mounted on an ivory plastic moulded cover plate to match theother accessories used.

Outlet plates shall be as manufactured by M/S Crabtree Ltd., M.K. Electric Ltd., Nettle Accessories Ltd., or equal and approved.

23 SECTION 23- FIRE ALARM AND DETECTION SYSTEM

23.1 Scope of Work

This section of the Specification covers supply, installation, connection, testing and commissioning of the fire alarm and detection system in accordance with theContract Drawings and Specification.

23.2 Operation

The fire alarm system shall function as follows: -

In the event of a fire breaking out in any part of a building the alarm can be raisedby an observer breaking the glass of the nearest contact. As a result of this actionthe following signals will be initiated: -

a) All the alarm bells within the affected zone shall sound.
b) The lamp of the appropriate zone indicator on the annunciator panelwill be illuminated.
c) A supervisory alarm buzzer on the annunciator panel will sound.

Such signals may be initiated similarly by smoke or heat detectors.
The audible alarms may be silenced by a `Mute' switch on the annunciator panel.The zone indicator will however remain illuminated until the broken glass of thefire alarm contact is replaced and the system re-set.

The operation of the `Mute' switch shall not preclude the receipt of further alarmsignals from other zones.

23.3 Wiring System

The equipment shall be wired using a 24-volt series fault monitoring circuitry witheach floor of the building constituting a separate zone on the annunciator panel.

Wiring shall be carried out using single core PVC insulated copper cables enclosedin high impact PVC embedded in the fabric of the building.

The fire alarm conduit system shall be completely separate from all other systems.Red conduits shall be used in the ceiling voids or all exposed areas.
The system shall be in accordance with BS 5839 PTI (1980).
The 24-volt DC supply for the system shall be derived from a battery/charger unit within the annunciator panel located on the Ground Floor reception area.

23.4 Battery/Charger Unit

The battery/charger unit will be incorporated in the annunciator panel and shallcontain a trickle charger unit, nickel cadmium battery cells, voltmeter and "mainon" lamp.

The battery/Charger unit is an integral part of the annunciator panel. It shall beas manufactured by M/s Honeywell or Menvier or other equal and approved andshall be to BS 5839 PTI 1980.

The power supply to the batter/charger unit shall be 240 volts a.c. and shall bederived from an unswitched fused spur unit with neon indicator.

23.5 Annunciator Panels

A 16 way flush mounted addressable fire alarm annunciator panel shall be installed at the ground floor reception area with a mimic panel installed in an agreed position.

The panels shall comprise of a sheet steel cabinet with a stainless-steel front platecontaining 16 No. indicator lights, mains failure light, zone fault light, bell circuitfault light, red fire light, supervisory buzzer and alarm mute switch. The functionof all indicator lights shall be clearly labelled.

The panels shall be as manufactured by M/S Honeywell, Menvier or other equaland approved.

23.6 Break Glass Contacts

Break glass contacts shall be mounted at a height of 1400 f.f.f.l. and shall be suitable for flush mounting.

The unit shall be complete with a black instruction plate engrave "FIRE-SMASHGLASS" and a test button mechanism.

The break glass units shall be as manufactured by Honey Well or other equaland approved.

23.7 Alarm Bells

The alarm bells shall be tangent type "8" diameter suitable for operation in the voltage range 12-24 volts DC as manufactured by M/S Honey Well or other equaland approved.

The bells shall be mounted at a height of 2000mm f.f.f.1. and shall be suitable formounting on a standard BESA conduit box with terminals capable of accommodating 2 No. 4mm² PVC cables.

23.8 Smoke Detectors

Smoke detectors shall be installed as shown on the Contract Drawings and shallbe of ionization chamber type and manufactured by M/S Honey Well, Menvieror other equal and approved.

23.9 Heat Detectors

Where called for, Heat detectors shall be suitable for operation on a closed loopcircuitry system and shall comprise of a bi-metal strip and tilting mercury switchtube mounted in a stainless-steel body as manufactured by M/s Honey Well, Menvier or other equal and approved.

24 SECTION 24- UVUVI LIGHT FITTINGS SCHEDULE

No.	TYPE	DESCRIPTION	Lamp Type	AREA OF USAGE	PHOTO
1	A5	Coreline surface mounted luminaire SM134V W20L120	34W, 3000K colour temperature, 50,000hrs lifetime and DALI dimming with diffuse light quality	Staff breakout area, smoking rooms, library	
2	DL1	300 x 300, Downlighter, LED Recessed Mounted	28W, 3000K colour temperature, 50,000hrs lifetime and DALI dimming with diffuse light quality	Washrooms and stores	
3	DL	Enlite EN-DL30/30 30w 2200lm non-dim LED panel 3k Warm White	30W, 3000K, 2600 Lumens	Offices, corridors, lounges, lobbies	
4	A4	Coreline surface mounted luminaire	48W, 3000 lumens LED lamp	Kitchenettes	
5	ST	Coreline surface-mounted luminaire WL120V	24W, 3000K colour temperature, 50,000hrs lifetime, waterproof and DALI dimming with frosted diffuser	staircases	
6	C	600 X 600 Coreline panel recessed RC132V LED36S/840 W60L60 ELB3 IA1 NOC	36W, 3000lumens, 4000K	Office areas, boardrooms	

7	Em exit	305mm x 160mm x 225mm, ESP EM2WMEXSIGND 2watt LED 3hour Maintained Exit Blade Down Legend	2W, 6000K Colour Temperature, 3 Hours Emergency Duration, 4.8v 600mAH Battery	Exit entrances and staircase	
8	Enm	389 x 126 x 80mm, Recessed mounting EMLED4WMFLUSH 4W LED Maintained Emergency Flush	4W, 5500K colour temperature, Mains light output - 131 Lumens Emergency light output - 105 Lumens, 3 Hours Emergency Duration	For offices, restaurants, corridors, lounges, lobbies	
9	S	Coreline surface-mounted luminaire WL120V	22W, 3000K colour temperature, 50,000hrs lifetime, waterproof and DALI dimming with frosted diffuser	Ducts and Lift Shafts	
10	SP	Aurora Enlite EN-MR165/40 MR16 5watt LED 4K Cool White Lamp	22W, 520 Lumens L70 25,000 hours	Boardrooms	
11	FL	LED Wall-mounted Floor Light	12 Watt warm white; 3000K IP54	Auditorium Floor Stairs	
12	F	LED Wall-mounted parapet	22W, 3000K, 2400Lumens	Terraces, and lift shaft	

FIRE DETECTION AND ALARM SYSTEM
(SPECIFICATIONS)

25 SECTION 25- FIRE DETECTION AND ALARM SYSTEM SPECIFICATION

25.1 INTELLIGENT REPORTING FIRE DETECTION SYSTEM

25.1.1 DESCRIPTION

i. The fire alarm system shall comply with requirements of NFPA Standard 72 for Protected Premises Signaling Systems except as modified and supplemented by this specification. The system shall be electrically supervised and monitor the integrity of all conductors.

ii. The facility shall have an emergency voice alarm communication system. Digitally stored message sequences shall notify the building occupants that a fire or life safety condition has been reported. Message generator(s) shall be capable of automatically distributing up to eight (8) simultaneous, unique messages to appropriate audio zones within the facility based on the type and location of the initiating event. The Fire Command Center (FCC) shall also support Emergency manual voice announcement capability for both system wide or selected audio zones, and shall include provisions for the system operator to override automatic messages system wide or in selected zones.

iii. The system shall be support additional, alternate Fire Command Centers, which shall be capable of simultaneous monitoring of all system events. Alternate Fire Command Centers shall also support an approved method of transferring the control functions to an alternate Fire Command Center when necessary. All Fire Command Centers shall be individually capable of assuming Audio Command functions such as Emergency Paging, audio zone control functions, and Firefighter's Telephone communication functions.

iv. Each designated zone shall transmit separate and different alarm, supervisory and trouble signals to the Fire Command Center (FCC) and designated personnel in other buildings at the site via a multiplex communication network

v. The FACP and peripheral devices shall be manufactured 100% by a single U.S. manufacturer (or division thereof). It’s acceptable for peripheral devices to be manufactured outside of the U.S. by a division of the U.S. based parent company.

vi. The system and its components shall be Underwriters Laboratories, Inc. listed under the appropriate UL testing standard as listed herein for fire alarm applications and the installation shall comply with the UL listing.

vii. The installing company shall employ NICET (minimum Level II Fire Alarm Technology) technicians on site to guide the final checkout and to ensure the systems integrity.

25.1.2 SCOPE:

A new intelligent reporting, microprocessor controlled fire detection system shall be installed in accordance to the project specifications and drawings.

Basic Performance:

i. Alarm, trouble and supervisory signals from all intelligent reporting devices shall be encoded on NFPA Style 4 (Class B) Signaling Line Circuits (SLC).
ii. Device Circuits (IDC) shall be wired Class A (NFPA Style D) as part of an addressable device connected by the SLC Circuit.
iii. Notification Appliance Circuits (NAC) shall be wired Class A (NFPA Style Z) as part of an addressable device connected by the SLC Circuit.
iv. On Style 6 or 7 (Class A) configurations a single ground fault or open circuit on the system Signaling Line Circuit shall not cause system malfunction, loss of operating power or the ability to report an alarm.
v. Alarm signals arriving at the FACP shall not be lost following a primary power failure (or outage) until the alarm signal is processed and recorded.
vi. Speaker circuits may be controlled by NAC outputs built into the amplifiers, which shall function as addressable points on the Digital Audio Loop.
vii. NAC speaker circuits shall be arranged such that there is a minimum of one speaker circuit per floor of the building or smoke zone whichever is greater.
viii. Audio amplifiers and tone generating equipment shall be electrically supervised for normal and abnormal conditions.
ix. NAC speaker circuits and control equipment shall be arranged such that loss of any one (1) speaker circuit will not cause the loss of any other speaker circuit in the system.

   Two-way emergency telephone communication circuits shall be supervised for open and short circuit conditions.

   Speaker circuits shall be arranged such that there is a minimum of one speaker circuit per smoke zone.

   Speaker circuits shall be electrically supervised for open and short circuit conditions. If a short circuit exists on a speaker circuit, it shall not be possible to activate that circuit.

x. Audio amplifiers and tone generating equipment shall be electrically supervised for abnormal conditions. Digital amplifiers shall provide built-in speaker circuits, field configurable as four Class B (Style Y), or two Class A (Style Z) circuits.
xi. Digital amplifiers shall be capable of storing up to two minutes of digitally recorded audio messages and tones. The digital amplifiers shall also be capable of supervising the connection to the associated digital message generator, and upon loss of that connection shall be capable of one of the following system responses:

a. The digital amplifier shall automatically broadcast the stored audio message.
b. The digital amplifier shall switch to a mode where a local bus input on the digital amplifier will accept an input to initiate a broadcast of the stored message. This bus input shall be connected to a NAC on a local FACP for providing an alternate means of initiating an emergency message during a communication fault condition.
c. Speaker circuits shall be either 25 VRMS or 70VRMS. Speaker circuits shall have 20% space capacity for future expansion or increased power output requirements.
d. Two-way emergency telephone (Fire Fighter Telephone) communication shall be supported between the Audio Command Center and up to seven (7) remote Fire Fighter's Telephone locations simultaneously on a telephone riser.
e. Means shall be provided to connect FFT voice communications to the speaker circuits in order to allow voice paging over the speaker circuit from a telephone handset.
f. The digital audio message generator shall be of reliable, non-moving parts, and support the digital storage of up to 32 minutes of tones and emergency messages, shall support programming options to string audio segments together to create up to 1000 messages, or to loop messages and parts of messages to repeat for pre-determined cycles or indefinitely.

25.1.3 *GUARANTY*:

The fire alarm control panel, voice panels and any head-end equipment shall have a manufacturer's warranty of a minimum of 3 years.

25.1.4 *POST CONTRACT MAINTENANCE*:

i. Complete maintenance and repair service for the fire detection system shall be available from a factory trained authorized representative of the manufacturer of the major equipment for a period of five (5) years after expiration of the guaranty.

ii. As part of the bid/proposal, include a quote for a maintenance contract to provide all maintenance, required tests, and list pricing for any replacement products included on the bill of materials, along with the list pricing for products not on the bill of materials; if test and inspection rates are different than full service rates the bid/proposal shall include pricing for all levels for a minimum period of five (5) years Rates and costs shall be valid for the period of five (5) years after expiration of the guaranty.

iii. Include also a quote for unscheduled maintenance/repairs, including hourly rates for technicians trained on this equipment, and response travel costs for each year of the maintenance period. Submittals that do not identify all post contract maintenance costs will not be accepted. Rates and costs shall be valid for the period of five (5) years after expiration of the guaranty.

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25.1.5 APPLICABLE STANDARDS AND SPECIFICATIONS:

i. The specifications and standards listed below form a part of this specification. The system shall fully comply with the latest issue of these standards, if applicable.

ii. National Fire Protection Association (NFPA) - KENYA:

No. 12	Extinguishing Systems (low and high)
No. 12A	Halon 1301 Extinguishing Systems
No. 13	Sprinkler Systems
No. 15	Water Spray Systems
No. 16	Foam / Water Deluge and Spray Systems
No. 17	Dry Chemical Extinguishing Systems
No. 17A	Wet Chemical Extinguishing Systems
No. 2001	Clean Agent Extinguishing Systems
No. 70	National Electric Code
No. 90A	Air Conditioning Systems
No. 92A	Smoke Control Systems
No. 92B	Smoke Management Systems in Malls, Atria, Large Areas
No. 72	National Fire Alarm Code
No. 101	Life Safety Code

iii. Underwriters Laboratories Inc. (UL) - KENYA:

No. 268	Smoke Detectors for Fire Protective Signalling Systems
No. 864	Control Units for Fire Protective Signalling Systems
No. 2572	Mass Notification Systems
No. 217	Smoke Detectors, Single and Multiple Station
No. 228	Door Closers - Holders for Fire Protective Signalling Systems
No. 268A	Smoke Detectors for Duct Applications
No. 521	Heat Detectors for Fire Protective Signalling Systems
No. 464	Audible Signalling Appliances
No. 38	Manually Actuated Signalling Boxes
No. 1481	Power Supplies for Fire Protective Signalling Systems

No. 346	Waterflow Indicators for Fire Protective Signalling Systems
No. 1076	Control Units for Burglar Alarm Proprietary Protective Signalling Systems
No. 1971	Visual Notification Appliances
No. 2017	Standard for General-Purpose Signaling Devices and Systems
No.60950	Safety of Information Technology Equipment

iv. Local and State Building Codes.
The Kenya Bureau of Standards codes for building will be used

v. All requirements of the Authority Having Jurisdiction (AHJ).

25.1.6 APPROVALS:

i. The system shall have proper listing and/or approval from the following nationally recognized agencies:

NMS	Nairobi Metropolitan Service
UL	Underwriters Laboratories
FM	Factory Mutual
FM 6320	Factory Mutual Gas Detection System
NFD	Nairobi Fire Department
NSFM	Nairobi State Fire Marshal

ii. The system shall be certified for seismic applications in accordance with the International Building Code (IBC). For OSHPD applications in California the system shall be pre-Approved for seismic applications. The basis for qualification of seismic approval shall be via shake table testing.

iii. The System shall be FM 6320 (Factory Mutual) approved as a Gas Detection system when employed with the FMM-4-20 monitor module and industry standard 4-20 mA gas detectors.

25.2 COMPONENTS

25.2.1MAIN FIRE ALARM CONTROL PANEL OR NETWORK NODE:

Main FACP or network node shall contain a microprocessor based Central Processing Unit (CPU) and power supply. The CPU shall communicate with and control the following types of equipment used to make up the system: intelligent addressable smoke and thermal (heat) detectors, addressable modules, printer, annunciators, and other system-controlled devices.

In conjunction with intelligent Loop Control Modules and Loop Expander Modules, the main FACP shall perform the following functions:

i. Supervise and monitor all intelligent addressable detectors and monitor modules connected to the system for normal, trouble and alarm conditions.
ii. Supervise all initiating signaling and notification circuits throughout the facility by way of connection to addressable monitor and control modules.
iii. Detect the activation of any initiating device and the location of the alarm condition. Operate all notification appliances and auxiliary devices as programmed. In the event of CPU failure, all SLC loop modules shall fallback to degrade mode. Such degrade mode shall treat the corresponding SLC loop control modules and associated detection devices as conventional twowire operation. Any activation of a detector in this mode shall automatically activate associated Notification Appliance Circuits.

25.2.1.1 System Capacity and General Operation

1.0 The FACP shall be capable of communicating over a Local Area Network (LAN) or Wide Area Network (WAN) utilizing a peer-to-peer, inherently regenerative communication format and protocol. The network shall support communication speed up to 100 Mb and support up to 200 panels / nodes per network.

2.0 The control panel shall be capable of expansion via up to 10 SLC loops. Each module shall support up to 318 analog/addressable devices for a maximum system capacity of 3180 points. The Fire Alarm Control Panel shall include a full featured operator interface control and annunciation panel that shall include a backlit 640-character liquid crystal display, individual, color coded system status LEDs, and a keypad for the control of the fire alarm system. Said LCD shall also support graphic bit maps capable of displaying the company name and logo of either thpany.

3.0 All programming or editing of the existing program in the system shall be achieved without interrupting the alarm monitoring functions of the fire alarm control panel.
The FACP shall be able to provide the following software and hardware features:

i. Pre-signal and Positive Alarm Sequence: The system shall provide means to cause alarm signals to only sound in specific areas with a delay of the alarm from 60 to up to 180 seconds after start of alarm processing. In addition, a Positive Alarm Sequence selection shall be available that allows a 15second time period for acknowledging an alarm signal from a fire detection/initiating device. If the alarm is not acknowledged within 15 seconds, all local and remote outputs shall automatically activate immediately.

ii. Smoke Detector Pre-alarm Indication at Control Panel: To obtain early warning of incipient or potential fire conditions, the system shall support a programmable option to determine system response to real-time detector sensing values above the programmed setting. Two levels of Pre-alarm indication shall be available at the control panel: alert and action.
iii. Alert: It shall be possible to set individual smoke detectors for pre-programmed pre-alarm thresholds. If the individual threshold is reached, the pre-alarm condition shall be activated.
iv. Action: If programmed for Action and the detector reaches a level exceeding the pre-programmed level, the control panel shall indicate an action condition. Sounder bases installed with either heat or smoke detectors shall automatically activate on action Pre-Alarm level, with general evacuation on Alarm level.
v. The system shall support a detector response time to meet world annunciation requirements of less than 3 seconds.
vi. Device Blink Control: Means shall be provided to turn off detector/module LED strobes for special areas.
vii. NFPA 72 Smoke Detector Sensitivity Test: The system shall provide an automatic smoke detector test function that meets the sensitivity testing requirements of NFPA 72.
viii. Programmable Trouble Reminder: The system shall provide means to automatically initiate a reminder that troubles exist in the system. The reminder will appear on the system display and (if enabled) will sound a piezo alarm.
ix. On-line or Off-line programming: The system shall provide means to allow panel programming either through an off-line software utility program away from the panel or while connected and on-line. The system shall also support upload and download of programmed database and panel executive system program to a Personal Computer/laptop. A single change to one CPU database shall not require a database download to other CPUs.
x. History Events: The panel shall maintain a history file of the last 4000 events, each with a time and date stamp. History events shall include all alarms, troubles, operator actions, and programming entries. The control panels shall also maintain a 1000 event Alarm History buffer, which consists of the 1000 most recent alarm events from the 4000 event history file.
xi. Smoke Control Modes: The system shall provide means to perform FSCS mode Smoke Control to meet NFPA-92A and 90B and HVAC mode to meet NFPA 90A.
xii. The system shall provide means for all SLC devices on any SLC loop to be auto programmed into the system by specific address. The system shall recognize specific device type ID's and associate that ID with the corresponding address of the device.
xiii. Passwords and Users: The system shall support two password levels, master and user. Up to 9 user passwords shall be available, each of which may be assigned access to the programming change menus, the alter status menus, or both. Only the master password shall allow access to password change screens.
xiv. Block Acknowledge: The system shall support a block Acknowledge for Trouble Conditions
xv. Sensitivity Adjust: The system shall provide Automatic Detector Sensitivity Adjust based on Occupancy schedules including a Holiday list of up to 15 days.

xvi. Environmental Drift Control: The system shall provide means for setting Environmental Drift Compensation by device. When a detector accumulates dust in the chamber and reaches an unacceptable level but yet still below the allowed limit, the control panel shall indicate a maintenance alert warning. When the detector accumulates dust in the chamber above the allowed limit, the control panel shall indicate a maintenance urgent warning.

xvii. Custom Action Messages: The system shall provide means to enter up to 100 custom action messages of up to 160 characters each. It shall be possible to assign any of the 100 messages to any point.

xviii. Local Mode: If communication is lost to the central processor the system shall provide added survivability through the intelligent loop control modules. Inputs from devices connected to the SLC and loop control modules shall activate outputs on the same loop when the inputs and outputs have been set with point programming to participate in local mode or when the type codes are of the same type: that is, an input with a fire alarm type code shall activate an output with a fire alarm type code.

xix. Read status preview - enabled and disabled points: Prior to re-enabling points, the system shall inform the user that a disabled device is in the alarm state. This shall provide notice that the device must be reset before the device is enabled thereby avoiding activation of the notification circuits.

xx. Custom Graphics: When fitted with an LCD display, the panel shall permit uploading of a custom bit-mapped graphic to the display screen.

xxi. Multi-Detector and Cooperating Detectors: The system shall provide means to link one detector with up to two detectors at other addresses on the same loop in cooperative multi-detector sensing. There shall be no requirement for sequential addresses on the detectors and the alarm event shall be a result of all cooperating detectors chamber readings.

xxii. ACTIVE EVENT: The system shall provide a Type ID called FIRE CONTROL for purposes of air-handling shutdown, which shall be intended to override normal operating automatic functions. Activation of a FIRE CONTROL point shall cause the control panel to (1) initiate the monitor module Control-by-Event, (2) send a message to the panel display, history buffer, installed printer and annunciators, (3) shall not light an indicator at the control panel, (4) Shall display ACTIVE on the LCD as well a display a FIRE CONTROL Type Code and other information specific to the device.

xxiii. NON-FIRE Alarm Module Reporting: A point with a type ID of NON-FIRE shall be available for use for energy management or other non-fire situations. NON-FIRE point operation shall not affect control panel operation nor shall it display a message at the panel LDC. Activation of a NON-FIRE point shall activate control by event logic but shall not cause any indication on the control panel.

xxiv. Mass Notification Override: The system shall be UL 2572 listed for Mass Notification and shall be capable, based on the Risk Analysis, of being programmed so that Mass Notification/Emergency Communications events take precedence over fire alarm events.

xxv. Security Monitor Points: The system shall provide means to monitor any point as a type security.

xxvi. One-Man Walk Test: The system shall provide both a basic and advanced walk test for testing the entire fire alarm system. The basic walk test shall allow a single operator to run audible tests on the panel. All logic equation automation shall be suspended during the test and while annunciators can be enabled for the test, all shall default to the disabled state. During an advanced walk test, field-supplied output point programming will react to input stimuli such as CBE and logic equations. When points are activated in advanced test mode, each initiating event shall latch the input. The advanced test shall be audible and shall be used for pull station verification, magnet activated tests on input devices, input and output device and wiring operation/verification.

xxvii. Control By Event Functions: CBE software functions shall provide means to program a variety of output responses based on various initiating events. The control panel shall operate CBE through lists of zones. A zone shall become listed when it is added to a point's zone map through point programming. Each input point such as detector, monitor module or panel circuit module shall support listing of up to 10 zones into its programmed zone map.

xxviii. Permitted zone types shall be general zone, releasing zone and special zone. Each output point (control module, panel circuit module) can support a list of up to 10 zones including general zone, logic zone, releasing zone and trouble zone. It shall be possible for output points to be assigned to list general alarm. Non-Alarm or Supervisory points shall not activate the general alarm zone.

xxix. 1000 General Zones: The system shall support up to 1000 general purpose software zones for linking inputs to outputs. When an input device activates, any general zone programmed into that device's zone map will be active and any output device that has an active general zone in its map will be active. It shall also be possible to use general zone as arguments in logic equations.

xxx. 1000 Logic Equations: The system shall support up to 1000 logic equations for AND, OR, NOT, ONLY1, ANYX, XZONE or RANGE operators that allow conditional I/O linking. When any logic equation becomes true, all output points mapped to the logic zone shall activate.

xxxi. 100 trouble equations per device: The system shall provide support for up to 100 trouble equations for each device, which shall permit programming parameters to be altered, based on specific fault conditions. If the trouble equation becomes true, all output points mapped to the trouble zone shall activate.

xxxii. Control-By-Time: A time based logic function shall be available to delay an action for a specific period of time based upon a logic input with tracking feature. A latched version shall also be available. Another version of this shall permit activation on specific days of the week or year with ability to set and restore based on a 24 hour time schedule on any day of the week or year.

xxxiii. Multiple agent releasing zones: The system shall support up to 10 releasing zones to protect against 10 independent hazards. Releasing zones shall provide up to three cross-zone and four abort options to satisfy any local jurisdiction requirements.

xxxiv. Alarm Verification, by device, with timer and tally: The system shall provide a user-defined global software timer function that can be set for a specific detector. The timer function shall delay an alarm signal for a userspecified time period and the control panel shall ignore the alarm verification timer if another alarm is detected during the verification period. It shall also be possible to set a maximum verification count between 0 and 20 with the "0" setting producing no alarm verification. When the counter exceeds the threshold value entered, a trouble shall be generated to the panel.

4.0 Network Communication

i. The FACP shall be capable of communicating over a Local Area Network (LAN) or Wide Area Network (WAN) utilizing a peer-to-peer, inherently regenerative communication format and protocol. The network shall support communication speed up to 100 Mb and support up to 200 panels/nodes per network.

5.0 Central Processing Unit

i. The Central Processing Unit shall contain and execute all control-by-event (1Including Boolean functions including but not limited to AND, OR, NOT, ANYx, and CROSSZONE) programs for specific action to be taken if an alarm condition is detected by the system. Such control-by-event programs shall be held in non-volatile programmable memory, and shall not be lost with system primary and secondary power failure

ii. The Central Processing Unit shall also provide a real-time clock for time annotation, to the second, of all system events. The time-of-day and date shall not be lost if system primary and secondary power supplies fail

iii. The CPU shall provide an EIA-232 interface between the fire alarm control panel and the UL Listed Electronic Data Processing (EDP) peripherals

iv. The CPU shall provide two EIA-485 ports for the serial connection to annunciation and control subsystem components.

v. The EIA-232 serial output circuit shall be optically isolated to assure protection from earth ground

6.0 Display

i. The system display shall provide a 640-character backlit alphanumeric Liquid Crystal Display (LCD). It shall also provide eleven Light-Emitting-Diodes (LEDs) that indicate the status of the following system parameters: AC POWER, FIRE ALARM, PREALARM, SECURITY, SUPERVISORY, SYSTEM TROUBLE, OTHER EVENT, SIGNALS SILENCED, POINT DISABLED, CONTROLS ACTIVE, and CPU FAILURE.

ii. The system display shall provide a keypad with control capability to command all system functions, entry of any alphabetic or numeric information, and field programming. Two different password levels with up to ten (one Master and nine User) passwords shall be accessible through the display interface assembly to prevent unauthorized system control or programming.

7.0 Loop (Signaling Line Circuit) Control Module:

i. The Loop Control Module shall monitor and control a minimum of 318 intelligent addressable devices. This includes 159 intelligent detectors (Ionization, Photoelectric, or Thermal) and 159monitor or control modules.

ii. The Loop Control Module shall contain its own microprocessor and shall be capable of operating in a local/degrade mode (any addressable device input shall be capable of activating any or all addressable device outputs) in the unlikely event of a failure in the main CPU.

iii. Each Loop shall be capable of operating as a NFPA Style 4 (Class B) circuit.

iv. The SLC interface board shall receive analog or digital information from all intelligent detectors and shall process this information to determine whether normal, alarm, or trouble conditions exist for that particular device. Each SLC Loop shall be isolated and equipped to annunciate an Earth Fault condition. The SLC interface board software shall include software to automatically maintain the detector's desired sensitivity level by adjusting for the effects of environmental factors, including the accumulation of dust in each detector. The analog information may also be used for automatic detector testing and the automatic determination of detector maintenance requirements.

8.0 Digital Voice Command Center

i. The Digital Voice Command Center located with the FACP, shall contain all equipment required for all audio control, emergency telephone system control, signaling and supervisory functions. This shall include speaker zone indication and control, telephone circuit indication and control, digital voice units, microphone and main telephone handset.

ii. Function: The Voice Command Center equipment shall perform the following functions:

a. Operate as a supervised multi-channel emergency voice communication system.

Operate as a two-way emergency telephone system control center. b. Audibly and visually annunciate the active or trouble condition of every speaker circuit and emergency telephone circuit.

c. Audibly and visually annunciate any trouble condition for digital tone and voice units required for normal operation of the system.

d. Provide all-call Emergency Paging activities through activation of a single control switch.

e. As required, provide vectored paging control to specific audio zones via dedicated control switches.

f. Provide a factory recorded "library" of voice messages and tones in standard WAV. File format, which may be edited and saved on a PC running a current Windows® operating system.

g. Provide a software utility capable of off-line programming for the DVC operation and the audio message files. This utility shall support the creation of new programs as well as editing and saving existing program files. Uploading or downloading the DVC shall not inhibit the emergency operation of other nodes on the fire alarm network.

h. Support an optional mode of operation with four analog audio outputs capable of being used with UL 864 fire-listed analog audio amplifiers and SLC controlled switching.
i. The Digital Voice Command shall be modular in construction, and shall be capable of being field programmable without requiring the return of any components to the manufacturer and without requiring use of any external computers or other programming equipment.
j. The Digital Voice Command and associated equipment shall be protected against unusually high voltage surges or line transients.

9.0 Power Supply:

i. The Main Power Supply shall operate on 120/240 VAC, 50/60 Hz, and shall provide all necessary power for the FACP.
ii. The Main Power Supply shall provide the required power to the CPU using a switching 24 VDC regulator and shall incorporate a battery charger for 24 hours of standby power using dual-rate charging techniques for fast battery recharge.
iii. The Main Power Supply shall provide a battery charger for 24 hours of standby using dual-rate charging techniques for fast battery recharge. The supply shall be capable of charging batteries ranging in capacity from 7-200 amp-hours within a 48-hour period.
iv. The Main Power Supply shall provide a very low frequency sweep earth detect circuit, capable of detecting earth faults.
v. The Main Power Supply shall be power-limited per UL864 requirements.
vi. The Main Power Supply shall communicate power supply, line voltage, battery status and charger status to the local LCD display. Any abnormal condition shall be annunicated and logged to the system alarm history log.
vii. Addressable Charger Power SupplyThe auxiliary addressable power supply is a remote 24 VDC power supply used to power Notification Devices and field devices that require regulated 24 VDC power.
viii. The addressable power supply for the fire detection system shall provide up to a minimum of 6.0 amps of 24 volt DC regulated power for Notification Appliance Circuit (NAC) power or 10.0 amps of 24 volt DC general power. The power supply shall have an additional 0.5 amp of 24 VDC auxiliary power for use within the same cabinet as the power supply. It shall include an integral charger designed to charge 12 - 200 amp hour batteries.
ix. The addressable power supply shall provide four individually addressable Notification Appliance Circuits that may be configured as Class "A" or Class "B" circuits. All circuits shall be power-limited per UL 864 requirements.
x. The addressable power supply shall provide built-in synchronization for certain Notification Appliances on each circuit without the need for additional synchronization modules. The power supply's output circuits shall be individually selected for synchronization. A single addressable power supply shall be capable of supporting both synchronized and non-synchronized Notification Devices at the same time.
xi. The addressable power supply shall operate on 120 or 240 VAC, 50/60 Hz.
xii. The interface to the power supply from the Fire Alarm Control Panel (FACP) shall be via the Signaling Line Circuit (SLC) or other multiplexed means Power

supplies that do not use an intelligent interface are not suitable substitutes. The required wiring from the FACP to the addressable power supply shall be a single unshielded twisted pair wire.

xiii. The addressable power supply shall supervise for battery charging failure, AC power loss, power brownout, battery failure, NAC loss, and optional ground fault detection. In the event of a trouble condition, the addressable power supply shall report the incident and the applicable address to the FACP via the SLC.

xiv. The addressable power supply shall have an AC Power Loss Delay option. If this option is utilized and the addressable power supply experiences an AC power loss, reporting of the incident to the FACP will be delayed. A delay time of zero, two, eight or sixteen hours shall be programmable.

xv. The addressable power supply shall have an option for Canadian Trouble Reporting and this option shall be programmable.

xvi. The addressable power supply mounts in either the FACP backbox or its own dedicated surface mounted backbox with cover.

xvii. Each of the power supply's four output circuits shall be programmed- for Notification Appliance Circuit or General Purpose 24 VDC power. Any output circuit shall be able to provide up to 2.5 amps of 24 VDC power.

xviii. The addressable power supply's output circuits shall be individually supervised when they are selected to be either a Notification Appliance Circuit when wired Class "A" or by the use of and end-of-line resistor. When the power supply's output circuit is selected as General 24 VDC power, the circuit shall be individually supervised when an end-of-line relay is used.

xix. When selected for Notification Appliance Circuits, the output circuits shall be individually programmable for Steady, March Time, Dual Stage or Temporal.

xx. When selected as a Notification Appliance Circuit, the output circuits of the addressable power supply shall have the option to be coded by the use of a universal zone coder.

xxi. The addressable power supply shall interface and synchronize with other power supplies of the same type. The required wiring to interface multiple addressable power supplies shall be a single unshielded, twisted pair wire.

xxii. An individual or multiple interfaced addressable power supplies shall have the option to use an external charger for battery charging. Interfaced power supplies shall have the option to share backup battery power.

10.0 Audio Amplifiers

i. The Audio Amplifiers will provide Audio Power () for distribution to speaker circuits.

ii. Multiple audio amplifiers may be mounted in a single enclosure, either to supply incremental audio power, or to function as an automatically switched backup amplifier(s).

iii. The audio amplifier shall include an integral power supply, and shall provide built-in LED indicators for the following conditions:

a. Earth Fault on DAP A (Digital Audio Port A)
b. Earth Fault on DAP B (Digital Audio Port B)
c. Audio Amplifier Failure Detected Trouble

d. Active Alarm Bus input
e. Audio Detected on Aux Input A
f. Audio Detected on Aux Input B
g. Audio Detected on Firefighter's Telephone Riser
h. Receiving Audio from digital audio riser
i. Short circuit on speaker circuit 1
j. Short circuit on speaker circuit 2
k. Short circuit on speaker circuit 3
l. Short circuit on speaker circuit 4
m. Data Transmitted on DAP A
n. Data Received on DAP A
o. Data Transmitted on DAP B
p. Data Received on DAP B
q. Board failure
r. Active fiber optic media connection on port A (fiber optic media applications)
s. Active fiber optic media connection on port B (fiber optic media applications)
t. Power supply Earth Fault
u. Power supply 5V present
v. Power supply conditions - Brownout, High Battery, Low Battery, Charger Trouble

iv. The audio amplifier shall provide the following built-in controls:
a. Amplifier Address Selection Switches
b. Signal Silence of communication loss annunciation Reset
c. Level adjustment for background music
d. Enable/Disable for Earth Fault detection on DAP A
e. Enable/Disable for Earth Fault detection on DAP A
f. Switch for 2-wire/4-wire FFT riser

v. Adjustment of the correct audio level for the amplifier shall not require any special tools or test equipment

vi. Includes audio input and amplified output supervision, back up input, and automatic switch over function, (if primary amplifier should fail).

vii. System shall be capable of backing up digital amplifiers.

viii. One-to-one backup shall be provided by either a plug-in amplifier card or a designated backup amplifier of identical model as the primary amplifier.

ix. One designated backup amplifier shall be capable of backing up multiple primary amplifiers mounted in the same or adjacent cabinets.

x. Multi-channel operation from a single amplifier shall be supported by the addition of an optional plug-in amplifier card.

11.0 Audio Message Generator (Prerecorded Voice)/Speaker Control:

i. Each initiating zone or intelligent device shall interface with an emergency voice communication system capable of transmitting a prerecorded voice message to all speakers in the building.

ii. Actuation of any alarm initiating device shall cause a prerecorded message to sound over the speakers. The message shall be repeated four (4) times.
Pre- and post-message tones shall be supported.

iii. A built-in microphone shall be provided to allow paging through speaker circuits.

iv. System paging from emergency telephone circuits shall be supported.

v. The audio message generator shall have the following indicators and controls to allow for proper operator understanding and control:

    i. Lamp Test
    ii. Trouble
    iii. Off-Line Trouble
    iv. Microphone Trouble
    v. Phone Trouble
    vi. Busy/Wait
    vii. Page Inhibited
    viii. Pre/Post Announcement Tone

12.0 Controls with associated LED Indicators:

i. Speaker Switches/Indicators

    a. The speaker circuit control switches/indicators shall include visual indication of active and trouble status for each speaker circuit in the system.
    b. The speaker circuit control panel shall include switches to manually activate or deactivate each speaker circuit in the system.\

ii. Emergency Two-Way Telephone Control Switches/Indicators

    a. The emergency telephone circuit control panel shall include visual indication of active and trouble status for each telephone circuit in the system.
    b. The telephone circuit control panel shall include switches to manually activate or deactivate each telephone circuit in the system.

13.0 Remote Transmissions:

i. Provide local energy or polarity reversal or trip circuits as required.

ii. The system shall be capable of operating a polarity reversal or local energy or fire alarm transmitter for automatically transmitting fire information to the fire department.

iii. Provide capability and equipment for transmission of zone alarm and trouble signals to remote operator's terminals, system printers and annunciators.
iv. Transmitters shall be compatible with the systems and equipment they are connected to such as timing, operation and other required features.

14.0 Field Programming

i. The system shall be programmable, configurable and expandable in the field without the need for special tools, laptop computers, or other electronic interface equipment. There shall be no firmware changes required to field modify the system time, point information, equations, or annunciator programming/information.
ii. All field defined programs shall be stored in non-volatile memory.

15.0 Specific System Operations

i. Smoke Detector Sensitivity Adjust: A means shall be provided for adjusting the sensitivity of any or all addressable intelligent detectors in the system from the system keypad. Sensitivity range shall be within the allowed UL window and have a minimum of 9 levels.
ii. Alarm Verification: Each of the intelligent addressable smoke detectors in the system may be independently selected and enabled to be an alarm verified detector. The alarm verification delay shall be programmable from 0 to 60 seconds and each detector shall be able to be selected for verification. The FACP shall keep a count of the number of times that each detector has entered the verification cycle. These counters may be displayed and reset by the proper operator commands.

16.0 System Point Operations:

i. Any addressable device in the system shall have the capability to be enabled or disabled through the system keypad or video terminal.
ii. System output points shall be capable of being turned on or off from the system keypad or the video terminal.
iii. Point Read: The system shall be able to display the following point status diagnostic functions without the need for peripheral equipment. Each point shall be annunciated for the parameters listed:

a. Device Status.
b. Device Type.
c. Custom Device Label.
d. Software Zone Label.
e. Device Zone Assignments.
f. Analog Detector Sensitivity.
g. All Program Parameters.

iv. System History Recording and Reporting: The fire alarm control panel shall contain a history buffer that will be capable of storing up to 4000 system events. Each of these events will be stored, with time and date stamp, until an operator requests that the contents be either displayed or printed. The contents of the history buffer may be manually reviewed; one event at a time, and the actual number of activations may also be displayed and or printed. History events shall include all alarms, troubles, operator actions, and programming entries.

v. The history buffer shall use non-volatile memory. Systems which use volatile memory for history storage are not acceptable.

vi. Automatic Detector Maintenance Alert: The fire alarm control panel shall automatically interrogate each intelligent system detector and shall analyze the detector responses over a period of time.

vii. If any intelligent detector in the system responds with a reading that is below or above normal limits, then the system will enter the trouble mode, and the particular Intelligent Detector will be annunciated on the system display, and printed on the optional system printer. This feature shall in no way inhibit the receipt of alarm conditions in the system, nor shall it require any special hardware, special tools or computer expertise to perform.

viii. The system shall include the ability (programmable) to indicate a "prealarm" condition. This will be used to alert maintenance personal when a detector is at 80% of its alarm threshold in a 60 second period.

25.2.2 Conventional Aspirating Detection

ix. An optional air aspiration detection system shall be available.

x. The aspirating system shall support multiple sensitivity settings.

xi. The aspirating system shall operate from 24 VDC.

xii. The aspirating system shall provide alarm and trouble relays used to activate a fire alarm control panel.

25.2.3 Aspiration System Interface:

xiii. The system shall be capable of supporting Interface Modules for integrating Vesda Aspiration detectors into SLC loop of the fire alarm control panel. The Interface Module shall support up to 19 detectors detectors, each SLC loop shall support one interface module.

25.2.4 **High *Level* Aspiration *System Interface*:**

xiv. The system shall be capable of supporting a High Level Interface for Vesda Aspirating Detection Systems. The interface shall support up to 100 detectors and allow the fire alarm network to monitor and control events on the aspiration system.

xv. Portable Emergency Telephone Handset Jack

xvi. Portable emergency telephone handset jacks shall be flush mounted on stainless steel plates as indicated on plans. Handset jacks shall be approved for emergency telephone system application.

xvii. Insertion of a remote handset plug into a jack shall send a signal to the fire command center which shall audibly and visually indicate the on-line condition, and shall sound a ring indication in the handset.

xviii. The two-way emergency telephone system shall support a minimum of seven (7) handsets on line without degradation of the signal.

25.2.5 Fixed Emergency Telephone Handset

i. The telephone cabinet shall be painted red and clearly labeled emergency telephone. The cabinets shall be located where shown on drawings.
ii. The handset cradle shall have a switch connection such that lifting the handset off of the cradle shall send a signal to the fire command center which shall audibly and visually indicate its on-line (off-hook) condition.
iii. The two-way emergency telephone system shall support a maximum of seven (7) handsets on line (off hook) without degradation of the signal.

25.2.6 Universal Digital Alarm Communicator Transmitter (UDACT). The UDACT is an interface for communicating digital information between a fire alarm control panel and an UL-Listed central station.

i. The UDACT shall be compact in size, mounting in a standard module position of the fire alarm control cabinet. Optionally, the UDACT shall have the ability for remote mounting, up to 6,000 feet from the fire alarm control panel. The wire connections between the UDACT and the control panel shall be supervised with one pair for power and one pair for multiplexed communication of overall system status. Systems that utilize relay contact closures are not acceptable.
ii. The UDACT shall include connections for dual telephone lines (with voltage detect), per UL/NFPA/FCC requirements. It shall include the ability for split reporting of panel events up to two different telephone numbers.
iii. The UDACT shall be capable of transmitting events in 4+2, SIA, and Contact ID.
iv. Communication shall include vital system status such as:

    a. Independent Zone (Alarm, trouble, non-alarm, supervisory)
    b. Independent Addressable Device Status
    c. AC (Mains) Power Loss
    d. Low Battery and Earth Fault
    e. System Off Normal
    f. 12 and 24 Hour Test Signal
    g. Abnormal Test Signal (per UL requirements)
    h. EIA-485 Communications Failure

i. Phone Line Failure

v. The UDACT shall support independent zone/point reporting when used in the Contact ID format. In this format the UDACT shall support transmission of up to 3,064 points. This enables the central station to have exact details concerning the origin of the fire or response emergency.
vi. The UDACT shall be capable of being programmed with the same programming utility as the host FACP, and saved, edited and uploaded and downloaded using the utility. UDACT shall be capable of being programmed online or offline. The programming utility shall also support upgrading UDACT operating firmware.
vii. The UDACT shall be capable of generating Central Station reports providing detailed programming information for each point along with the central station point address.
viii. An IP or IP/GSM Communicator option shall be available to interface to the UDACT and be capable of transmitting signals over the internet/intranet or Cellular (GSM) network to a compatible receiver.

25.2.7 Field Wiring Terminal Blocks

For ease of service all panel I/O wiring terminal blocks shall be removable, plug-in types and have sufficient capacity for #18 to #12 AWG wire. Terminal blocks that are permanently fixed are not acceptable.

25.2.8 **Printer**

i. The printer shall provide hard-copy printout of all changes in status of the system and shall time-stamp such printouts with the current time-of-day and date. The printer shall be standard carriage with 80-characters per line and shall use standard pin-feed paper. The printer shall be enclosed in a separate cabinet suitable for placement on a desktop or table. The printer shall communicate with the control panel using an interface complying with Electrical Industries Association standard EIA-232D. Power to the printer shall be 120 VAC @ 60 Hz.
ii. The system shall have a strip printer capable of being mounted directly in the main FACP enclosure. Alarms shall be printed in easy-to-read RED, other messages, such as a trouble, shall be printed in BLACK. This printer shall receive power from the system power supply and shall operate via battery back-up if AC mains are lost. The strip printer shall be UL 864 listed.
iii. The system shall have a strip printer capable of being mounted directly in the main FACP enclosure. Alarms shall be printed in easy-to-read RED, other messages, such as a trouble, shall be printed in BLACK. This printer shall receive power from the system power supply and shall operate via battery back-up if AC mains are lost. The strip printer shall be UL 864 listed.

25.2.9 Smoke Control Annunciator

i. On/Auto/Off switches and status indicators (LEDS) shall be provided for monitoring and manual control of each fan, damper, HVAC control unit, stairwell pressurization fan, and smoke exhaust fan. To ensure compliance the units supplied shall meet the following UL categories: UUKL, PAZX, UDTZ, QVAX as well as the requirements of NFPA 90A, HVAC, and NFPA 92A & 92B, Smoke Control. The control System shall be field programmable for either 90A operation or 92A/B operation to allow for future use and system expansion.

ii. The OFF LED shall be Yellow, the ON LED shall be green, the Trouble/Fault LED shall be Amber/Orange for each switch. The Trouble/Fault indicator shall indicate a trouble in the control and/or monitor points associated with that switch. In addition, each group of eight switches shall have two LEDS and one momentary switch which allow the following functions: An Amber LED to indicate an OFF-NORMAL switch position, in the ON or OFF position; A Green LED to indicate ALL AUTO switch position; A Local Acknowledge/Lamp Test momentary switch.

iii. Each switch shall have the capability to monitor and control two addressable inputs and two addressable outputs. In all modes, the ON and OFF indicators shall continuously follow the device status not the switch position. Positive feedback shall be employed to verify correct operation of the device being controlled. Systems that indicate on/off/auto by physical switch position only are not acceptable.

iv. All HVAC switches (i.e., limit switches, vane switches, etc.) shall be provided and installed by the HVAC contractor.

v. It shall be possible to meet the requirements mentioned above utilizing wall mounted custom graphic.

25.2.10 Gateway & Webserver Options

1.0 **Common Alerting Protocol (CAP) Gateway**:

The system shall support an optional CAP Gateway (Common Alerting Protocol). The CAP Gateway translates fire system messages to industry standard CAP messages for integration with CAP-compliant clients. A CAP gateway shall be available from the fire alarm control panel manufacturer.

2.0 LEDSIGN Gateway:

The system shall support an optional and proprietary LEDSIGN Gateway to interface to LED signs that will automatically display emergency messages. The signs shall be capable of storing up to 100 messages that can be activated via system programming with the ability to be manually overridden. The Sign Gateway shall support up to 10 independent signs, each sign capable of playing an independent message. Multiple LEDSIGN Gateways can be used in network applications. An LEDSIGN gateway shall be available from the fire alarm control panel manufacturer.

3.0 BACnet Interface Gateway:

The system shall be capable of being interfaced with BACNet compliant clients. A BACnet interface supporting BACnet/IP communication shall be available from the fire alarm control panel manufacturer.

4.0 MODbus Interface Gateway:

The system shall be capable of being interfaced with MODbus compliant clients. A MODbus interface supporting MODbus/TCP communication shall be available from the fire alarm control panel manufacturer.

5.0 Net Gateway:

The system shall support an IP based gateway to enable the panel or local Net to be connected to a Graphics software workstation via the Internet or Intranet. This gateway shall also support the ability to integrate the system to an interactive firefighter's display. The Net Gateway shall be available from the fire alarm control manufacturer.

6.0 Webserver:

The system shall support a webserver allowing remote connection via the Internet or Intranet. Authorized users will have the ability to view panel/network history, event status and device properties. The webserver shall also support sending event information via email or text to up to 50 registered users, the webserver shall be available from the fire alarm control panel manufacturer.

7.0 Web Portal Interface:

The system shall be capable of being interfaced with a web portal to integrate with Inspection and Service Manager Utilities. The web portal and inspection and service manager utilities shall be available from the fire alarm control panel manufacturer.

25.3 SYSTEM COMPONENTS - ADDRESSABLE DEVICES

25.3.1 Addressable Devices – General

i. Addressable devices shall provide an address-setting means using rotary decimal switches. Addressable devices that require the address be programmed using a programming utility are not an allowable substitute.

ii. Addressable devices shall use simple to install and maintain decade, decimal address switches. Devices shall be capable of being set to an address in a range of 001 to 159.

iii. Addressable devices, which use a binary-coded address setting method, such as a DIP-switch, are not an allowable substitute. Addressable devices that require the address be programmed using a special tool or programming utility are not an allowable substitute.

iv. Addressable devices, which use a binary-coded address setting method, such as a DIP-switch, are not an allowable substitute. Addressable devices that require the address be programmed using a special tool or programming utility are not an allowable substitute.

v. Detectors shall be intelligent (analog) and addressable, and shall connect with two wires to the fire alarm control panel Signaling Line Circuits.

vi. Addressable smoke and thermal detectors shall provide dual alarm and power/polling LEDs. Both LEDs shall flash green under normal conditions, indicating that the detector is operational and in regular communication with the control panel, and both LEDs shall be placed into steady red illumination by the control panel, indicating that an alarm condition has been detected. If required, the LED flash shall have the ability to be removed from the system program. An output connection shall also be provided in the base to connect an external remote alarm LED.

vii. The fire alarm control panel shall permit detector sensitivity adjustment through field programming of the system. The panel on a time-of-day basis shall automatically adjust sensitivity.

viii. Using software in the FACP, detectors shall automatically compensate for dust accumulation and other slow environmental changes that may affect their performance. The detectors shall be listed by UL as meeting the calibrated sensitivity test requirements of NFPA Standard 72.

ix. The detectors shall be ceiling-mount and shall include a separate twist-lock base with tamper proof feature. Base options shall include a sounder base with a built-in (local) sounder rated at 85 DBA minimum, a relay base and an isolator base designed for Style 7 applications. The system shall also support an intelligent programmable sounder base, the programmable sounder base shall be capable of providing multiple tones based on programming and at a minimum be capable of providing a Temp-4 tone for CO (Carbon Monoxide) activation and a Temp-3 tone for fire activations and be capable of being synchronized with other programmable sounder bases and common area notification appliances; 85 DBA minimum.

x. Detectors shall also store an internal identifying type code that the control panel shall use to identify the type of device (ION, PHOTO, THERMAL).

xi. Detectors will operate in an analog fashion, where the detector simply measures its designed environment variable and transmits an analog value to the FACP based on real-time measured values. The FACP software, not the detector, shall make the alarm/normal decision, thereby allowing the sensitivity of each detector to be set in the FACP program and allowing the system operator to view the current analog value of each detector.

xii. Addressable devices shall store an internal identifying code that the control panel shall use to identify the type of device.

xiii. A magnetic test switch shall be provided to test detectors and modules. Detectors shall report an indication of an analog value reaching 100% of the alarm threshold.

xiv. Addressable modules shall mount in a 4-inch square (101.6 mm square), 21/8 inch (54 mm) deep electrical box. An optional surface mount Lexan enclosure shall be available.

25.3.2 Addressable Manual Fire Alarm Box (manual station)

Addressable manual fire alarm boxes shall, on command from the control panel, send data to the panel representing the state of the manual switch and the addressable communication module status; They shall use a key operated test-reset lock, and shall be designed so that after actual emergency operation, they cannot be restored to normal use except by the use of a key.

All operated stations shall have a positive, visual indication of operation and utilize a key type reset.

Manual fire alarm boxes shall be constructed of Lexan with clearly visible operating instructions provided on the cover. The word FIRE shall appear on the front of the stations in raised letters, 1.75 inches (44 mm) or larger.

25.3.3 Intelligent Photoelectric Smoke Detector:

The intelligent photoelectric smoke detector shall use the photoelectric (light-scattering) principal to measure smoke density and shall, on command from the control panel, send data to the panel representing the analog level of smoke density.

25.3.4 Intelligent VIEW® Laser Photo Smoke Detector:

i. The intelligent laser photo smoke detector shall be a spot type detector that incorporates an extremely bright laser diode and an integral lens that focuses the light beam to a very small volume near a receiving photo sensor. The scattering of smoke particles shall activate the photo sensor.
ii. The laser detector shall have conductive plastic so that dust accumulation is reduced significantly
iii. The intelligent laser photo detector shall have nine sensitivity levels and be sensitive to a minimum obscuration of 0.02 percent per foot.
iv. The laser detector shall not require expensive conduit, special fittings or PVC pipe.
v. The intelligent laser photo detector shall support standard, relay, isolator and sounder detector bases.
vi. The laser photo detector shall not require other cleaning requirements than those listed in NFPA 72. Replacement, refurbishment or specialized cleaning of the detector head shall not be required.
vii. The laser photo detector shall include two bicolor LEDs that flash green in normal operation and turn on steady red in alarm.

25.3.5 Intelligent Ionization Smoke Detector:

The intelligent ionization smoke detector shall use the dual-chamber ionization principal to measure products of combustion and shall, on command from the control panel, send data to the panel representing the analog level of products of combustion.

25.3.6 Intelligent Multi Criteria Acclimating Detector:

i. The intelligent multi-criteria Acclimate® Plus™ detector shall be an addressable device that is designed to monitor a minimum of photoelectric and thermal technologies in a single sensing device. The design shall include the ability to adapt to its environment by utilizing a built-in microprocessor to determine its environment and choose the appropriate sensing settings. The detector design shall allow a wide sensitivity window, no less than 1 to 4% per foot obscuration. This detector shall utilize advanced electronics that react to slow smoldering fires and thermal properties all within a single sensing device.

ii. The intelligent multi criteria detection device shall include the ability to combine the signal of the thermal sensor with the signal of the photoelectric signal in an effort to react hastily in the event of a fire situation. It shall also include the inherent ability to distinguish between a fire condition and a false alarm condition by examining the characteristics of the thermal and smoke sensing chambers and comparing them to a database of actual fire and deceptive phenomena

25.3.7 Intelligent Thermal Detectors:

The intelligent thermal detectors shall be addressable devices rated at 135 degrees Fahrenheit (58 degrees Celsius) and have a rateof-rise element rated at 15 degrees F (9.4 degrees C) per minute. A high heat thermal detector rated at 190 degrees Fahrenheit shall also be available. The thermal detectors shall connect via two wires to the fire alarm control panel signaling line circuit.

25.3.8 Intelligent Duct Smoke Detector:

The smoke detector housing shall accommodate an intelligent photoelectric detector that provides continuous analog monitoring and alarm verification from the panel. When sufficient smoke is sensed, an alarm signal is initiated at the FACP, and appropriate action taken to change over air handling systems to help prevent the rapid distribution of toxic smoke and fire gases throughout the areas served by the duct system. The Intelligent Duct Smoke Detector shall support the installation of addressable Photoelectric detector capable or being tested remotely. The Intelligent Duct Detector housing shall be model # DNR(W) and the remote test capable photoelectric smoke detector.

25.3.9 IntelliQuad™ Advanced Multi-Criteria Intelligent Detector

viii. Intelligent multi-criteria fire detector shall be an addressable intelligent multi-criteria smoke detector. The detector shall be comprised of four sensing elements, including a photoelectric (light-scattering) particulate sensor, an electrochemical carbon monoxide (CO) sensor, a daylight-filtered infrared sensor and solid state thermal sensor(s) rated at 135°F (57.2°C). The device shall be able to indicate distinct smoke and heat alarms.

ix. The intelligent multi-criteria detection device shall include the ability to combine the signal of the photoelectric signal with other sensing elements in an effort to react quickly in the event of a fire situation. It shall also include the inherent ability to distinguish between a fire condition and a nuisance alarm condition. The product design shall be capable of selecting the appropriate sensitivity levels based on the environment type chosen by user in which it is installed (office, manufacturing, kitchen etc.) and then have the ability to automatically change the setting as the environment changes.

x. The detector shall be capable of automatically adjusting its sensitivity by means of drift compensation and smoothing algorithms. The detector shall be capable of automatically adjusting its sensitivity by means of drift compensation and smoothing algorithms. The device shall provide unique signals to indicate when 20% of the drift range is remaining, when 100% of drift range is used, and when there is a chamber fault to show unit requires maintenance.

xi. The detector shall indicate CO trouble conditions including 6 months of sensor life remaining and sensor life has expired. The detector shall indi cate a combined signal for any of the following: low chamber trouble, thermistor trouble, CO self test failure, IR self test failure, and freeze warning

xii. The detectors shall provide address-setting means on the detector head using rotary switches. Because of the possibility of installation error, systems that use binary jumpers or DIP switches to set the detector address are not acceptable. The detectors shall also store an internal identifying code that the control panel shall use to identify the type of detector. Systems that require a special programmer to set the detector address (including temporary connection at the panel) are labor intensive and not acceptable. Each detector occupies any one of at least 99 possible addresses on the signaling line circuit (SLC) loop. It responds to regular polls from the system and reports its type and status.

xiii. The detectors shall provide a test means whereby they will simulate an alarm condition and report that condition to the control panel. Such a test may be initiated at the detector itself (by activating a switch) or initiated remotely on command from the control panel. There are three test methods: functional magnet, smoke entry aerosol, or direct heat method.

xiv. The detectors shall provide two LEDs to provide 360° visibility. The LEDs are placed into steady red illumination by the control panel indicating that an alarm condition has been detected. An output connection shall also be provided in the base to connect an external remote alarm LED, sounder base, and / or relay base (optional accessories). The external remote alarm can be interconnected to other sounder or relay bases for activating all devices in a space via a single alarming unit.

xv. Two LEDs on the sensor are controlled by the panel to indicate sensor status. Coded signals, transmitted from the panel, can cause the LEDs to blink, latch on, or latch off. Refer to the control panel technical documentation for sensor LED status operation and expected delay to alarm.

xvi. The detectors shall be ceiling-mount and shall be plug-in mounted into a twist-lock base. These detectors shall be constructed of off-white UV resistant polymer and shall be detachable from the mounting base to simplify installation, service and maintenance. Mounting base wiring connections shall be made by means of SEMS screws. The detector shall allow pre-wiring of the base and the head shall be a plug-in type. Mounting base shall be mounted on junction box which is at least 1.5 inches (3.81 cm) deep. Mounting base shall be available to mount to standard junction boxes. Suitable boxes include:

a. 4.0" (10.16 cm) square box with and without plaster ring.
b. 4.0" (10.16 cm) octagonal box.
c. 3.5" (8.89 cm) octagonal box.
d. Single-gang box.

xvii. Meets Agency Standards

a. ANSI/UL 268 -Smoke Detectors for Fire Alarm Signaling Systems
b. CAN/ULC-S529- Smoke Detectors for Fire Alarm Systems
c. FM 3230-3250- Smoke Actuated Detectors for Automatic Fire Alarm Signaling

25.3.10 IntelliQuad™ PLUS Advanced Multi-Criteria Intelligent Fire/CO Detector

i. Advanced Multi-Criteria Fire/CO detector shall be an addressable advanced multi-criteria smoke detector with a separate signal for carbon monoxide (CO) detection per UL 2075 standards.
ii. The detector shall be comprised of four sensing elements, including a photoelectric (light-scattering) particulate sensor, an electrochemical CO sensor, a daylight-filtered infrared (IR) sensor and solid state thermal sensor(s) rated at 135°F (57.2°C). The device shall be able to indicate distinct smoke and heat alarms.
iii. The advanced multi-criteria detection device shall include the ability to combine the signal of the photoelectric signal with other sensing elements in order to react quickly in the event of a fire situation. It shall also include the inherent ability to distinguish between a fire condition and a nuisance alarm condition. The detector shall be capable of selecting the appropriate sensitivity levels based on the environment type (office, manufacturing, kitchen, etc.) in which it is installed, and then have the ability to automatically change the setting as the environment changes.

iv. The CO detector component shall be capable of a functional gas test using a canned test agent to test the functionality of the CO sensing cell.
v. The detector shall be capable of automatically adjusting its sensitivity by means of drift compensation and smoothing algorithms. The device shall provide unique signals to indicate when 20 percent of the drift range is remaining, when 100 percent of drift range is used, and when there is a chamber fault to show the unit requires maintenance.
vi. The detector shall indicate CO trouble conditions, including six months of sensor life remaining and sensor life has expired. The detector shall indicate a combined signal for any of the following: low chamber trouble, thermistor trouble, CO self test failure, IR self test failure, and freeze warning.
vii. The detector shall provide address-setting means on the detector head using rotary switches. Because of the possibility of installation error, systems that use binary jumpers or DIP switches to set the detector address are not acceptable. The detector shall also store an internal identifying code that the control panel shall use to identify the type of detector. Systems that require a special programmer to set the detector address (including temporary connection at the panel) are labor intensive and not acceptable. Each detector occupies any one of at least 159 possible addresses on the signaling line circuit (SLC) loop. It responds to regular polls from the system and reports its type and status.
viii. The detector shall provide a test means whereby it will simulate an alarm condition and report that condition to the control panel. Such a test may be initiated at the detector itself (by activating a switch) or initiated remotely on command from the control panel. There shall be four test methods: functional magnet, smoke entry aerosol, carbon monoxide aerosol or direct heat method.
ix. The detector shall provide two LEDs to provide 360° visibility. The LEDs shall be placed into steady red illumination by the control panel indicating that an alarm condition has been detected. An output connection shall also be provided in the base to connect an external remote alarm LED. The detector must be capable of connecting to a sounder base that provides both temporal 3 and temporal 4 patterns for fire and CO alarm.
x. Two LEDs on the sensor shall be controlled by the panel to indicate sensor status. Coded signals, transmitted from the panel, shall cause the LEDs to blink, latch on, or latch off. Refer to the control panel technical documentation for sensor LED status operation and expected delay to alarm.
xi. The detector shall be plug-in mounted into a twist-lock base. The detector shall be constructed of off-white, UV-resistant polymer and shall be detachable from the mounting base to simplify installation, service and maintenance. Mounting base wiring connections shall be made by means of SEMS screws. The detector shall allow pre-wiring of the base and the head shall be a plug-in type. The mounting base shall be mounted on a junction box that is at least 1.5 inches (3.81 cm) deep. The mounting base shall be available to mount to standard junction boxes. Suitable boxes include:

a. 4.0" (10.16 cm) square box with and without plaster ring.
b. 4.0" (10.16 cm) octagonal box.

c. 3.5" (8.89 cm) octagonal box.
d. Single-gang box.
e. Double-gang box

xii. Meets Agency Standards

a. ANSI/UL 268 -Smoke Detectors for Fire Alarm Signaling Systems
b. CAN/ULC-S529- Smoke Detectors for Fire Alarm Systems
c. FM 3230-3250- Smoke Actuated Detectors for Automatic Fire Alarm Signaling
d. UL 2075 – Gas and Vapor Detector and Sensors – Systems Connected

25.3.11 Intelligent Addressable Aspiration Detector:

The intelligent aspiration detector shall be an addressable aspiration detector that communicates directly with the fire alarm control panel via the SLC communication protocol, no modules or high-level interfaces shall be required. The fire alarm control panel shall support up to thirty-one intelligent aspiration detectors per SLC loop. The aspiration detector shall have dual source (blue LED and infrared laser) optical smoke detection for a wide range of fire detection with enhanced immunity to nuisance particulates. The FACP shall be capable of monitoring and annunciating up to five smoke event thresholds and eleven trouble conditions. Each event threshold shall be capable of being assigned a discrete type ID at the FACP.

25.3.12 Intelligent Addressable Reflected Beam Detector

The intelligent single-ended reflected beam smoke detector shall connect with two wires to the fire alarm control panel signaling line circuit (SLC). The detectors shall consist of a transmitter/receiver unit and a reflector and shall send data to the panel representing the analog level of smoke density. The detector shall be capable of being tested remotely via a keyswitch and shall be equipped with an integral sensitivity test feature.

25.3.13 Addressable Dry Contact Monitor Module

ii Addressable monitor modules shall be provided to connect one supervised IDC zone of conventional alarm initiating devices (any N.O. dry contact device) to one of the fire alarm control panel SLCs.
iii The IDC zone shall be suitable for Style D/Class A or Style B/Class B operation. An LED shall be provided that shall flash under normal

conditions, indicating that the monitor module is operational and in regular communication with the control panel

iv For difficult to reach areas, the monitor module shall be available in a miniature package and shall be no larger than 2-3/4 inch (70 mm) x 1-1/4 inch (31.7 mm) x 1/2 inch (12.7 mm). This version need not include Style D or an LED

v For multiple dry contact monitoring a module shall be available that provides 10 Style B or 5 Style D input circuits

25.3.14 **Two Wire Detector Monitor Module**

iii. Addressable monitor modules shall be provided to connect one supervised IDC zone of conventional 2-wire smoke detectors or alarm initiating devices (any N.O. dry contact device);

iv. The IDC zone may be wired for Class A or B (Style D or Style B) operation. An LED shall be provided that shall flash under normal conditions, indicating that the monitor module is operational and in regular communication with the control panel

v. For multiple 2-wire smoke detector circuit monitoring a module shall be available that provides 6 Style B/Class A or 3 Style D/Class B input circuits

25.3.15 **Addressable Control Module**

ii. Addressable control modules shall be provided to supervise and control the operation of one conventional circuit of compatible Notification Appliances, 24VDC powered, polarized audio/visual notification appliances;

iii. The control module NAC may be wired for Style Z or Style Y (Class A/B) with a current rating of 2 Amps for Style Z and 3 Amps for Style Y

iv. Audio/visual power shall be provided by a separate supervised circuit from the main fire alarm control panel or from a supervised UL listed remote supply

v. For multiple circuit control a module shall be available that provides 6 Style Y (Class B) or 3 Style Z (Class A) control circuits

25.3.16 Addressable Releasing Control Module

i. An addressable FlashScan releasing module shall be available to supervise and control compatible releasing agent solenoids

ii. The module shall operate on a redundant protocol for added protection

iii. The module shall be configurable for Style Z or Style Y (Class A/B) and support one 24 volt or two 12 volt solenoids.Add FMM-4-20.

iv. Addressable 4-20 mA module shall be available to monitor industry-standard, linear-scale, 4-20 mA protocol sensors. The module converts the sensor output to communication protocol that can be interpreted by the FACP for monitoring and display.

v. The module shall support programming of up to five programmable event thresholds.

vi. The System shall be FM 6320 (Factory Mutual) approved as a Gas Detection system when employed with the monitor module and industry standard 420 mA gas detectors.

25.3.17 Addressable Relay Module:

i. Addressable Relay Modules shall be available for HVAC control and other network building functions;

ii. The module shall provide two form C relays rated at up to 3 Amps resistive and up to 2.0 Amps inductive.

iii. The relay coil shall be magnetically latched to reduce wiring connection requirements, and to insure that 100% of all auxiliary devices energize at the same time on the same pair of wires;

iv. For multiple relay control a module shall be available that provides 6 programmable Form-C relays;

25.3.18 Addressable Two-In / Two-Out Monitor/Relay Module:

ix. An addressable Two-In / Two-Out module shall be available;

ii. The two-in/two-out module shall provide two Class B/Style B dry-contact input circuits and two independent Form-C relays rated at up to 3 Amps resistive and up to 2.0 Amps inductive

25.3.19 Isolator Module:

i. Isolator modules shall be provided to automatically isolate wire-to-wire short circuits on an SLC Class A or Class B branch. The isolator module shall limit the number of modules or detectors that may be rendered inoperative by a short circuit fault on the SLC loop segment or branch. At least one isolator module shall be provided for each floor or protected zone of the building;

ii. If a wire-to-wire short occurs, the isolator module shall automatically open circuit (disconnect) the SLC. When the short circuit condition is corrected, the isolator module shall automatically reconnect the isolated section

iii. The isolator module shall not require address-setting, and its operations shall be totally automatic. It shall not be necessary to replace or reset an isolator module after its normal operation

iv. The isolator module shall provide a single LED that shall flash to indicate that the isolator is operational and shall illuminate steadily to indicate that a short circuit condition has been detected and isolated

25.3.20 Serially Connected Annunciator Requirements

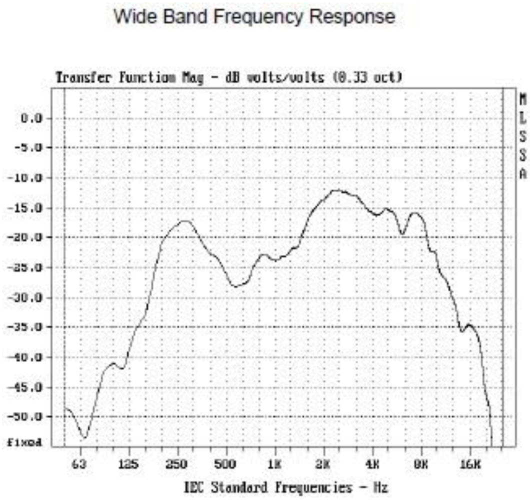
i. The annunciator shall communicate to the fire alarm control panel via an EIA 485 (multi-drop) two-wire communications loop. The system shall support two 6,000 ft. EIA-485 wire runs. Up to 32 annunciators, each configured up to 96 points, may be connected to the connection, for a system capacity of 3,072 points of annunciation.
ii. An EIA-485 repeater shall be available to extend the EIA-485 wire distance in 3,000 ft. increments. The repeater shall be UL864 approved
iii. Each annunciator shall provide up to 96 alarm and 97 trouble indications using a long-life programmable color LED's. Up to 96 control switches shall also be available for the control of Fire Alarm Control Panel functions. The annunciator will also have an "ON-LINE" LED, local piezo sounder, local acknowledge and lamp test switch, and custom zone/function identification labels
iv. The annunciator may be field configured to operate as a "Fan Control Annunciator". When configured as "Fan Control," the annunciator may be used to manually control fan or damper operation and can be set to override automatic commands to all fans/dampers programmed to the annunciator. 5. Annunciator switches may be programmed for System control such as, Global Acknowledge, Global Signal Silence, Global System Reset, and on/off control of any control point in the system
v. An optional module shall be available to utilize annunciator points to drive EIA-485 driven relays. This shall extend the system point capacity by 3,072 remote contacts
vi. The LED annunciator shall offer an interface to a graphic style annunciator and provide each of the features listed above

25.3.21 SpectrAlert Advance Speakers

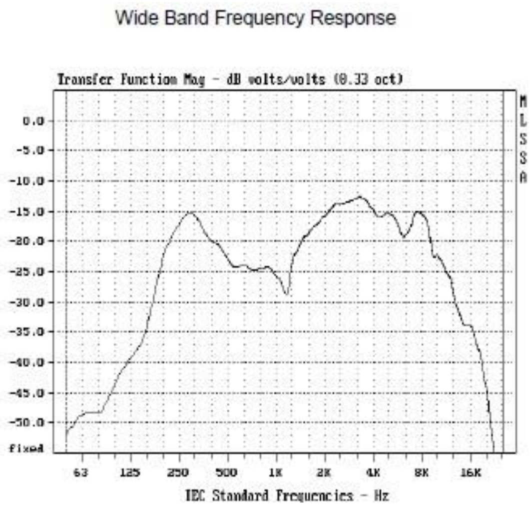
i. The Speaker appliance shall be System Sensor SpectrAlert Advance model ______ Speaker. The speaker shall be listed to UL 1480 for Fire Protective Signaling Systems. It shall be a dual-voltage transformer speaker capable of operation at 25.0 or 70.7 nominal Vrms. The speaker shall have a frequency range of 400 to 4,000 Hz and shall have an operating temperature between 32°F and 120°F. It shall mount to a 4 x 4 x 2 1/8-inch back box
ii. A universal mounting plate shall be used for mounting ceiling and wall speaker products. The notification appliance circuit and amplifier wiring shall terminate at the universal mounting plate
iii. Speakers shall be plug-in and shall have the ability to check wiring continuity via a shorting spring on the universal mounting plate. The shorting spring shall also provide tamper resistance via an open circuit if the device is removed. Speaker design shall isolate speaker components to reduce ground fault incidents
iv. The speaker shall have power taps (from ¼ watt to 2 watts) and voltage that are selected by rotary switches. All models shall have a maximum sound output of 86 dB at 10 feet and shall incorporate an open back construction

v. All notification appliances shall be backward compatible

Ceiling Speaker



Wall Speaker



Note: The wide band frequency response is derived using MLS methods

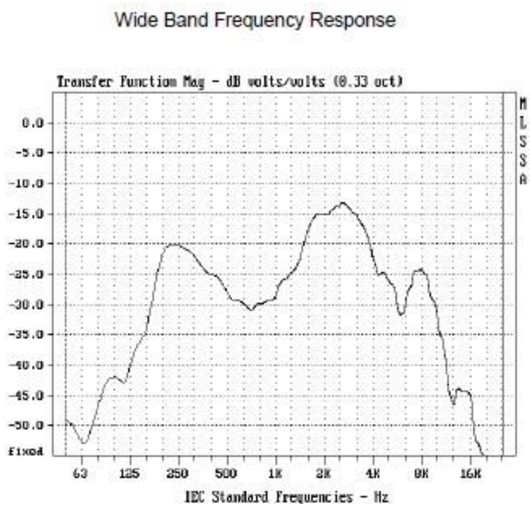
1.2.3.14. SpectrAlert Advance Speaker Strobes

i. The Speaker Strobe appliance shall be System Sensor SpectrAlert Advance model ______ Speaker Strobe. The speaker strobe shall be listed to UL 1971 and UL 1480 and be approved for fire protective signaling systems. It shall be a dual-voltage transformer speaker strobe capable of operation at 25.0 or 70.7 nominal Vrms. The speaker shall have a frequency range of 400 to 4,000 Hz and shall have an operating temperature between 32°F and 120°F. It shall mount to a 4 x 4 x 2 1/8-inch back box.

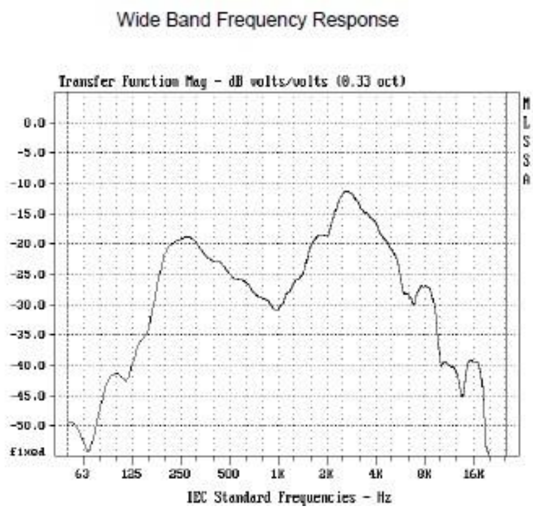
ii. A universal mounting plate shall be used for mounting ceiling and wall speaker strobe products. The notification appliance circuit and amplifier wiring shall terminate at the universal mounting plate. Also, SpectrAlert Advance speaker strobes and the Sync•Circuit™ Module MDL3 accessory, if used, shall be powered from a non-coded notification appliance circuit output and shall operate on a nominal 12 or 24 volts (includes fire alarm panels with built in sync). When used with the Sync•Circuit Module MDL3, 12-volt rated notification appliance circuit outputs shall operate between 8.5 and 17.5 volts; 24-volt rated notification appliance circuit outputs shall operate between 16.5 to 33 volts. If the notification appliances are not UL 9th edition listed with the corresponding panel or power supply being used, then refer to the compatibility listing of the panel to determine maximum devices on a circuit

iii. Speaker strobes shall be plug-in and shall have the ability to check wiring continuity via a shorting spring on the universal mounting plate. The shorting spring shall also provide tamper resistance via an open circuit if the device is removed. Speaker strobe design shall isolate speaker components to reduce ground fault incidents
iv. The speaker strobe shall have power taps (from ¼ watt to 2 watts) and voltage that are selected by rotary switches. All models shall have a maximum sound output of 86 dB at 10 feet and shall incorporate an open back construction. The strobe shall consist of a xenon flash tube with associated lens/reflector system and operate on either 12V or 24V. The strobe shall also feature selectable candela output, providing options for 15 or 15/75 candela when operating on 12V and 15, 15/75, 30, 75, 110, or 115 when operating on 24V. The strobe shall comply with NFPA 72 and the Americans with Disabilities Act requirement for visible signaling appliances, flashing at 1 Hz over the strobe's entire operating voltage range
v. All notification appliances shall be backward compatible
vi. Strobe lights shall meet the requirements of the ADA, UL Standard 1971and be fully synchronized

Ceiling Speaker Strobe



Wall Speaker Strobe



Note: The wide band frequency response is derived using MLS methods

25.4 EXECUTION

25.4.1*INSTALLATION*:

i. Installation shall be in accordance with the NEC, NFPA 72, local and state codes, as shown on the drawings, and as recommended by the major equipment manufacturer.
ii. All conduit, junction boxes, conduit supports and hangers shall be concealed in finished areas and may be exposed in unfinished areas. Smoke detectors shall not

be installed prior to the system programming and test period. If construction is ongoing during this period, measures shall be taken to protect smoke detectors from contamination and physical damage.

iii. All fire detection and alarm system devices, control panels and remote annunciators shall be flush mounted when located in finished areas and may be surface mounted when located in unfinished areas.

iv. Manual fire alarm boxes shall be suitable for surface mounting or semi-flush mounting as shown on the plans, and shall be installed not less than 42 inches (1067 mm), nor more than 48 inches (122 mm) above the finished floor

25.4.2 TEST:

The service of a competent, factory-trained engineer or technician authorized by the manufacturer of the fire alarm equipment shall be provided to technically supervise and participate during all of the adjustments and tests for the system. All testing shall be in accordance with NFPA 72.

i. Before energizing the cables and wires, check for correct connections and test for short circuits, ground faults, continuity, and insulation.
ii. Close each sprinkler system flow valve and verify proper supervisory alarm at the FACP
iii. Verify activation of all waterflow switches
iv. Open initiating device circuits and verify that the trouble signal actuates
v. Open and short signaling line circuits and verify that the trouble signal actuates
vi. Open and short notification appliance circuits and verify that trouble signal actuates
vii. Ground all circuits and verify response of trouble signals.
viii. Check presence and audibility of tone at all alarm notification devices.
ix. Check installation, supervision, and operation of all intelligent smoke detectors using the walk test
x. Each of the alarm conditions that the system is required to detect should be introduced on the system. Verify the proper receipt and the proper processing of the signal at the FACP and the correct activation of the control points
xi. When the system is equipped with optional features, the manufacturer's manual shall be consulted to determine the proper testing procedures. This is intended to address such items as verifying controls performed by individually addressed or grouped devices, sensitivity monitoring, verification functionality and similar

25.4.3 FINAL *INSPECTION*:

At the final inspection, a factory-trained representative of the manufacturer of the major equipment shall demonstrate that the system functions properly in every respect.

25.4.4 *INSTRUCTION*:

i. Instruction shall be provided as required for operating the system. Hands-on demonstrations of the operation of all system components and the entire system including program changes and functions shall be provided.

ii. The contractor and/or the systems manufacturer's representatives shall provide a typewritten "Sequence of Operation.

TECHNICAL SPECIFICATIONS

(ELEVATORS)

26 SECTION 26- TECHNICAL SPECIFICATIONS (ELEVATORS)

26.1 PRODUCTS FURNISHED BUT NOT INSTALLED UNDER THIS SECTION

Deliver the following item to the Construction Work Contractor for installation:

i. Concrete inserts for support of guide rails.

26.2 PRODUCTS PROVIDED BY OTHERS

26.2.1 ITEMS PROVIDED BY THE CONSTRUCTION WORK CONTRACTOR

The Construction Work Contractor will provide the following items:

i. Enclosed hoistway, including structural beams at top of shaft to carry the loads imposed on the building by the elevator equipment.
ii. Elevator pit of proper depth below the lowest landing including waterproofing and a pit ladder.
iii. Machine room of sufficient size to accommodate the elevator equipment.
iv. Sill support angles for each hoistway entrance.

26.2.2 ITEMS PROVIDED BY THE ELECTRICAL WORK CONTRACTOR

The Electrical Work Contractor will provide the following items:

i. Power feeder to machine room, terminating at line terminals of elevator controller.
ii. Fused disconnect switch or enclosed circuit breaker with auxiliary contact.
iii. Single-phase circuit for elevator cab lighting, terminating in a fused disconnect switch or circuit breaker in elevator machine rooms.
iv. Smoke detection system for Phase I - Emergency Recall Operation terminating at a terminal strip cabinet in elevator machine room.
v. Emergency power signaling conductors from automatic transfer switches to the elevator controller(s).
vi. Lighting in machine room and elevator pit.
vii. Telephone wiring terminated in the elevator machine room.
viii. Thermostatically controlled mechanical ventilation of the elevator machine room.

26.3 PRODUCTS FURNISHED BY OTHERS AND INSTALLED UNDER THIS CONTRACT

The following items will be furnished under the Electrical Work Contract for installation under this Contract:

(a). Public address speaker and backbox for each elevator cab.
(b). Fire warden telephone jack for each elevator cab.
(c). Card access control equipment.
(d). CCTV equipment.

26.4 DEFINITIONS

26.4.1 *Company Field Advisor*:

An employee of the company which lists and markets the primary components of the elevator under their name, who is certified by the company to be technically qualified in design, installation, and servicing of the required products, or an employee of an organization certified by the foregoing company to be technically qualified in design, installation and servicing of the required products

26.5 SUBMITTALS

26.5.1 Submittals Package:

Submit the shop drawings, product data, samples, and quality control submittals specified below at the same time as a package except for the following

i. Control System Wiring Diagrams (Shop Drawings)
ii. Test Report (Quality Control Submittal).

26.5.2 Shop drawings

i. Machine room (layout, size, etc).
ii. Hoistway, sections and layouts showing reaction points with reactions
iii. Entrance and car details
iv. Details of doors, frames, and sills
v. Control System Wiring Diagrams
vi. Car and lobby fixture details
vii. Isolation transformer KVA rating with calculations utilized to determine KVA rating provided.
viii. Manufactures machine and emergency brake drawings.

26.5.3 Product Data

i. Manufacturer’s catalog sheets, specifications and installation instructions for each component specified
ii. Motor data shall be certified by the manufacture. Provide calculations utilized to determine horsepower rating provided
iii. Hydraulic pump data with calculations utilized to determine the gallons per minute rating provided.
iv. Hydraulic cylinder data with calculations utilized to determine diameter and wall thickness of cylinder provided

26.5.4 Samples

i. Hoist cable (two - 2-foot lengths).

ii. Governor Cable (two - 2-foot lengths).
iii. Travel cable (two - 2-foot lengths).
iv. Stainless steel.
v. Bronze.
vi. Handicap access signage.
vii. Phase I and II procedure signage.
viii. Colour Selections.

26.5.5 Quality Control Submittals

i. Installers Qualifications Data

a. Name of each person who will be performing the Work.
b. Employer's name, business address and telephone number
c. Names and addresses of the required number of similar projects that each person has worked on which has met the experience criteria

ii. Test Report: Acceptance test report
iii. Certificate: Affidavit signed by the Company Field Advisor and notarized, certifying that the equipment meets contract requirements and is operating properly

26.5.6 *Contract Closeout Submittals*:

i. Operation and Maintenance Data: Deliver 2 copies, covering the installed products to the Director's Representative. Include lubrication charts, wiring diagrams and instructions. Mount and hang one copy of wiring diagrams in elevator machine room. Each sheet of wiring diagrams shall be laminated in plexiglass.
ii. Deliver all portable diagnostic keyboards and or programming tools required for testing, service or maintenance to the Director's Representative. Include manuals containing all passwords, set up parameters, fault coding and all other operational and maintenance requirements. Contractor shall be able to demonstrate the required functionality of the diagnostic devices.

26.6 QUALITY ASSURANCE

Company Qualification: The Company, installers and supervisors employed to perform the Work of Division 14, shall be experienced in elevator Work, and shall have been engaged in the rehabilitation of elevators and have installed the products specified in Division 14 for use on this project for a minimum of 3 years.

1. Furnish to the Director the names and addresses of 5 similar projects, which the products specified in Division 14 for use on this project, have been installed during the past 3 years.

Product Manufacturer Qualification: If products by Companies other than those specified in Division 14 are proposed for use, furnish the name, address and telephone number of at least 5 comparable installations located within a 100-mile radius of the project site, which can prove the proposed products have operated satisfactorily for 3 years.

1. Elevator control systems shall be supported by a manufacturer's technical support office staffed with technical field advisors located within a 300-mile radius of the project site.

Company Field Advisor: Secure the services of a Company Field Advisor for the following:

1. Render advice regarding installation, adjustment and operation of equipment.
2. Witness tests and certify with an affidavit that the equipment installed is in accordance with contract documents and is operating properly.
3. Explain available service programs to facility supervisory personnel for consideration.

Seismic Design Criteria:

1. Effective peak velocity acceleration (Av) for Project's location is ______.
2. Design earthquake spectral response acceleration, short period (Sds) for project is _______.
3. Project seismic design category is __________.

26.7 DELIVERY, STORAGE, AND HANDLING

26.7.1 *Packing and Shipping*:

Protect equipment and exposed finishes during transportation and erection against damage.

26.8 COORDINATION

Coordinate installation of sleeves, block outs, elevator equipment with integral anchors, and other items that are embedded in concrete or masonry for elevator equipment. Furnish templates, sleeves, elevator equipment with integral anchors, and installation instructions and deliver in time for installation.

Coordinate locations and dimensions of other work relating to the elevator including pit ladders, sumps, and floor drains and sump pumps in pits; entrance sill support angles and beams.

26.9 WARRANTY

Special Manufacturer's Warranty

Manufacturer's standard form in which manufacturer agrees to repair, restore, or replace defective elevator work within specified warranty period.

1. Warranty Period: _____________ from date of Project acceptance.

26.10 MAINTENANCE SERVICE

Initial Maintenance Service:

Beginning upon Project acceptance, provide one-year full maintenances service by skilled employees of elevator Installer. Include monthly preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper elevator operation at rated speed and capacity. Provide parts and supplies same as those used in the manufacture and installation of original equipment.

1. Perform maintenance, including emergency call-back service, during normal working hours.
   a. Response Time: Two hours or less.

26.11 ELEVATOR EQUIPMENT

Acceptable Companies

Adams Elevator Equip. Co., ThyssenKrupp Elevator Co., Elevator Equipment Co., Elevator Products Co., Elevator Safety Co., G.A.L. Mfg Corp., Hollister-Whitney Elevator Corp., Imperial Electric Co., Motion Control Engineering M.C.E., Kone Elevator Co., Maxton, Nylube Products Co., Otis Elevator Co., Peele Door, PTL Equip. Mfg. Co. Inc., Schindler Elevator Co., Titan Machine Corp. or an approved equivalent.

Type of Elevator: Passenger.

1. Rated Load: ___________.
   a. Freight Load Classification: ___________.
2. Rated Speed: ___________.
3. Controller: ___________.
4. Operation: ___________.
5. Levelling: Two way automatic.
6. Travel: ___________.
7. Stops: ___________.
8. Openings: ___________.
9. Type of Machine: ___________.
   a. Roping: ___________.
10. Machine Location: Overhead.
11. Machine Room Floor: Concrete.
12. Car Platform Size: ___________.
13. Net Car Size (Inside): ___________.
14. Hoistway Entrances: ___________.
    a. Two speed centre opening horizontal slide type.
    b. Centre opening horizontal slide type.
    c. Two speed horizontal slide type.
    d. Single speed horizontal slide type.
    e. Vertical bi-parting, counterbalance type.
    f. Vertical slide up type.
    g. Vertical slide down type.
15. Car Doors: ___________.

a. Two speed centre opening horizontal slide type.
b. Centre opening horizontal slide type.
c. Two speed horizontal slide type.
d. Single speed horizontal slide type.
e. Collapsing horizontal slide gate.
f. Single speed slide up type gate.
g. Two speed slide up type gate.

16. Door Operation: Power.
17. Signals in Car:

a. Car position indicator.
b. Car operating panel.
c. Call registration lights.
d. Direction indicators.
e. Alarm button and gong.

18. Signals at Landings:

a. Position indicators.
b. Push button stations.
c. Direction indicators.

PAINTING

2.2.1 Finish ferrous surfaces of the elevator Work with Company's standard multiple coat paint finish, (unless a more stringent finish is specified) including primer and latex enamel finish totalling not less than two coats. Exceptions: Do not paint sliding and rubbing surfaces. Use Company's standard colours, except as otherwise indicated.

HANDICAP ACCESS SIGNS

i. Size: Minimum 6 x 6 inches.
ii. Material: Plastic laminate.
iii. Message: International Symbol of Access, with:
iv. Colours:
  a. Background: Blue.
  b. Figures or Graphic Symbols: White.

CODE DATA PLATE

Provide a code data plate in accordance with Section 8.9 of the A17.1 elevator safety code. Attach code data plate to the front of the controller.

26.12 ELEVATOR DOOR OPERATORS

DEFINITIONS

Elevator Door Operator:

The means of opening and closing of hoistway and car doors at each entrance of elevator.

POWER CAR/MANUAL HOISTWAY DOOR OPERATORS

Function
Automatically opens and closes car door. Attendant manually operates hoistway doors.

Type:

i. Car Door: Electric motor driven.
ii. Hoistway Door: Manual, broken arm type; with provisions for lubrication of pivots and bearing points.

Operation (Car Door):

i. When the car has stopped at a landing the car door opens automatically. The closing of the car door takes place by continuous pressure on the car door close button or landing push buttons provided the hoistway doors are closed.
ii. Power opening and closing of the car doors is made smoothly and cushioned at final limits of door travel.
iii. Power opening of the car door takes place only when the car is stopping, within the levelling zone, or at rest at a landing.
iv. An electric contact on the car door prevents operation of the elevator unless the car door is closed.
v. In the event of interruption or failure of power from any cause, the car doors may be opened manually.

Operation (Hoistway Door):

i. A continuous pull on the handle opens the door. When the handle is released, the door closes to a near closed position and is then checked in motion by an oil door check, to bring the door to a noiseless and easy stop.An adjustable oil check controls door closing speed and prevents slam.

ii. A door hold open device holds the doors in the open position. Hold open device consists of a rack fastened to the door sill or head and a spring-loaded cam or roller attached to face of door, so that when door is pushed back beyond its normal opening, the cam or roller engages the fixed rack and holds the door in the open position. Door hold open device is released by pushing back on doors to release the cam, permitting doors to close.

26.13 CAR AND HOISTWAY DOOR OPERATORS

Function:
Automatically opens and closes car doors and hoistway doors.

Type:

Electric motor driven, medium-speed, high internal resistance heavy duty direct current master type, complete with door clutch.

Operation:

i. The car and hoistway doors open automatically when the car reaches the respective landing and again closes either after the expiration of a predetermined time interval or the moment a car button is registered.
ii. Selective door operation (front and rear openings) causes only the car and hoistway door corresponding to the opening for which the car has been called or sent to open on arrival of the car at that particular opening.
iii. Power opening and closing of the doors is cushioned or checked, and made quietly and smoothly by the device which opens the car door and hoistway door simultaneously and closes the car door and hoistway door simultaneously.
iv. Pressing the hall button at the first floor when the car is standing, will reopen the car and hoistway doors.
v. Pressing the door open push button in the car operating panel reopens the car and hoistway doors.
vi. An electric contact on the door prevents movement of the elevator away from the landing unless the door is in the closed position.
vii. A spring closer of the automatic self-closing type insures the self-closing of hoistway door. Spirator type closers are also acceptable.
viii. Power is not required to hold the doors open or closed.
ix. The door operator permits the manual opening of both the car and hoistway doors to a maximum of 4 inches when outside of the leveling zone.

26.14 CAR GATE AND COUNTERBALANCED HOISTWAY DOOR ELECTRIC POWER OPERATORS

Function:
Individual power door operators open car gates and hoistway doors.

Type:
1. Car Gate: Electric motor driven.
2. Hoistway Gate: Electric motor driven; equipped with door controller (contacts, resistors, thermal overloads and wiring neatly arranged on panel supported by steel frame).

Operation:

1. When the car has stopped at a landing the car gate and hoistway door open by continuous pressure on car operating panel door open button or landing pushbuttons. The closing of the car gate and hoistway door takes place

by continuous pressure on the car operating panel door close button or landing pushbuttons.

2. In the event the car gate meets an obstruction in closing, the gate immediately stops in its downward travel and then reopens. (Reopening device does not project into clear opening when gates are in the open position.)

26.15 DOOR PROTECTIVE DEVICES FOR USE WITH DOOR OPERATORS

3.5.1 Door Protective Device:

Infrared curtain field with "3D" detection zone.

1. Type: Janus Elevator Products, Inc. Pana40 Plus 3D or approved equal.
2. Function: Causes car and hoistway doors to reopen upon penetration of the infrared sensing curtain which protects opening up to a height of 5'-11" above floor.

3.5.2 Door Protective Device:

Infrared curtain field.

1. Type: Adams Elevator Equipment Co.'s (I.C.U. 47/Plus), G.A.L. ScanGard 8000 or approved equal.
2. Function: Causes car and hoistway doors to reopen upon penetration of the infrared sensing curtain which protects opening from 2 inches to 80 inches above floor.

26.16 ELEVATOR CONTROLLER AND OPERATION

26.16.1 DEFINITION

Controller:

The method of governing the starting, stopping, direction of travel, acceleration, retardation and speed of the elevator.

Operation:

The manner of method an elevator or group of elevators automatically respond to button calls for service, and programmed traffic control.

26.16.2 PRODUCTS

STATIC MOTOR CONTROL (SCR)

Function:

SCR digital motor drive providing full wave rectification to DC hoist motor. Reversing and regeneration shall be accomplished by the armature supply.

Type:

Solid state rectification unit, having full wave rectification (360 Hz ripple). Magnetek Elevator Drive or approved equal.

Drive Controller:

D.C. control panel with full wave microprocessor basedc regenerative drive in a chassis mounted enclosure. Power conductors must be isolated from the signal wiring with brake and all relay coils suppressed to avoid induction of electrical noise into regulating system.

a. Equip drive controller with diagnostic and adjustment capabilities via either a handheld tool or on-board controls. Tool shall provide diagnostics, parameter observation, fault readout, operation of drive and digital voltmeter.

b. Regulation provided by a closed loop static speed regulator utilizing a feed-back tachometer on the hoist motor.

Harmonic Distortion:

The motor drive shall use the design guide lines of the IEEE-519 in an effort to limit the amount of total demand distortion TDD). The drive shall achieve a total harmonic distortion of current (THDI) of less than 8%.

DRIVE ISOLATION TRANSFORMER

Function:

Reduces line pollution feedback resulting from SCR firing circuits isolating the primary distribution system.

Type and Size:

i. Delta connected primary with wye connected secondary having a minimum of ___ KVA. The primary voltage shall match building distribution voltage and secondary voltage matched to the SCR drive input voltage.

ii. Transformer shall be specifically sized to the SCR drives KVA requirements, braced to withstand the mechanical stresses of current reversals and short circuits associated with SCR drives. Transformers shall be suitable for continuous operation in a 40 degree C ambient temperature with an 80 degree C temperature rise. Insulation class on windings shall be rated for 220 degree C.

iii. Transformers shall have copper windings with 2-1/2 percent full capacity taps above and below nominal voltage for incoming source adjustment building system voltage of ___ Volt 3 phase AC. Equip transformer with sound dampening pads which isolate the core and coil from the case.

iv. All connections to and from the transformer must employ the use of non rigid conduit for the final electrical connection, with all other conduit supports and clamps provided with neoprene inserts.

CHOKE AND FILTER NETWORK

i. Provide a choke and ripple filter network sized for the amperage of the SCR motor drive assembly, designed to minimize transient voltages and spikes for noise suppression. Shall have copper coils and 220-degree C. insulation class.

ii. Choke and filter network shall be installed in a separate ventilated cabinet or may be installed in the controller cabinet.

MICROPROCESSOR LOGIC CONTROLLER

Function:

Continuously analyse each elevator's changing position, condition and workload. The microprocessor shall constantly scan the system for registered hall calls and will calculate the estimated time of arrival for each car and its assigned hall call.

i. In calculating the estimated time of arrival, the following factors will be used.
   a. Number of floors to travel from the current position.
   b. The time it takes to travel one floor at top speed.
   c. Calls assigned to a car.
   d. Car reversal time to respond to a call in the o opposite direction of travel.

ii. An internal constant shall be set, requiring a maximum time for a car to respond to a call. When a car status changes or additional hall calls are registered, the estimated time of arrival shall be recalculated and calls reassigned if necessary.

Type:

Microprocessor based programmable controller with an Erasable Programmable Read Only Memory.

i. The printed circuit boards (modules) shall be of the type that plug into pre-wired mounting racks. No field wiring or alteration shall be necessary in order to replace defective modules.

ii. Any field wiring changes required during construction shall be made only to the mounting rack connection points and not to the individual module circuitry or components. If it becomes necessary to alter individual modules, they shall be returned to the factory where such design changes are made and module design records changed so that correct replacement units are available.

iii. Wiring connections for operating circuits and for external control circuits shall be brought to terminal blocks mounted in an accessible location within the controller cabinet. Terminal blocks using pierce-through serrated washers are not acceptable.

iv. Safety and Motion Circuits: Electro-Mechanical pilot type relays. Safety circuits are monitored by the microprocessor for redundant protection. All outputs are individually fused.

v. Identify each device and fuse (ampere rating) on panels by name, letter, or standard symbol, in an approved indelible and legible manner. Coordinate identification markings with wiring diagrams. All logic symbols and circuitry designations shall be in accordance with ASME Standards.

vi. Incorporate the use of chokes and filter network to minimize transient voltages and spikes for noise suppression. Filters shall be installed in a ventilated 14 gage steel enclosure mounted on top of each drive enclosure.

Motion Control:

SCR drive system having a dual-loop digitized feedback regulator utilized to control speed control and based primarily on car position. The velocity profile is calculated by the microprocessor-based control system in effect producing extremely smooth and accurate stops. The velocity transducer will permit continuous comparison of machine speed to velocity profile and to actual car speed.

Position Selection:

The position selection is a integrated part of the Microprocessor based control system. The car position in the hoistway is digitized through a steel tape running the full length of the hoistway encoded by the car position transducer. The car position transducer detects magnetic levelling strips installed on the tape for floor reference and stopping accuracy. The microprocessor-based control system will store the floor position and slowdown points in memory.

Performance:

Adjust elevators to meet the following performance requirements:

i. Running Speed: +/- 5 percent of contract speed under all load conditions.
ii. Floor to Floor Performance: 11 seconds between typical floors. Time is recorded from start of doors closing until doors are 3/4 open and car is level with floor. Under all load conditions with a 12-foot floor height.
iii. Door Open Time: 1.7 - 2.7 seconds.
iv. Door Close Time: 2.4 - 3.5 seconds.
v. Car Call Dwell Time: 3 seconds, adjustable to 10 seconds.
vi. Door Nudging Time: 4 seconds, with a 5 second advance signal per ADA standards based on distance. Adjustable to 20 seconds.

Emergency Dispatching:

Emergency dispatching operation is activated by loss of communication with group and loss of hall button power.

i. In the event of communication loss with the group, each car will automatically dispatch to the nearest floor or other dedicated floor.
ii. With the loss of hall button power, the group internally sets the up and down hall calls at every floor. The cars are dispatched to the floor by the group assignment mechanism.

Machine Room Video Monitor, Keyboard and Printer:

Located in dispatch controller in the elevator machine room. The monitor, minimum 15" LCD shall display information in tabular form consisting of, but not limited to the following: Status of individual input/output devices, slowdown position, operating modes, door status and fault flags.

i. Diagnostics, Maintenance and Serviceability:
    a. Keyboard which interacts with Machine Room Video Monitor displays.

b. On-board Real-Time Clock displaying time and date, fully adjustable by on broad controls.
c. Field programmability of all timer values by on board controls.
d. Access to all security codes for alteration and viewing.
e. Traffic Studies.

ii. NOTE: If portable diagnostic keyboards and or programming tools are required for testing, service or maintenance such devices must be proprietary type and turned over to the facility personnel with all reference manuals, including all fault coding and other operational requirements. Contractor shall demonstrate the required functionality of the diagnostic devices.

Building Manager Interface Software:

Provide a window's based software package capable of being installed on an existing building computer. The local network connection will be provided by the Facility in each machine room. The software shall enable the user to interface with the server in the machine rooms. The Building Manager interface software shall allow a limited number of functions as follows:

i. Provide visual display of all elevators.
ii. Status display.
iii. Floor and door position.
iv. Permit various security functions to enable locking out of calls.

Interfacing:

All interfacing between the central processing units and transducers, feedback loop shall be shielded cable installed in individual raceways.

Fault Protection System:

i. Protect against the following:
   a. Complete power circuit from failure under short circuit.
   b. Surge protection.
   c. Overload.
   d. Low voltage, phase loss, unbalanced voltage.

4.2.5 FLUX VECTOR (VVVF) AC MOTOR CONTROL

4.2.5.1. Acceptable Manufacturers:

Baldor Electric Co., Magnetek Elevator Drive or approved equal.

Function:

i. The flux vector drive shall produce optimum motor torque from rated speed down to zero speed.
ii. Stepless acceleration and deceleration.
iii. Direct drive optical digital type, closed loop velocity encoder on hoist machine. Update car position at each floor and automatically restore after power loss.

Motion Control:

i. Digital feedback regulator utilized to control speed control and based primarily on car position. The velocity profile is calculated by the microprocessor, in effect producing extremely smooth and accurate stops. The velocity transducer will permit continuous comparison of machine speed to velocity profile and to actual car speed.

Enclosure Assembly:

i. Type: Wall mounted dead back or free standing, housing controller components with integral fan and filtered vent perforations.
ii. Fabrication:
    a. Frame: Angle iron.
    b. Covering: Sheet metal, enclosing top and sides.
    c. Doors: Sheet metal, front and rear, hinged for access to components, with latches and locks, including filtered slots for ventilation.
iii. Component Mounting Panels:
    Mount inverter contacts, relays and microprocessor on common panel.
    a. Panel Material: Phenolic or polyester, thickness as required to support components.
    b. Panel Braces: Metal angle bars attached to frame.

Components and Operating Devices:

i. Motor Drive:
    a. Control of three phase AC induction motors shall be performed through the use of a high-resolution encoder.
    b. Full-wave bridge rectifier to provide a DC voltage supply for the solid-state inverter.
    c. Pulse width modulation.
    d. Fully adjustable to match the AC motor characteristics.
    e. RFI Filters - (Radio Frequency Interference).
    f. Diagnostic tool for maintenance. (On board devices are acceptable).
ii. Inverter:
    a. Insulated Gate Bipolar Transistors (IGBT's).
    b. Frequency accuracy of 0.01 percent.
    c. Closed loop design.
    d. Adjustable voltage/frequency ratio.
    e. Stall prevention.
    f. Slip compensation.
    g. Regenerative power absorption.
    h. Electronic thermal motor overload protection.

iii. NOTE: Elevator controller must be fully protected against over and under voltage conditions without damage to any circuit boards, relays or electronic devices. Memory and initial parameters must be retained in non-volatile memory for protection during power outages.

26.17 SIMPLEX SELECTIVE COLLECTIVE OPERATION

Function:
Operating devices consisting of a series of dispatch buttons in the car operating panel corresponding to the landings served and a single riser of landing hall buttons, electrically connected to controller, govern floor selection and direction of travel.

Operation:

i. When car is idle and one or more car or landing buttons above the landing at which car is standing is pressed, the car starts in the Up direction. The car stops on the Up trip at each landing for which a car button or Up landing button is pressed sufficiently in advance of the car arrival at such landings to permit these stops to be made. After each stop, the car proceeds in the Up direction until it reaches the highest landing for which a car or landing call is registered. Stops are made in the order in which the landings are reached, irrespective of sequence in which buttons have been pressed. The car will not stop on the Up trip at any landing in response to a Down landing call unless this call is the highest call registered. Similarly, if car is idle and one or more landing buttons below the landing at which the car is standing are pressed, the car starts in the Down direction, proceeding to the lowest landing for which a button is pressed and stops at each intermediate landing for which car button or Down landing button is pressed.

ii. When the car is idle and a button above the car and a button below the car is pressed, the car starts toward the landing corresponding to the button first pressed. The call registered for the landing in the opposite direction from the car will be answered after the car has responded to the farthest call in the direction established by the first button pressed.

iii. The minimum time from audible and signal notification that the elevator car is answering a landing call until the doors start to close is 6 seconds (doors fully open for a minimum of 3 seconds), to enable passengers to enter or leave the car. Pressing a car button for another landing before this time elapses, causes the car to start, provided the car door and hoistway doors are closed and interlock circuits established. When the car has answered the farthest call, this interval will permit a car button call to be registered to establish the direction of car travel, even if other landing calls are registered.

iv. When all calls have been answered, car remains at landing last served.

v. When all calls have been answered, the car returns to the main floor or other designated landing.

26.18 DUPLEX SELECTIVE COLLECTIVE OPERATION

Function:
Operating devices consisting of a series of dispatch buttons in the car operating panel corresponding to the landings served and a single riser of landing hall

buttons, electrically connected to controller, govern floor selection and direction of travel.

Operation:

i. One car normally "parks" at the main floor and the other, a "free" car at the landing last served.

ii. "Free" car answers landing calls either above or below the landing at which car is standing except main floor landing calls.

iii. When "free" car is clearing calls, the other car automatically starts to answer landing calls under any of the following conditions:

   a. Registration of an Up call from a landing below the "free" car while it is traveling up.

   b. Registration of an Up or Down call from a landing above the "free" car while it is traveling down.

   c. Inability of "free" car to clear all registered landing calls within approximately 40 seconds, or to move in response to registered landing calls within this time limit.

v. When car has been started either in response to car button or landing calls, the car responds to its own car button calls and to landing calls registered for the direction in which car is traveling in the order in which landings are reached, irrespective of the sequence in which calls are registered. When both cars are clearing calls only one car stops in response to any one landing call. The first car clearing all its calls returns to main floor. Should both cars finish their calls at the main floor, the car arriving first becomes the "free" car.

vi. The minimum time from audible and signal notification that a specific elevator car is answering a landing call until the doors start to close is 6 seconds (doors fully open for a minimum of 3 seconds), to enable passengers to enter or leave car. Pressing a car button for another landing before this time elapses, causes the car to start, provided the car door and hoistway doors are closed and interlock circuits established. When a car has answered its furthest call, this interval permits a car button call to be registered to establish the direction of car travel, even if other landing calls are registered.

vii. If either car is removed from service, the other car answers all its own car calls and all landing calls.

viii. Car will not start in answer to car or hall calls unless car doors and hoistway doors are closed and locked, and interlock circuits established.

26.19 AUTOMATIC GROUP SUPERVISORY OPERATION

Type:

Microprocessor; providing the lowest average waiting time for all passengers in a given interval. Traffic data shall be continuously gathered and stored. Hall calls, car calls and landing car stops shall be monitored and recorded to provide a data base from which these factors can be assessed and applied to the algorithm. The system automatically adjusts dispatching to respond to traffic pattern changes and reassigns high density traffic areas based on actual traffic, without software reprogramming.

i. The following parameters provided by the continuously gathered historical traffic data shall be considered:

   a. Probable Stops and Destination.

b. Hall Call Arrival Rates.
c. Peak Operation Status.
d. Car Parking.

ii. In allotting and reallotting parameters, the following physical and statistical parameters shall be considered:
   a. Car Service Status.
   b. Long Wait Calls.
   c. Power Status.
   d. Car Calls Status.
   e. Door Status.
   f. Car Load.
   g. Coincident Calls.
   h. Car Position.
   i. Motion Status.

Function:

Operating devices consisting of a series of dispatch buttons in the car operating panel corresponding to the landings served and two riser of landing hall buttons, one in each group electrically connected to the controller, govern floor selection and direction of travel.

i. Registration of a landing call from either riser of landing hall buttons causes a car to stop at that floor for the direction in which the call was registered.

Operation:

i. Upon entering car, passengers press car dispatch buttons corresponding to landing to which they wish to go. After door interlock circuits are established, the car automatically starts, accelerates, slows down and stops at first landing for which a car dispatch button has been pressed, or which a landing call has been registered corresponding to direction in which car is traveling. Car continues to serve remaining car dispatch and landing calls in the order the landings are reached, regardless of manner buttons are pressed, provided button for given landing has been pressed sufficiently in advance of car arrival at that landing to permit slow down and stop.

ii. Car and hoistway doors open automatically when car stops at an intermediate landing and close at a predetermined time interval after opening, unless closing is interrupted by car door reversing device or door open button. Car automatically starts following full closing of doors.
   a. The minimum time from audible and signal notification that a specific elevator car is answering a landing call until the doors start to close shall be as established in the Americans with Disabilities Act.

iii. Elevators operate no higher than necessary and in presence of demands for service below Up traveling cars, elevator reverses at highest car call or down landing call or, if neither exists, at the next landing at which normal stop may be made.

iv. Intermittent Two-Way Traffic: This type of traffic shall be determined through historical data and current hall calls entered throughout the building.

v. Parking Feature: Arrange a variable number of cars to park at designated main entrance floor, with doors open and hall lantern illuminated.
   a. When an elevator is in service and available the microprocessor control system shall have the ability to dispatch the car to any floor.
vi. Heavy Up Traffic: Recognized through historical data and by current conditions for changes in passenger loads, the number of calls entered at the lobby, the number of cars departing the lobby which are compared to the activity throughout the building. A high priority shall be placed on providing a car at the lobby to avoid lobby congestion. The cars shall depart when the loading time has expired or the load weighing device senses that the car is full. The lobby loading time shall be determined by the number of car calls, passenger load and the door courtesy time.
vii. Heavy Two-Way Traffic: This traffic pattern shall be recognized through historical data and when the current hall calls are entered throughout the building without a consensus of direction. All cars available for group operation shall be brought into operation to minimize waiting time.
viii. Heavy Down Traffic: This traffic pattern shall be recognized through historical data and the current entry of hall calls. Down hall calls shall be allotted to provide service to the traffic while achieving the lowest average waiting time for all passengers within a given interval.
ix. Fail Safe Operation: Continuity of service feature shall keep the elevator running in case of certain failures. This feature shall be effective only when cars are operating on automatic mode and become effective automatically when certain failures occur. The operation shall be as follows:
   a. Central Dispatch Computer Failure: Communication failure with the Central Dispatch Computer shall result in reverting to a pre-arranged and adjustable operation.
   b. Failure of Car to Start: Car start failure shall result in the car being from service and its assignment given to another available car.
   c. Failure of Hall Pushbutton Circuit: Hall pushbutton circuit failures shall result in registering down hall calls and lobby up hall calls and shall then proceed to answer the calls in the most efficient manner possible.
x. Traffic Analysis Information:
   a. The computer system shall be capable of providing traffic analysis for all elevators in the group.
   b. The traffic analysis shall provide a display of hall calls waiting times and cars in and out of service. A hard copy report shall also be available.

26.20 ADDITIONAL CONTROL FEATURES FOR EACH ELEVATOR

Top of Car Operating Device:

i. Function: Used for inspection and maintenance procedures.
ii. Design: Up and Down direction buttons and emergency stop button in metal enclosure, equipped with a flexible type cord with strain relief device at both connections.

iii. Operation:

a. Control of the elevator is transferred to the top of car operating device by means of a transfer switch located on the car top between the car crosshead and the side of the car nearest to the hoistway entrance normally used for access to the car top.

b. Car is operated by constant pressure on appropriate direction button, and by simultaneously pressing a safety button.

c. Car will not operate unless both buttons are pressed.

..**Stop Switch in Elevator Pit and Overhead Sheave space:**

i. Function: Removes car from service during inspection and maintenance procedures. (Car cannot be operated).

ii. Design: Metal enclosure, housing red button (positively open mechanically, opening not solely dependent on springs). Permanently mark button, indicating Stop and Run positions.

Automatic Levelling:

i. Function: Causes elevator to make accurate stops at each landing and makes adjustments to keep elevator within specified tolerances at the landing.

ii. Operation:

a. Adjusts elevator if car is more than 1/4 inch above or below landing level when the car has come to rest at any landing, irrespective of load in car within specified capacity and irrespective of direction of travel.

b. If car is displaced from the floor for any reason other than operation of control buttons, the car returns automatically to a position, level with the landing within 1/4 inch above or below.

Independent Service:

i. Function: Causes car to operate only from its car button, and becomes independent of the hall buttons.

ii. Operation:

a. When key operated switch is in ‘on ‘position car is removed from normal style of operation.

b. All previously registered car calls are cancelled.

c. Car door and hoistway door remain open when car is at a floor, until a car button for another landing is momentarily pressed.

d. If several calls are registered after each stop, a car button must be pressed to effect door closing.

e. Previously registered hall calls shall not be cancelled, but answered when car is back in normal automatically operation.

Emergency Hospital Service:

Equip hall pushbutton station at each floor with key switch and signal light to permit an available elevator to be called to that landing thereby cancelling all car calls and bypassing all hall calls upon actuation. Upon arrival, doors open for a predetermined time to permit the car to be placed on Emergency Hospital Service. The signal lights shall illuminate while a car is responding to a priority call and will be extinguished when the car has been placed on Emergency Hospital Service or has been returned to normal service. If there is no car available for this priority service, the signal lights shall remain illuminated until a car becomes available to receive a priority service call. Another priority call cannot be initiated until the signal lights are extinguished.

Load Weighing Device:

i. Function: Prevents given percent loaded car from making unnecessary stops.

ii. Operation:
   a. Device automatically weighs load on car platform and, if loaded, car by-passes all landing calls.
   b. Landing calls remain registered for next available car.
   c. Weighing device does not affect the stopping of car at any floor in answer to registered car calls.
   d. Adjustable type.

Anti-Nuisance Feature:

i. Function:

Arrange the elevators so that in the event more car calls are registered than a corresponding passenger load in the car, all car calls shall be cancelled so that registration of proper number of car calls are made.

Position Selection:

The position selection is an integrated part of the microprocessor-based control system.

i. Proximity switches activated by vanes mounted in the hoistway for stepping, levelling, and door zone sensing.
   a. Switches installed in steel enclosure mounted on car.

ii. Steel tape mounted in hoistway to include complete travel of elevator. Car top assembly with tape guides, tape sensors, and magnetic strips for stepping and levelling.

iii. Steel tape mounted in hoistway to include complete travel of elevator car. Car position transducer, with tape guides and magnetic or optical switches, provides controller with digitized information of precise car position.

iv. Car top mounted car position transducer, which rides on guide rail provides controller with digitized information of precise car position in conjunction with hoistway mounted magnetic switches and sensors.

Cross Cancellation Panel:

i. Function:

Designed to temporarily integrate both the existing control system with the new control system to prevent dispatching of both control systems from the same hall calls. This shall remain connected until all elevators in a group are complete.

ii. Type: Microprocessor based or relay logic.

iii. Design: Contractor shall verify voltage and power requirements of both the existing and new control systems to ensure compatibility.

26.21 ELEVATOR LANDING SIGNAL EQUIPMENT

26.21.1 *DEFINITIONS*

Landing Signal Equipment:

Buttons, lanterns, indicators or other devices located at landings, operating in conjunction with elevator control equipment to call elevator to that floor and indicate the stopping and direction of elevator travel.

26.21.2 PRODUCTS

POWER SUPPLY

Transformers or rectifiers to suit signal equipment electrical parameters.

LANDING FIXTURES

Hall Buttons – Flush Mount:

i. Faceplate: Stainless steel; 14 gage minimum, No. 304 with dull satin finish No. 4.
ii. Backbox: steel, 16 gage.
iii. Button Construction: Mechanical vandal resistant type, stainless steel having positive stop contacts.
iv. Pictograph: Equip upper portion of faceplate with engraved, red epoxy filled hall station pictograph "H1" from the ASME A17.1 Elevator Code. (Pictograph wording shall read "IN FIRE EMERGENCY, DO NOT USE ELEVATOR, USE EXIT STAIRS" accompanied by corresponding pictograph)

Hall Buttons – Surface Mount:

Elevator Products Corporations, "Inchline Signal Fixtures" or approved equal, having:

i. Faceplate: Surface mounted one piece, sized to conceal all voids of wall construction eliminating the need for additional blank faceplates, stainless steel with satin finish; 14 gage minimum. Edges of faceplate shall have a radius contour leaving a smooth finished appearance. Equip upper portion of faceplate with engraved, red epoxy filled hall station pictograph "H1" from the ASME A17.1 Elevator Code. (Pictograph wording shall read "IN FIRE EMERGENCY, DO NOT USE ELEVATOR, USE EXIT STAIRS" accompanied by corresponding pictograph). Utilize 16 gage minimum cold rolled steel backplate

ii. Button Construction: Mechanical stainless steel type with illuminating halo, having contacts and wearing parts of material and design to meet the severe requirements of elevator service.

Call Register Light:

i. Style: Integral with push button so that button is illuminated when call is registered.
ii. Operation: When the button is pressed, the indicator or button illuminates indicating that a call is registered. When call is answered, the indicator is extinguished.

Hall Lanterns – Flush Mount:

i. Design - L.E.D. Digital Type:
   a. Faceplate: Stainless steel; No. 304 with dull satin finish No. 4.
   b. Backbox: Steel, 16 gage.
   c. Characters: Minimum surface measurement; 2-1/2 inches in the smallest dimension.
   d. Gong or Chime: Integral.

ii. Operation:
   a. Illumination of appropriate arrow indicates the impending arrival of car and direction.
   b. Gong sounds once when upper arrow illuminates. Gong sounds twice when lower prism illuminates.

Hall Lanterns – Surface Mount:

C.E. Electronics Incorporated, “Turnkey Surface Mount Displays” with the following:
   i. Design: Segmented type, arrows not less than 2-1/2 inches high with smaller side arrow indicators incorporated into projecting prism
   ii. Faceplate: Surface mounted stainless steel with satin finish.
   iii. Operation: As car arrives at floor arrow illuminates and chime sounds indicating direction of travel.
   iv. Gong or Chime: Upon arrival at floor, an audible chime shall sound corresponding with appropriate arrow illumination indicating direction of travel. Chime shall sound once in “up” direction of travel and twice in “down” direction direction of travel.

Hall Position Indicators:

i. Design: L.E.D. Digital Type.
   a. Faceplate: Stainless steel; No. 304 with dull satin finish No. 4.
   b. Characters: Not less than 2 inches high.
ii. Operation: As car passes through hoistway, its position is indicated by illumination of the numeral corresponding to the landing at which the car is stopped or passing. Arrows illuminate to indicate direction of travel. “Up” direction arrow illuminates white; “Down” direction arrow illuminates red.

Hall Position Indicators:

i. Design: L.E.D. Digital type, characters not less than 1/2 inch high, integral with hall button face plate.
ii. Operation: As car passes through hoistway, its position is indicated by the illumination of the numeral corresponding to the landing at which the car is stopped or passing.

Combination Hall Lantern and Position Indicator:

i. Design: L.E.D. Digital Type.
   a. Faceplate: Stainless steel; No. 304 with dull satin finish No. 4.
   b. Characters shall be not less than 2-1/2 inches.
   c. Audible Indicator: Integral chime or gong.

ii. Operation: Indicators announce, by both audible and visual means, an impending car arrival and indicates the position and movement of the car in the hoistway at all times.
   a. As the car travels through the hoistway, its position is indicated. Arrows illuminate to indicate direction of travel.
   b. Audible indicator sounds once when upper visual indicator illuminates. Audible indicator sounds twice when lower visual indicator illuminates.

Lobby Display Panel:

i. Faceplate: Stainless steel with satin finish equipped with tamper resistant fasteners suitably sized for all equipment. Divide dispatch panel into 2 sections; each section equipped with concealed hinges and cylinder lock. Containing the following:

2. Upper Section: 17-inch LCD flat monitor located behind lexan lens in door. Monitor shall display the car position graphically and numerically displayed and the following as a minimum:
   a. Floor number.
   b. Up and down hall calls.
   c. Car door status.
   d. Direction of car travel.
   e. Car out of service status.

3. Lower Section: Accommodate the following switches and controls:
   a. Switches: Security type. Coordinate keying requirements with the Facility. Furnish 10 keys per core.
   b. Emergency Power Selector Switch Cabinet and Controls.
   c. Phase I Emergency Service key switch. FEO National Standard key.

4. Backbox: Steel, 16 gage.

5. Engraving: Black epoxy filled ¼ inch high characters for all switches except red epoxy filled engraving for Phase I Emergency Service key switch and instructions.

26.22 ELEVATOR EMERGENCY OPERATION AND EMERGENCY SIGNAL DEVICES

26.22.1 SYSTEM DESCRIPTION

The elevator emergency operation and emergency signal devices enable elevators to be operated under fire or other emergency condition.

Passengers in elevator cars may communicate with the **_________** *via a hands free auto-dialer telephone system.*
The elevator mechanic/emergency personnel may communicate with each elevator car via the machine room phone system or the master base station at the designated landing.

. Phase I - Firefighters Emergency Operation: A three position (reset, off, on) key operated switch at the designated floor enables elevators controlled by the switch to be secured under fire or other emergency conditions:

1. Operation of Phase I Firefighters Emergency Operation shall be in accordance with ASME A17.1 Rule 2.27.3.

Phase II - Emergency In-Car Operation: A three position (off, hold, on) key operated switch in or adjacent to each car operating panel becomes effective only when the Phase I switch has been turned to the "on" position or a smoke detector has been activated.

1. Operation of Phase II - Emergency In-Car Operation shall be in accordance with ASME A17.1 Rule 2.27.3.3.

Failure of a.c. operating power to normal elevator lighting fixtures automatically causes a battery powered emergency light to illuminate.

Failure of a.c. operating power to alarm bell automatically causes bell to operate from battery source when emergency call button is pushed.

Passengers in a stalled elevator can determine car location by referring to floor numbers on the hoistway door and on the walls of the elevator shaft.
Upon failure of normal electric service to the elevators, an emergency electric service (standby generator) powers the elevators on a limited, priority basis. Sequence of operation:

1. Upon transfer to emergency power, the elevator dispatch controller receives a signal from the automatic transfer switch and activates the emergency dispatching function; One elevator at a time per group will be dispatched automatically, sequentially to the designated floor lobby. At no time shall more than one elevator be operational. A manual selector switch at the designated floor allows emergency personnel to override the automatic sequencing during the emergency stand-by power mode. Upon restoration of normal power, the automatic transfer switch sends a pre transfer signal to the elevator dispatch controller and the elevators stop one at a time at the nearest floor and revert to normal operation. If the automatic dispatching function was overridden via the manual selector switch in the designated floor dispatch panel the manual station must be reset to the automatic position and the elevators will revert to normal operation mode.

26.22.2 RELATED ITEMS FURNISHED BY OTHERS AND INSTALLED UNDER THIS SECTION

Public address speakers and backbox for each elevator cab.

26.22.3 PRODUCTS

PHASE I AND PHASE II OPERATION

Phase I and Phase II Switches:

1. FEO National standard key.
2. Key Change Removal:
   a. Phase I Switch: Key change removable only in the “off and on” position.
   b. Phase II Switch: Key change removable in the “off and hold” position.

Identification of Emergency Controls:
Label switches and buttons used for Phase I and Phase II operation as required by the ASME A17.1 Code.

Audible and Visual Signal Devices:

1. Audible Signal Devices: May be horns, buzzers or bells, particularly suited for the type of alarm to be sounded.
2. Visual Signal Devices: Illuminating jewel in Phase I station and flashing firemen’s cap in cab as required per ASME A17.1.
3. Label the audible and visual signal devices with engraved nameplates, minimum 1/4” high lettering stating function of the device.

Smoke Detection System:
Smoke detection, associated control panel and wiring will be provided by the Electrical Contractor, including a terminal strip cabinet in the elevator machine room. Final electrical connections between terminal strip cabinet and the elevator controllers by Elevator Contractor. Coordinate all voltage and contact requirements.

EMERGENCY LIGHT AND ALARM SYSTEM

Light and Alarm Unit, having:

1. Minimum of 2 lamps. (Not less than 0.2 foot candles 4 feet above car floor and l foot in front of car station).
2. Six inch alarm bell. (Operated by emergency alarm button located in car operating panel).
3. Sealed nickel cadmium type batteries of capacity to maintain light intensity for minimum of 4 hours, and ring the 6 inch alarm bells for 1 hour. Two bells shall be provided, one mid point in the hoistway and one in the hoistway at the designated floor.
4. Battery charger as recommended by manufacturer.

PROCEDURE SIGN

Instructions for the operation of the elevators under Phase I and Phase II conditions:

1. Locate instructional signage adjacent to the designated floor Phase I key switch engraved in hall station faceplate. Locate engraved red epoxy filled instructional signage in the car operating panel adjacent to the Phase II switches.

2. Lettering not less than 1/4” in height.

TELEPHONE COMMUNICATION SYSTEM

In-Car Telephone:

Rath Microtech smartphone model 2100 or approved equal. Mount auto dialer telephone behind main car operating panel faceplate within prescribed height of controls. Coordinate mounting studs, visual indicator, speaker perforations and activation button locations with telephone manufacturer.

Machine Room Telephone:

Rath Microtech Model No. 2300-630RC or approved equal. Provides two-way communication to each individual elevator car.

Master Base Station:

Rath Microtech Model No. 2500-28RCF or approved equal. Provides two-way communication to each individual elevator car.

Distribution Module/Power Supply:

Rath Microtech distribution module and RP7700104 power supply with battery back-up.

Telephone Lines:

Wiring from the telephone interconnection cabinet to the machine room telephone modular phone jacks shall be provided by the Facility.

EMERGENCY IDENTIFICATION SIGNAGE

The driving machinery, disconnect switch, controller, transformer, car operating panel, lobbies and crosshead of each elevator shall be identified with corresponding numbers as shown on plans. In addition, a warning sign shall be mounted on disconnect switches of multiple elevators and read as follows: “Warning - Parts of the control panel are not de-energized by this switch.”

Numerals and signage shall be a minimum of 2 inches high and applied with paint or nameplate. (Exception: Car operating panel lettering shall be 1/2 inch high engraved).

Each elevator entrance of each elevator shall contain elevator identification to be engraved with contrasting letters/numbers on to a metal plate having two-inch-high letters. The plate shall be installed over each entrance, either on transom or wall surface.

VOICE ANNOUNCER

Voice Synthesizer:

1. Operation: Produces speech in pleasant, natural sounding female voice from vocabulary stored in memory.
2. Features:
    a. Audible Device: Voice announcer, microprocessor-based equipment.

b. Speaker: 8 ohms. Mount speaker in car operating panel.
c. Speed: Variable, adjustable to speed of car.
d. Power Supply: As required for supply voltage.
e. Volume Control: Adjustable.

3. Vocabulary: Programmable, stating:
a. Floor arrival announcement and direction of travel.
b. Special Emergency Service (Phase I Key Switch Turned On): Announces "This elevator is needed for an emergency. Please exit when the doors open."

EMERGENCY ELECTRIC SERVICE ACCESSORIES

Manual Selector Switch for Selective Operation of Elevators:

Located at designated floor.

1. Enclosure: Lockable, recessed, to match decor. Equip with illuminating "Emergency Power" signal which illuminates during periods of emergency power.
2. Operation: Interlocked strip switch. One of the buttons shall be labeled "Auto" and shall be the default position for the automatic sequencing operation. The remaining buttons shall be interlocked so that not more than one button may be depressed at any time. The "Auto" button shall not be able to be depressed while any of the other buttons are depressed. If the "Auto" button is depressed the remaining buttons will return to their normal position simultaneously.
3. Key: FEO National Standard.
4. Label switch with red epoxy filled characters.

Automatic Operation for Selective Operation of Elevators:

1. *Equip controllers with necessary relays and wiring for automatic operation of one elevator at a time under emergency power. Equip dispatch controllers with signaling provisions and corresponding logic to communicate with other dispatch controllers in the building. Control wiring from automatic transfer switch to machine room shall be provided by the Electrical Contractor.*
2. Equip the elevator controllers for all elevators with provisions and circuitry to allow the elevators to operate at a field adjustable reduced speed while under periods of emergency power.

PUBLIC ADDRESS SYSTEM

. **Public Address Speakers:**

Provide all elevators with mounting devices and wiring to each cab from hoistway junction box for installation of public address speakers. (Speakers Furnished by others).

26.23 ELEVATOR WIRING

26.23.1 REFERENCES

1. NEMA, ASME, and UL.

26.23.2 PRODUCTS

RACEWAYS, FITTINGS AND ACCESSORIES

Rigid Ferrous Metal Conduit:

Steel, galvanized on the outside and enamelled on the inside or hot dipped galvanized on the outside and inside, UL categorized as Rigid Ferrous Metal Conduit (identified on UL Listing Mark as Rigid Metal Conduit - Steel or Rigid Steel Conduit), by Allied Tube & Conduit Corp., Midwest Electric, Occidental Coating Co., Robroy Industries Inc., Steel duct Conduit Products, Triangle PWC Inc., or Wheatland Tube Co.

Flexible Metal Conduit:

Galvanized steel strip shaped into interlocking convolutions, UL categorized as Flexible Metal Conduit (identified on UL Listing Mark as Flexible Steel Conduit or Flexible Steel Conduit Type RW), by American Flexible Conduit Co., Cerro Conduit Co., Ettco Wire and Cable Corp., or International Metal Hose Co.

Liquidtight Flexible Metal Conduit:

Anaconda Metal Hose Anamet Inc.'s Sealtite Type UA, Electri-Flex Co.'s Type LA Liquatite, Flexible Technology Corp.'s Type UA, or Universal Metal Hose Co.'s Universal Sealflex - U.

Wireways, Fittings and Accessories:

16 gage minimum, screw cover, by Hoffman Engineering Co., Keystone/Rees Inc., or Square D Co.

Insulated Bushings:

By Appleton Electric Co., Efcor Inc., OZ/Gedney Co., or Thomas & Betts Corp.

Connectors and Couplings:

1. Couplings (For Rigid Metal Conduit): Standard threaded c ouplings as furnished by conduit manufacturer.
2. Flexible Metal Conduit Connectors: Midwest Electric Mfg. Corp.'s 1708, 1736 Series, OZ/Gedney Co.'s C-8T, 24-34T, ACV-50T Series, or Thomas & Betts Corp.'s Nylon Insulated Tite-Bite Series.
3. Liquidtight Connectors (For Liquidtight Flexible Metal Conduit): Appleton Electric Co.'s STB Series, Crouse-Hinds Co.'s LTB Series, Efcor Inc.'s 11-50B Series, Ideal Industries Inc.'s 75-521 Series, Midwest Electric Mfg. Corp.'s LTB Series, OZ/Gedney Co.'s 4Q-50T Series, Raco Inc.'s 3512 Series, or Thomas & Betts Corp.'s 5332 Series.

Conduit Bodies (Threaded):

Appleton Electric Co.'s Unilets, Crouse-Hinds Co.'s Condulets, Efcor Inc.'s Efcorlets, or OZ/Gedney Co.'s Conduit Bodies.

Vertical Conductor Supports:

Kellems Div. Harvey Hubbell Conduit Riser Grips, or OZ/Gedney Co.'s Type M, Type R.

CONDUCTORS (600 VOLTS AND UNDER) AND ACCESSORIES

Date of Manufacture:

No insulated conductor over one year old when delivered to the site will be acceptable.

Conductors:

Annealed uncoated copper or annealed coated copper in conformance with the applicable standards for the type of insulation to be applied on the conductor.

Insulation:

1. Types for General Application:
   a. Type XHHW: Moisture and heat resistant cross-linked polyethylene insulation rated 600V conforming to U.L. requirements for type XHHW insulation (75 degrees C Wet and 90 degrees C dry).
   b. Type THWN: Polyvinylchloride insulation rated 600V with nylon jacket conforming to U.L. requirements for type THWN insulation (75 degrees C).
   c. Type THHN: Polyvinylchloride insulation rated 600V with nylon jacket conforming to U.L. requirements for type THHN insulation (90 degrees C).
2. Types for Specific Application:

   As required by Article 620 of the National Electrical Code.
3. Traveling Cables:
   a. Type: Elevator cables as listed in Article 400,Table 4 00-4 of the National Electrical Code.
   b. Insulation Thickness: Suitable for the voltage to which the cables are subjected.
   c. Minimum Size:
      1) Lighting Circuits: No. 14 AWG.
      2) Operating, Control, Signaling and Communication Circuits: No. 18 AWG.
   d. Shielded Twisted Pairs: No. 20 AWG; Number and style to suit operating, control, signaling and communication circuit requirements, minimum of 6 pair.
      1) Provide number required for fire speaker and fire telephone circuit requirements: No. 20AWG.

e. Coaxial Cable: RG6/U with mechanical properties to protect against deformation.

f. Spare Conductors: Not less than 10 percent.

Splice Connectors:

1. **Spring Type:**
Amerace Corp. Elastimold Div.'s Buchanan B-Cap, Electrical Products Div./3M's Scotchlok Type Y, R, G, or B, Ideal Industries Inc.'s Wing Nuts or Wire Nuts, or Thomas & Betts Corp.'s Piggies.

2. **Indent Type with Insulating Jacket:**
Amerace Corp. Elastimold Div.'s Buchanan Pressure Connectors, Ideal Industries Inc.'s Crimp Connectors, or Thomas & Betts Corp.'s STA-KON.

Terminals:
Nylon insulated pressure terminal connectors by Amp Special Industries, Burndy Corp., Ideal Industries Inc., Panduit Corp., Thomas & Betts Corp., or Wiremold Co.

Lugs:

1. **Single Cable (Compression Type Lugs):**
Copper, one- or 2-hole style (to suit conditions), long barrel; Burndy Corp.'s Hylug YA, Ideal Industries Inc.'s CCB or CCBL, or Thomas & Betts Corp.'s 54930BE or 54850BE Series.

2. **Single Cable (Mechanical Type Lugs):**
Copper, one- or 2-hole style (to suit conditions); Burndy Corp.'s Quicklug Series, or Thomas & Betts Corp.'s Locktite Series.

Insulation Tapes:

1. Plastic Tape: Bishop Electric Corp.'s No. 85, Electrical Products Div./3M's Scotch 88, Plymouth Rubber Co.'s Premium CW.
2. Rubber Tape: Bishop Electric Corp.'s No. W-963, Electrical Products Div./3M's Scotch 23, or Plymouth Rubber Co.'s Splicing Compound ASTM.

OUTLET, JUNCTION AND PULL BOXES

Galvanized Steel Boxes for Concealed Work:
Standard type galvanized steel boxes and device covers by Appleton Electric Co., Electrical Products Div. Midland-Ross (Steel City), or Raco Inc.

Galvanized Steel Junction and Pull Boxes For Exposed Work:
Code gage, galvanized steel screw cover boxes by Gray Metal Products Inc.'s, Hoffman Engineering Co., Keystone Columbia Inc., or Queen Products Co. Inc.

Threaded Type Boxes For Exposed Work:
Malleable iron with cadmium or galvanized finish by Appleton Electric Co., Crouse-Hinds Co., or OZ/Gedney Co.

Specific Purpose Outlet Boxes:
As fabricated by equipment manufacturers for mounting their equipment.

SUPPORTING DEVICES

"C" Beam Clamps:

1. For 1 inch Conduit Maximum: Caddy Fastener Div./Erico Products Inc.'s BC-8P and BC-8PSM Series, or HIT Spring Steel Fasteners Inc.'s CH Series.
2. For 3 inch Conduit Maximum: Appleton Electric Co.'s BH-500 Series beam clamp with H50W/B Series hangers, Kindorf Elec. Prod. Div./Midland Ross Corp. 500 Series beam clamp with 6HO-B Series hanger, or OZ/Gedney Co.'s IS-500 Series beam clamp with H-OWB Series hanger.

Fastening Fittings for Existing Masonry:

Kindorf Elec. Prod. Div./Midland Ross Corp. E-243, E-244, E-245, E-170, Unistrut Corp.'s P2682, or Versabar Corp.'s VX-4310, VX-2308, VX-4308, VX-4309.

Pipe Straps:

Two-hole steel conduit straps with Galv-Krom finish; Kindorf Elec. Prod. Div./Midland Ross Corp. C-144 or C-280 Series.

Pipe Clamps:

One-hole malleable iron type clamps; Kindorf Elec. Prod. Div./Midland Ross Corp. HS-400 Series, or OZ/Gedney Co.'s 14-50 Series.

EXECUTION

ELEVATOR INSTALLATION EXECUTION

INSTALLATION

Handicap Access Signs:

Mark accessible elevator routes which are accessible for those with mobility disabilities.

1. Signs: Install 1 sign on each floor in locations deemed to be the most strategic and conspicuous. Mount signs 5 feet above floor (centerline of characters) at all interior and most exterior locations. Mount signs with manufacture's adhesive strips

PREPARATION

Protection:

Protect exposed equipment, door operators, car safeties, guide shoes, interlocks and limit switches from foreign material during course of construction.

FIELD QUALITY CONTROL

Acceptance Tests:

In addition to the tests outlined below, perform all tests required per Part 8.10 of the ASME A17.1 Safety Code for Elevators and Escalators. All tests must be witnessed by aqualified elevator inspector (QEI).

1. Buffer Test: Test is not required for solid or spring type buffers. Test oil buffers in accordance with ASME code.
2. Normal Operation Test: Run car, in both up and down direction, by normal operation devices, with full load, stopping at each floor served, in both directions of travel.
3. Speed Test:
   a. Determine actual speed of elevator car in both directions of travel with full load and no load in car.
   b. Determine speed of car by use of tachometer.
   c. Perform speed tests before and after normal operation tests.
4. Limit Switches: Test limit switches. (Car should not move).
5. Safety Tests:
   a. Perform tests on all safety equipment to determine that they function properly. Tests are to be in accordance with the best practices of the trade.
   b. Test car safety and governor in accordance with ASME Code.
   c. File off any safety marks on guide rails after tests have been completed.
6. Static Load: Perform static load test to determine any movement of elevator car away from landing.
7. Pressure Relief: Test, set and seal pressure relief valve in accordance with ASME code.
8. Test all items of elevator to assure entire elevator system is operating properly.

Before safeties are reset check if:

1. Any part of the equipment has broken or is out of order.
2. Ropes are in respective sheave grooves.
3. The machine brake is applied.
4. Slack in hoisting ropes has been taken up (winding drum machines).
5. The governor jaws, and car releasing carrier, if any, have been reset to their normal running position.
6. The car platform is out of level more than that required by the ASME A17.1 Code.

Perform tests in presence of Director’s Representative and QEI.

1. Sign completed ASME Elevator Test Report.

26.24 TECHNICAL SEMINAR/MAINTENANCE TRAINING

Upon completion of the Project, arrange with the Director's Representative to provide on the job training and seminar; a complete review of the documentation, operation and maintenance of the equipment and demonstration of any special features.

Minimum Seminar Length: One 2-hour seminar.

CLEANING

Clean elevator equipment of dust, dirt, grease and foreign materials.

Remove articles of tools and material from shafts and machine rooms not necessary for maintenance and operation of elevator.

1.1 DOOR OPERATION EXECUTION

INSTALLATION

Install door operators and integrate with elevator control equipment for required operation.

1. Install electric power hoistway door operators at each opening, inside of shaft. If dual type operators are used, mount each operator one on each side of door, inside the shaft, rigidly supported.
2. Install electric power gate operator on top of car, on rigidly framed supporting members.

FIELD QUALITY CONTROL

Inspect components for proper operation, ascertaining those operators and component are neatly and securely installed and aligned.

Tests: Demonstrate that door operators perform in accordance with required operation.

1. Test door operators step by step as specified under function, and operation.

26.25 ELEVATOR CONTROL AND OPERATION EXECUTION

INSTALLATION

Install elevator controllers in the elevator machine room.

Install components and integrate with controllers for required operation of elevators.

FIELD QUALITY CONTROL

. **Inspection:**

1. Power Off: Inspect control equipment for dirt, dust, grease or other foreign material that would prevent proper operation.
2. Power On:
   a. Run elevator up and down shaft, stopping at each floor. Check for accurate landings and smooth stops and starts under all load conditions.
   b. With elevator running, inspect control equipment for excessive arcing, heating of coils, misalignment of relays, contactors or switches.
   c. Inspect motor generator for smooth operation (no excessive noise or vibration).

Tests:

1. Individually test each component for compliance with its specified function and operation.
2. Demonstrate that elevators perform in accordance with required type of operation.
   a. Test elevators step by step as specified under function, and operation

26.26 ELEVATOR LANDING SIGNAL EQUIPMENT EXECUTION

INSTALLATION

General: Install elevator landing signal equipment and integrate with elevator control equipment for required operation.

Power Supply for Signal Equipment: Install in elevator or machine room.

Landing Fixtures: Install one riser of landing fixtures.

Landing Fixtures: Install 2 risers of landing fixtures. Locate one riser between elevator Nos. ________ and ________. Locate the other riser between elevators Nos. ________ and ________.

1. Hall Buttons: Flush mount hall buttons at each landing served by the elevators.
   a. Locate hall buttons with centre line of buttons eyeing 42 inches above finished floor.
   b. Install single buttons at terminal landings. Install “Up” and “Down” buttons at intermediate landings.
2. Hall Lanterns:
   a. Flush mount hall lanterns over each hoistway entrance door served by the elevator. At top terminal install “Down” lantern. At bottom terminal install “Up” lantern. At intermediate landings install both “Up” and “Down” lanterns.
   b. Place hall lanterns as high as possible (no less than 72 inches from landing floor).
3. Hall Position Indicators:

a. Flush mount hall position indicator over each entrance served by the elevator.

4. Combination Hall Lantern and Position Indicator:
   a. Flush mount combination hall lantern and position indicator over each entrance served by the elevator.

Lobby Display System:

1. Flush mount lobby display panel at designated floor.
   a. Flush mount panel in wall between elevators.

26.27 ELEVATOR EMERGENCY OPERATION AND EMERGENCY SIGNAL DEVICES EXECUTION

INSTALLATION

Phase I and Phase II Operation:

1. Integrate components with elevator controller system for required operation.
2. The phase I key switch shall be located at the designated floor.

Emergency Light and Alarm System:

1. Recess emergency light fixture in operating panel of cab. Reinforce cut out in car panel for mounting of fixture.
2. Install wiring, relays, contacts as required to connect emergency light unit to 120-volt power source on car, and to inter-connect the six inch alarm bell on emergency light unit with emergency call button and emergency stop button in car operating panel. In addition; provide interconnections to existing alarm bell located at the designated floor for each group of elevators.
3. Test battery capacity and recharge time. Operate one unit for required number of hours and load conditions.

Telephone Communication System:

1. Install the system in accordance with the Company's printed instructions.

Floor Numbers:

1. Paint minimum four-inch-high white gloss enamel numerals on the hoistway side of each hoistway door panel

Emergency Electric Service:

1. Mount strip switch for emergency power operation at the designated floor.
2. Integrate components with elevator controller system for required operation.

26.28 ELEVATOR WIRING EXECUTION

RACEWAY INSTALLATION

Raceway Types and Locations:

1. Install rigid ferrous metal conduit in all locations unless otherwise specified.
2. Flexible Metal Conduit:
   a. Use for short runs to equipment such as interlocks, limit switches, hall buttons or items requiring adjustments (dry locations).
   b. Use 1 to 2 feet of flexible metal conduit for final connection to equipment subject to vibration (dry locations).
3. Liquid tight Flexible Metal Conduit:
   a. Use for short runs to equipment such as interlocks, limit switches, hall buttons or other items requiring adjustment (damp and wet locations).
   b. Use for 1 to 2 foot of liquidtight flexible metal conduit for final conduit connection to equipment subject to vibration (damp and wet locations).
4. Wire ways: May be installed in dry locations and not within 4 feet of elevator pit floor.

CONDUCTOR INSTALLATION

Install wiring in raceways. Exceptions:

1. Traveling cables connecting the car and hoistway wiring.
2. As permitted otherwise by the exceptions to National Electric Code Article 620-21.

Traveling Cables:

1. Terminate ends of traveling cables in NEMA 1 junction boxes equipped with labeled terminal strips and strain relief devices at both connections. Travel cable may be terminated on labeled terminal strips in control system cabinet.

OUTLET, JUNCTION AND PULLBOX INSTALLATION

Boxes For Concealed Conduit System:

1. Install boxes of depth to suit job conditions and also comply with Article 370 of the National Electrical Code.
2. Use galvanized steel boxes with flush covers for junction and pull boxes.

Boxes For Exposed Conduit System:

1. Use galvanized steel junction and pull boxes for Work in dry locations and damp locations.
2. Use threaded type boxes for all Work in wet locations and within 4 feet of elevator pit floor.

Specific Purpose Outlet Boxes:

Use specific purpose outlet boxes to mount equipment when available and suitable for job conditions.

SUPPORTING DEVICE INSTALLATION

Attachment of Conduit System:

1. Masonry Construction: Attach conduit to masonry construction by means of pipe straps or pipe clamps and masonry anchorage devices.
2. Steel Beams: Attach conduit to steel beams by means of “C” beam clamps and hangers.

27 SECTION 27- TECHNICAL SPECIFICATIONS & PRICE SCHEDULE (GENERATOR)

PART A

PARTICULAR SPECIFICATION AND CONDITIONS

SECTION 1

27.1 STANDBY GENERATOR

PARTICULAR CONDITIONS

Location of Site

The site of the proposed Sub-Contract work shall be situated at South C in Nairobi, Kenya.

The following climatic conditions apply at the site of the works and all plant, equipment, apparatus, materials and installation shall be suitable for these conditions.

Maximum temperature	-	27^0 C
Minimum temperature	-	12^0C
Average temperature range	-	19.5^0C
Relative Humidity range	-	35% - 98%
Altitude	-	1795 metres above sea-level
Latitude	-	00^0 20'N
Longitude	-	32^0 36'E
Rainfall		Extremely heavy including thunderstorms at certain period of the year.

Description of Project

The project comprises the supply and installation of 2No. Standby Diesel Generating Set rated at 300kVA (at site) for Proposed Uvuvi House.

Scope of Works

The scope of work comprises the supply, erection, assembly, wiring, connection, testing, commissioning and setting to work, 2No 300 kVA standby diesel generator, together with control panels in accordance with the Specification and Contract Drawings to provide a complete and operable installation. The generating set shall be provided with sound insulation to contribute no more than 70 decibels of noise (at 1-metre distance) to the surrounding.

Commencement of Works

The subcontractor, in submitting his tender shall be deemed to have included for commencing any necessary works on site at such time as will comply with the Main Contractor's programme.

Duration of Contract

The subcontractor shall be required to phase his work in accordance with the Main Contractor's programme (or its revision). The programme is to be agreed with the Electrical subcontractor. The subcontractor shall indicate the anticipated contract period in weeks.

Contract Drawings

The subcontractor shall be deemed to have studied all relevant Contract Drawings and to have allowed for any necessary provisions in his Sub-Contract Works required thereby.

Materials and Plant

The origin of all materials and plant on this project shall be declared by the Tenderer.

SECTION 2

27.2 DIESEL ENGINE

Cylinder Block

The cylinder block shall be made of one-piece cast iron. It shall have full-length water jacket with circulation around each cylinder. The cylinder block shall have wet liners with rubber seal at the bottom end.

Cylinder Head

The cylinder head for each bank of cylinders shall be of one piece and manufactured from cast iron. It shall be secured by studs of high tensile steel and be easily detachable Valve seats shall be replaceable.

Pistons

The pistons shall be made of die cast aluminium alloy and tapered with a ground skirt. The pistons shall have at least three compression and two oil control rings. The combustion chamber and the valve recess shall be smooth contoured. The pistons shall have fully floating pins.

Valves

The valves shall have separate guides presses into the cylinder head. Operating shall be of the normal pushrod/rocker type with tappet adjustment at the rocker arm.

Flywheel

The flywheel shall be of heavy cast iron with close coupling type cast iron flywheel housing and shall have a gear ring bolted onto it. The gear shall have heat treated teeth.

Crankshaft

The crankshaft shall be forged steel with induction hardened main and pin journals. It shall be statically and dynamically balanced and shall have replaceable, line steel bearings.

<u>Connecting roods</u>

The connecting rods shall be of 'I' Section forged steel.

<u>Fuel and Air system</u>

The engine shall have a mono-block injection pump which is gear driven through flexible coupling. The fuel pump shall be integral and shall incorporate a head primer. The engine shall have a multi-core injector nozzle. A fuel filter shall be provided complete with a replacement element and the engine shall have a heavy-duty oil bath air cleaner.

<u>Governor</u>

The governor shall be of the centrifugal type operating direct on the fuel line and shall be capable of maintaining the speed constant within 3% of nominal output in accordance with B.S.649 : 1958 Class A2.

<u>Protection</u>

The engine shall be provided with the following protective devices capable of providing audible and visible alarm signals at one or more remote locations:

a) Low lubricating oil pressure

b) High lubrication oil temperature

c) High cooling water temperature

d) High engine speed

<u>Instrumentation</u>

The engine shall be provided with the following instruments to indicate the various speeds and temperatures:

i) Tachometer indicating the engine speed

ii) Instrumentation to indicate the temperature of the exhaust gases.

iii) Instrumentation to indicate the temperature of the lubrication oil.

iv) Instrumentation to indicate the pressure of the lubrication oil

v) Instrumentation to indicate the temperature of the cooling water.

<u>Ancillary equipment</u>

The subcontractor shall be responsible for providing the following ancillary equipment for the installation:

a) Exhaust piping and heavy-duty silencer including flexible piping off the engine exhaust manifold. The exhaust piping provided shall be sufficiently long to cover the route shown on the Contract Drawings. The Contractor shall liaise with the building contractor for the final positioning of the exhaust pipe. The exhaust pipe shall be terminated in a duct 500 x 500mm internal dimension to the top of the building. Any additional silencers shall be provided to ensure the specified noise levels are maintained.

b) Fuel storage tank of capacity 1,500 litres with contents gauge drainpipe with cock, vent, gill connection and engine supply with isolating valve. If the generator is supplied with an integral fuel tank, the additional tank shall be supplied to make up the specified capacity.

c) Basic set of tools and special tools or gauges required for maintenance, all contained in a steel, lockable box. The tools may include but not limited to the following:

- set of open-ended spanners
- set of ring spanners
- set of box spanners with tommy bar
- circlip pliers (internal and external)
- Normal pliers
- Insulated crocodile pliers
- set of insulated screwdrivers
- hammer
- valve spring compression tool
- piston band assembling set
- set of feeler gauges
- valve grinding tool
- cleaning outfit for injector nozzle

d) Semi-rotary hand pump to be mounted adjacent at the Ground Floor Level with necessary piping from pump to header tank.

<u>Cooling system</u>

Unless otherwise specified elsewhere, a suitable radiator shall be provided for the cooling water and lubricating oil requirements of the engine when operating under the site conditions stated. This shall be complete with engine driven fan and drive, guard for fan and drive, belt tensioner and all integral oil and water piping connections.

A suitable duct from the radiator face flange, extending to the ending room wall, total distance one metre, shall be supplied incorporating a flexible section if required.

Circulation of both lubricating oil and primary water shall be catered for by means of geared or belt driven pumps, integral with the engine.

A thermostatic bypass shall be fitted in the water outlet from the engine to give a quick warm up and even temperature control over the load range.

<u>Lubrication</u>

The engine components shall be lubricated via a pressure oil system from an integral oil pump driven by the engine. The system shall incorporate oil filters, the secondary oil filter being of the changeable type. A suitable relief valve shall be provided to maintain the pump discharge pressure within safe limits.

<u>Starting</u>

The engine shall start up by means of a D.C. motor, which shall be supplied, from a set of rechargeable batteries of an appropriate voltage and of such a capacity as to enable up to ten start-ups in one hour when fully charged.

Compliance

The equipment and installation shall comply with B.S.649 and also with C.P. 323.

The subcontractor shall in his statement of compliance confirm that the engine would be capable of running on class `A' fuel to B.S.2869.

Noise level

The subcontractor shall state in his statement of compliance the level of noise in decibels expected in the engine room. The set shall be supplied complete with any necessary noise reduction cover to give a maximum noise level of 70 decibels at a distance of 10 metres from the generator building.

Ancillary Power requirements

In selecting the size of the diesel engine, the subcontractor shall make suitable allowances for power requirements for the cooling system, the lubricating system and any other requirements that may be necessary for that set.

Ventilation

The subcontractor must ensure that adequate ventilation in the generator room is provided.

Exhaust Fumes

The Sub-contractor shall provide piping to discharge exhaust fumes away from the building.

SECTION 3

27.3 GENERATOR SET

Alternator

The alternator shall be of 12 wire reconnectable brushless type rated at 0.8 p.f. lagging in accordance with B.S. 2613:1975 and having a revolving field, a single self-aligning roller bearing and solid half coupling to connect to the engine.

The alternator shall be screen protected, drip-proof and shall be wound high temperature, tropicalised class B insulation of the stature and class F insulation on the rotor. The stature frame shall be barrel design with conventional two layer winding in semi-enclosed skewed slots, pitched to give a good waveform with low harmonic content.

The rotor core shall be specially constructed with strip winding to obtain maximum cooling effect from the fabricated fan, with separate air circuits cooling the rotor and stature.

A.C. exciter

An A.C. exciter of direct - coupled flange mounted type shall be supplied. The exciter frame shall be of nodular iron and shall serve additionally as the bearing housing. The exciter armature shall be mounted on a tub on the alternator shaft. Connections shall be taken to the rotating rectifiers, which shall be carried on aluminium castings, from the main room.

Automatic Voltage Regulator

A Thyristor type static automatic voltage regulator shall be used to regulate machine. This regulator shall incorporate a zener diode bridge reference voltage circuit, thyristor drive reactor with series silicon diode and a further commutating diode. Under steady conditions, the automatic voltage regulator shall maintain the voltage within 3% for all balanced loads between no load and full load at power factors between unity and zero lagging. The automatic voltage regulator shall be complete with hand-operated manual control potentiometer which shall be fitted in control panel.

The voltage level controls shall enable the terminal voltage to be adjustable within the range - 5% to +10%.

The voltage gain controls shall be adjustable to compensate for engine speed variations when operating with a speed droop governor.

After any change of load, the voltage shall not vary by more than

- 15% the rated voltage, and shall return to within
- 3% within 3 seconds, and to within
- 2.5% rated voltage within 15 seconds. On starting, the voltage overshoot shall not exceed 15% and shall return to within 3% within 3 seconds.

Terminal box

Any suitable dimensioned terminal box suitable for conduit or cable entry shall be supplied with undrilled gland plate.

Rating

The machine shall be continuously maximum rated in accordance with B.S. 2613 and shall give the output specified in the particular specification. Allowance shall be made for a 10% overload for one hour in any 12 hours without any injurious overheating.

Engine rating

The engine driving the generator set shall be rated in accordance with B.S. 649:1958 and shall be so de-rated owing to site conditions that the specified electrical output is obtained from the alternator. The subcontractor shall provide additional labelling on the generator to distinguish clearly between the nameplate ratings and the actual ratings on site.

The tenderer's manufacturer's catalogue should indicate the percentage reductions from the nameplate ratings resulting from altitude and inlet temperature for any of the following engine variations:

a) Naturally aspirated.

b) Turbocharged without a charge air cooler.

c) Turbo-charged with a charge air cooler.

Radio Interference suppression

The generator sets shall be suppressed for radio interference in accordance with B.S. 833 and C.P 1006.

Duty performance

The generator will be used as a standby duty generator.

Generator Set specification

The generator shall be sound attenuated (super silent) and shall be rated for the following parameters after suitable derating for the site service conditions and allowing for power requirements for integral cooling systems, lubricating system and any other integral parts of the set.

Generator output	300kVA each (at site)
Rated power factor	0.8 lagging
Rated speed	1500 RPM
Frequency	50 Hz
Rated voltage	415/240V, 3 phase
Fuel Autonomy at Full load	9 Hours
Day Tank capacity	12-hours utilization
Maximum Sound level	70dB(A)
Ambient temperature	up to 45 degrees C

The generator set shall also be provided with heavy-duty skid base fitted with anti-vibration mountings.

Testing and commissioning

The subcontractor shall include for fully commissioning the set and its control equipment, and for the purpose of the required tests, shall provide all necessary instruments, tools, fuel full tank and lubricating oil.

The tests and checks shall be carried out by the subcontractor in the presence of the Engineer or his representative, as applicable.

i) Check that the main frame is level in all directions, engine and generator shafts are in proper alignment and the vibration absorbing devices are properly installed and located.

ii) Check water and sump oil levels and that the water jacket is in working order.

iii) Check the battery electrolyte levels and the specified gravity.

iv) Ensure that sufficient oil is in the fuel tank for a two-hour test run.

v) Examine the containers in which the fuel and lubricating oils were delivered and check that the type of oils are recommended for the unit.

vi) Check that the engine block water drain points are free from sludge and other blockages.

vii) Check engine bolts, main drive coupling, valve clearances, fuel pumps settings, governor settings, pipe line connections, water hose, exhaust couplings, flexible pipework etc. and the ball valve and overflow work.

viii) Check all outgoing connections on the generator and at the control panel. All lugs for principal connections shall have clean and bright contact surfaces. A suitable abrasive material shall be used where necessary.

ix) Check access panels and doors for proper opening and closing and for the functioning of any interlocks fitted.

x) With the set isolated from the main supply and the selector switch in the `Manual' position, start the engine by means of the `start' push button and allow it to run up to normal speed. Check that during the time the engine starter motor is in operation, the mains battery charger is automatically switched off to avoid its being overloaded by the reduction in voltage across the battery.

xi) Check instruments and gauges for normal operation and response and that the generator voltage is being maintained within the prescribed limits, making due allowance for no-load conditions. Compare the reading of the frequency meter with that of the engine tachometer.

xii) Stop engine by turning selector switch to "off" position and verify that generator contactor opens at between 85% - 95% of normal voltage. Recheck water and oil levels.

xiii) Turn selector switch to `Auto' position. Disconnect the sending circuit supply and check that the set starts, the mains contactor opens, and the generator contactor closes in correct order. Reconnect the sensing circuit to verify that the engine stops on restoration of the mains supply and that the contactors operate correctly. Check voltage sensing time delays on each phase in turn and also that the push buttons for mains failure simulation and engine stopping operate correctly.

N.B. ***Running of the engine for any length of time under no-load conditions is undesirable and tests calling for such operation should be carried out in as short a time as is consistent with thoroughness.***

xiv) Operate the necessary isolators and switches to put the set on standby for essential services network with the selector switch in the `Auto" position, and using the mains failure simulation push, verify that the set operates correctly with the appropriate time delay for taking up load and that the carrying of the load and its distribution over the three phases are satisfactory.

xv) Run the set at various loads for periods totalling at least 30 minutes. Check the voltage and current in each phase in turn and that the voltage and frequency are being maintained within the required limits with large alterations of load.

xvi) Check the operation of the turbocharger units and the colour of the exhaust gas at various loads.

xvii) Check that the various engine safeguards operate satisfactorily.

xviii) Check the vibration absorbing devices for proper operation and that the performance of all flexible connections, both mechanical and electrical, is satisfactory.

xix) Recheck the lubricating oil and water level, replenish the fuel oil tank and leave the set in normal operating order.

xx) An initial supply of all lubricating oils and greases shall be provided by the subcontractor.

SECTION 4

27.4 CONTROL CUBICLE

General

The control panel shall be totally enclosed type plant wall mounted in the generator room, fitted with removable covers giving access to the control gear, terminal and connection blocks and undrilled gland plates for cables entry and shall be finished in stove enameled grey hammer paint.

Function

The control cubicles shall house the start/stop buttons and protection systems and shall be complete with all the necessary relays and circuitry to the following requirements.

Control and Logic section

Facilities shall be available with suitable fuse protection for the following functions:

a) Manual start

b) Manual Stop

c) Stall lockout, i.e. a lockout to prevent re-cranking of an engine upon fuel failure, or stall conditions.

Protection circuits

Suitably fused protection circuits, for oil, water, speed and one spare, shall be allowed for. The first stage protection shall be by means of fail-safe circuits, while the second stage shall be energised on fault circuits. All circuits except over-speed shall be commissioned after a delay following engine start-up.

The circuits for:-

(a) Lubricating oil pressure.

(b) Water temperature.

(c) Spare.

shall be either alarm, or alarm and shutdown. The latter shall be achieved by means of a link within the control panel.

The circuit for engine over-speed shall give simultaneous alarm and shut down.

When the engine has a fault condition, the protection circuits shall still accept further faults. Once a shutdown signal has been given, the protection circuits shall be locked on as:

(i) not to give further fault indication as engine stops.

(ii) to give indication of fault condition even when the engine has stopped.

The fault circuit shall be reset by pushing the "reset" button.

One audible alarm mute shall be provided for each fault channel. This shall mute the alarm for the fault causing the alarm, but shall leave the Klaxon prepared for further faults.

Switching section

A suitably fused switching section for engine functions as per list below shall be provided:

- Fuel rack solenoid (start or stop)
- Starter motor solenoid via a repeater

Indication

Indicator lamps as per list below shall be provided:

(a) Engine running and protection circuits commissioned - green.

(b) Fault parameters - all red.

The indication circuits shall have a lamp test pushbutton by means of which the lamp filaments can be tested.

Control switching

A rotary switch with off/on positions, to switch the control circuit supplies. In the `ON' position the engine shall be started by depressing a push button and stopped by depressing a `Stop' push button.

The indicators, switches and push buttons shall be mounted on the front face of the chassis unit

Alarm

The subcontractor shall supply and install a Klaxon which is loud enough to be heard even when the engine is running. The supply for this Klaxon shall be obtained from the control cubicle through suitably rated fuses.

Mains detection

A mains detection unit which can register a mains voltage failure under the following conditions shall be provided:

(a) Failure of any one or more phases

(b) Incorrect phase sequence

(c) Low volts on any individual or all phases - i.e. below 85% of normal voltage.

(d) Excessive frequency change i.e. +/- 3Hz

The failure condition shall be used to produce a start signal for the standby engine after a delay. The delay shall be adjustable and shall ensure the failure is not a transient condition.

Mains detection units shall receive their sensing supplied from the main board feeding the load.

Instrumentation and controls

The following equipment shall be provided by the Generator supplier:

(a) Moulded case air circuit breaker, triple pole and neutral, with magnetic release to provide alternator short circuit protection, trip free handle and shunt trip.

(b) One bolted neutral link.

(c) Alternator voltage trimmer regulator.

(d) 3No., one per phase, flush mounting ammeters.

(e) 1 No., flush mounting voltmeter.

(f) 1 No., voltmeter rotary selector switch.

(g) One set of control circuit instruments and the accompanying fuses.

(h) All internal wiring, terminals, cable lugs, legends and one main earthing bar.

(i) 1 No., frequency meter, vibrating leaf type.

(j) 1 No., governor motor raise and lower switch.

(k) Cable boxes and glands to suit.

(l) 1 No. Kilowatt-hour meter.

Terminations

All internal wiring terminations shall be numbered and marked with ferrules.

Earthing

The subcontractor shall be responsible for ensuring that the earthing of the generator neutral is carried out efficiently and that the resistance of the generator neutral from the earth does not exceed one ohm.

Earth pit provision has been given under builder's works for the installation of an earth mat but the subcontractor shall be responsible for the supply and installation of an earth mat comprising of 1000mm x 1000mm mesh of 25mm x 3mm copper tape.

The earth rods shall be 2m long by 15mm diameter, extensible type as "copperweld" 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 copper earth mat shall be laid in 1200mm x 1200mm x 800mm deep earth the surface of the pit with a concrete inspection cover.

The subcontractor shall ensure that the earthing system of the generator is adequately bonded to the permanent earth system of the `normal' supply.

All earthing shall be carried out in accordance with the appropriate section of the I.E.E. Regulations.

Trickle charger

The trickle charger shall have rating and service parameters such as to keep the engine start batteries fully charged and ready for service whenever required. When the engine is running the batteries shall be charged form integral dynamo.

Hours counter

The subcontractor shall allow for the installation of an hours counter on the control panel for the generator.

Automatic Changeover Contactor unit

(a) A contactor unit shall be provided in the main switchroom. On failure of the normal electricity supply the change-over panel will automatically initiate the starting of and effect the transfer of load to the standby generator. The unit shall contain power contactors and ancillary apparatus as specified.

A control cable shall be laid between the changeover panel and the generator control panel in the new generator room.

(b) Failure of normal supply shall mean complete loss of voltage or the falling below 85% of the normal voltage between any two phases or phase and neutral.

(c) The power circuit shall consist of two contactors feeding a common busbar to which the load will be directly connected. One contactor shall control the normal supply, the other standby supply; they shall be electrically and mechanically interlocked so that they cannot both be closed at the same time.

(d) On failure of the normal supply, the unit shall operate in the following manner:

(i) After a delay, adjustable from 0 to 5 seconds (to avoid operation by a transient dip in voltage) a signal shall be given to start the standby generating set.

(ii) On receipt of a signal from the standby generating set that it is ready to take the load and providing that the failure of the normal supply still persists, the normal supply contactor shall close. If the normal supply still persists, the normal supply contactor shall close. If the normal supply has been restored before the changeover has taken place, the contactors shall not operate and the starting delay contacts shall open to initiate the shutting down of the standby generating set.

(e) When the standby supply is in operation and the normal supply is restored and remains within 10% of rated voltage on all phases for a preset time (adjustable to 30 seconds) the standby contactor shall open and the contacts shall then open to shut down the standby generating set.

Provision should be so made that automatic return to normal supply can be prevented if required.

Once a start signal has been sent to the standby generating set, the engine starting sequence shall be allowed to continue until the set is ready to take the load before a stopping signal is sent.

By addition of external connections the following facilities shall be available:

Remote starting of the standby generating set and transfer of the load to it.

Restoration of the normal supply on failure of the standby generating set.

Each switch shall be labelled with its duty and each position shall be marked.

The following switches shall be fitted:

Contactor control switch, with make before break contacts and `Hand" and `Auto' positions. In the `Hand' position the unit shall be controlled the "Contactor Hand Control Switch". In the "Auto" position the unit shall operate automatically irrespective of the position of the "Contactor Hand Control Switch".

A contactor Hand Control Switch: with `Standby' and `Normal' position.

An Auto Return Switch; having `ON' and `OFF' positions. In the `ON' position the return to normal supply shall be automatic when the normal supply is restored.

Contactor by-pass switches: shall be provided to enable the essential load circuits to be served direct from the normal supply to enable the generator and/or the control equipment to be serviced. The by-pass switches shall be provided with a suitable and conspicuous label warning against leaving the generator in the disconnected position.

Indicating lamps shall be provided. They shall be appropriately labelled, easily visible and shall give the following information:

Normal supply available.

Standby supply available.

Normal supply in use.

Standby supply in use.

A push button labelled `Test' shall be provided to enable a failure of normal supply to be simulated. If the button is pressed and released the equipment shall complete the starting sequence and when the set is ready to take the load it shall be shut down. If the button is held depressed the equipment shall change over to the standby supply when the set is ready to take load.

The control circuit supply shall be either 12 volts or 24 volts D.C. depending upon the starting battery and charger.

No current shall be drawn from the control supply when the unit is accepting the normal power supply.

27.5 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 Nairobi 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.............................. Arprim Consultants P.O. Box 207- 00606, Nairobi

APPROVED IN PRINCIPLE WITH CORRECTIONS INDICATED. Date................................ Signature.............................. Arprim Consultants P.O. Box 207- 00606, Nairobi

APPROVED IN PRINCIPLE Date................................ Signature.............................. Arprim Consultants P.O. Box 207- 00606 Nairobi

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 Nairobi.

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.

27.6 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.

27.7 DIESEL ENGINE

Cylinder Block

The cylinder block shall be made of one-piece cast iron. It shall have full-length water jacket with circulation around each cylinder. The cylinder block shall have wet liners with rubber seal at the bottom end.

Cylinder Head

The cylinder head for each bank of cylinders shall be of one piece and manufactured from cast iron. It shall be secured by studs of high tensile steel and be easily detachable Valve seats shall be replaceable.

Pistons

The pistons shall be made of die cast aluminium alloy and tapered with a ground skirt. The pistons shall have at least three compression and two oil control rings. The combustion chamber and the valve recess shall be smooth contoured. The pistons shall have fully floating pins.

Valves

The valves shall have separate guides presses into the cylinder head. Operating shall be of the normal pushrod/rocker type with tappet adjustment at the rocker arm.

Flywheel

The flywheel shall be of heavy cast iron with close coupling type cast iron flywheel housing and shall have a gear ring bolted onto it. The gear shall have heat treated teeth.

Crankshaft

The crankshaft shall be forged steel with induction hardened main and pin journals. It shall be statically and dynamically balanced and shall have replaceable, line steel bearings.

Connecting roods

The connecting rods shall be of 'I' Section forged steel.

Fuel and Air system

The engine shall have a mono-block injection pump which is gear driven through flexible coupling. The fuel pump shall be integral and shall incorporate a head primer. The engine shall have a multi-core injector nozzle. A fuel filter shall be provided complete with a replacement element and the engine shall have a heavy-duty oil bath air cleaner.

Governor

The governor shall be of the centrifugal type operating direct on the fuel line and shall be capable of maintaining the speed constant within 3% of nominal output in accordance with B.S.649 : 1958 Class A2.

Protection

The engine shall be provided with the following protective devices capable of providing audible and visible alarm signals at one or more remote locations:

a) Low lubricating oil pressure

b) High lubrication oil temperature

c) High cooling water temperature

d) High engine speed

Instrumentation

The engine shall be provided with the following instruments to indicate the various speeds and temperatures:

i) Tachometer indicating the engine speed

ii) Instrumentation to indicate the temperature of the exhaust gases.

iii) Instrumentation to indicate the temperature of the lubrication oil.

iv) Instrumentation to indicate the pressure of the lubrication oil

v) Instrumentation to indicate the temperature of the cooling water.

Ancillary equipment

The subcontractor shall be responsible for providing the following ancillary equipment for the installation:

a) Exhaust piping and heavy-duty silencer including flexible piping off the engine exhaust manifold. The exhaust piping provided shall be sufficiently long to cover the route shown on the Contract Drawings. The Contractor shall liaise with the building contractor for the final positioning of the exhaust pipe. The exhaust pipe shall be terminated in a duct 500 x 500mm internal dimension to the top of the building. Any additional silencers shall be provided to ensure the specified noise levels are maintained.

b) Fuel storage tank of capacity 10,500 litres with contents gauge drainpipe with cock, vent, gill connection and engine supply with isolating valve. If the generator is supplied with an integral fuel tank, the additional tank shall be supplied to make up the specified capacity.

c) Basic set of tools and special tools or gauges required for maintenance, all contained in a steel, lockable box. The tools may include but not limited to the following:

- set of open-ended spanners
- set of ring spanners
- set of box spanners with tommy bar
- circlip pliers (internal and external)
- Normal pliers
- Insulated crocodile pliers
- set of insulated screwdrivers
- hammer
- valve spring compression tool
- piston band assembling set
- set of feeler gauges
- valve grinding tool
- cleaning outfit for injector nozzle

d) Semi-rotary hand pump to be mounted adjacent at the Ground Floor Level with necessary piping from pump to header tank.

Cooling system

Unless otherwise specified elsewhere, a suitable radiator shall be provided for the cooling water and lubricating oil requirements of the engine when operating under the site conditions stated. This shall be complete with engine driven fan and drive, guard for fan and drive, belt tensioner and all integral oil and water piping connections.

A suitable duct from the radiator face flange, extending to the ending room wall, total distance one metre, shall be supplied incorporating a flexible section if required.

Circulation of both lubricating oil and primary water shall be catered for by means of geared or belt driven pumps, integral with the engine.

A thermostatic bypass shall be fitted in the water outlet from the engine to give a quick warm up and even temperature control over the load range.

Lubrication

The engine components shall be lubricated via a pressure oil system from an integral oil pump driven by the engine. The system shall incorporate oil filters, the secondary oil filter being of the changeable type. A suitable relief valve shall be provided to maintain the pump discharge pressure within safe limits.

Starting

The engine shall start up by means of a D.C. motor, which shall be supplied, from a set of rechargeable batteries of an appropriate voltage and of such a capacity as to enable up to ten start-ups in one hour when fully charged.

Compliance

The equipment and installation shall comply with B.S.649 and also with C.P. 323.

The subcontractor shall in his statement of compliance confirm that the engine would be capable of running on class `A' fuel to B.S.2869.

Noise level

The subcontractor shall state in his statement of compliance the level of noise in decibels expected in the engine room. The set shall be supplied complete with any necessary noise reduction cover to give a maximum noise level of 70 decibels at a distance of 10 metres from the generator building.

Ancillary Power requirements

In selecting the size of the diesel engine, the subcontractor shall make suitable allowances for power requirements for the cooling system, the lubricating system and any other requirements that may be necessary for that set.

Ventilation

The subcontractor must ensure that adequate ventilation in the generator room is provided.

Exhaust Fumes

The Sub-contractor shall provide piping to discharge exhaust fumes away from the building.

27.8 GENERATOR SET

Alternator

The alternator shall be of 12 wire reconnectable brushless type rated at 0.8 p.f. lagging in accordance with B.S. 2613:1975 and having a revolving field, a single self aligning roller bearing and solid half coupling to connect to the engine.

The alternator shall be screen protected, drip-proof and shall be wound high temperature, tropicalised class B insulation of the stature and class F insulation on the rotor. The stature frame shall be barrel design with conventional two layer winding in semi-enclosed skewed slots, pitched to give a good waveform with low harmonic content.

The rotor core shall be specially constructed with strip winding to obtain maximum cooling effect from the fabricated fan, with separate air circuits cooling the rotor and stature.

A.C. exciter

An A.C. exciter of direct - coupled flange mounted type shall be supplied. The exciter frame shall be of nodular iron and shall serve additionally as the bearing housing. The exciter armature shall be mounted on a tub on the alternator shaft. Connections shall be taken to the rotating rectifiers, which shall be carried on aluminium castings, from the main room.

Automatic Voltage Regulator

A Thyristor type static automatic voltage regulator shall be used to regulate machine. This regulator shall incorporate a zener diode bridge reference voltage circuit, thyristor drive reactor with series silicon diode and a further commutating diode. Under steady conditions, the automatic voltage regulator shall maintain the voltage within 3% for all balanced loads between no load and full load at power factors between unity and zero lagging. The automatic voltage regulator shall be complete with hand-operated manual control potentiometer which shall be fitted in control panel.

The voltage level controls shall enable the terminal voltage to be adjustable within the range - 5% to +10%.

The voltage gain controls shall be adjustable to compensate for engine speed variations when operating with a speed droop governor.

After any change of load, the voltage shall not vary by more than
15% the rated voltage, and shall return to within
3% within 3 seconds, and to within
2.5% rated voltage within 15 seconds. On starting, the voltage overshoot shall not exceed 15% and shall return to within 3% within 3 seconds.

Terminal box

Any suitable dimensioned terminal box suitable for conduit or cable entry shall be supplied with undrilled gland plate.

Rating

The machine shall be continuously maximum rated in accordance with B.S. 2613 and shall give the output specified in the particular specification. Allowance shall be made for a 10% overload for one hour in any 12 hours without any injurious overheating.

Engine rating

The engine driving the generator set shall be rated in accordance with B.S. 649:1958 and shall be so derated owing to site conditions that the specified electrical output is obtained from the alternator. The subcontractor shall provide additional labelling on the generator to distinguish clearly between the nameplate ratings and the actual ratings on site.

The tenderer's manufacturer's catalogue should indicate the percentage reductions from the nameplate ratings resulting from altitude and inlet temperature for any of the following engine variations:

b) Naturally aspirated.

b) Turbocharged without a charge air cooler.

c) Turbo-charged with a charge air cooler.

Radio Interference suppression

The generator sets shall be suppressed for radio interference in accordance with B.S. 833 and C.P 1006.

Duty performance

The generator will be used as a standby duty generator.

Generator Set specification

The generator shall be sound attenuated (super silent) and shall be rated for the following parameters after suitable derating for the site service conditions and allowing for power requirements for integral cooling systems, lubricating system and any other integral parts of the set.

Generator output	300kVA (at site)
Rated power factor	0.8 lagging
Rated speed	1500 RPM
Frequency	50 Hz
Rated voltage	415/240V, 3 phase
Fuel Autonomy at Full load	9 Hours
Day Tank capacity	12-hours utilization
Maximum Sound level	70dB(A)
Ambient temperature	up to 45 degrees C

The generator set shall also be provided with heavy-duty skid base fitted with anti-vibration mountings.

Testing and commissioning

The subcontractor shall include for fully commissioning the set and its control equipment, and for the purpose of the required tests, shall provide all necessary instruments, tools, fuel full tank and lubricating oil.

The tests and checks shall be carried out by the subcontractor in the presence of the Engineer or his representative, as applicable.

i) Check that the main frame is level in all directions, engine and generator shafts are in proper alignment and the vibration absorbing devices are properly installed and located.

ii) Check water and sump oil levels and that the water jacket is in working order.

iii) Check the battery electrolyte levels and the specified gravity.

iv) Ensure that sufficient oil is in the fuel tank for a two-hour test run.

v) Examine the containers in which the fuel and lubricating oils were delivered and check that the type of oils are recommended for the unit.

vi) Check that the engine block water drain points are free from sludge and other blockages.

vii) Check engine bolts, main drive coupling, valve clearances, fuel pumps settings, governor settings, pipe line connections, water hose, exhaust couplings, flexible pipework etc. and the ball valve and overflow work.

viii) Check all outgoing connections on the generator and at the control panel. All lugs for principal connections shall have clean and bright contact surfaces. A suitable abrasive material shall be used where necessary.

ix) Check access panels and doors for proper opening and closing and for the functioning of any interlocks fitted.

x) With the set isolated from the main supply and the selector switch in the `Manual' position, start the engine by means of the `start' push button and allow it to run up to normal speed. Check that during the time the engine starter motor is in operation, the mains battery charger is automatically switched off to avoid its being overloaded by the reduction in voltage across the battery.

xi) Check instruments and gauges for normal operation and response and that the generator voltage is being maintained within the prescribed limits, making due allowance for no-load conditions. Compare the reading of the frequency meter with that of the engine tachometer.

xii) Stop engine by turning selector switch to "off" position and verify that generator contactor opens at between 85% - 95% of normal voltage. Recheck water and oil levels.

xiii) Turn selector switch to `Auto' position. Disconnect the sending circuit supply and check that the set starts, the mains contactor opens, and the generator contactor closes in correct order. Reconnect the sensing circuit to verify that the engine stops on restoration of the mains supply and that the contactors operate correctly. Check voltage sensing time delays on each phase in turn and also that the push buttons for mains failure simulation and engine stopping operate correctly.

N.B. ***Running of the engine for any length of time under no-load conditions is undesirable and tests calling for such operation should be carried out in as short a time as is consistent with thoroughness.***

xiv) Operate the necessary isolators and switches to put the set on standby for essential services network with the selector switch in the `Auto" position, and using the mains failure simulation push, verify that the set operates correctly with the appropriate time delay for taking up load and that the carrying of the load and its distribution over the three phases are satisfactory.

xv) Run the set at various loads for periods totalling at least 30 minutes. Check the voltage and current in each phase in turn and that the voltage and frequency are being maintained within the required limits with large alterations of load.

xvi) Check the operation of the turbocharger units and the colour of the exhaust gas at various loads.

xviii) Check that the various engine safeguards operate satisfactorily.

xviii) Check the vibration absorbing devices for proper operation and that the performance of all flexible connections, both mechanical and electrical, is satisfactory.

xix) Recheck the lubricating oil and water level, replenish the fuel oil tank and leave the set in normal operating order.

xxi) An initial supply of all lubricating oils and greases shall be provided by the subcontractor.

27.9 **CONTROL** CUBICLE

General

The control panel shall be totally enclosed type plant wall mounted in the generator room, fitted with removable covers giving access to the control gear, terminal and connection blocks and undrilled gland plates for cables entry and shall be finished in stove enameled grey hammer paint.

Function

The control cubicles shall house the start/stop buttons and protection systems and shall be complete with all the necessary relays and circuitry to the following requirements.

Control and Logic section

Facilities shall be available with suitable fuse protection for the following functions:

a) Manual start

b) Manual Stop

c) Stall lockout, i.e. a lockout to prevent recranking of an engine upon fuel failure, or stall conditions.

Protection circuits

Suitably fused protection circuits, for oil, water, speed and one spare, shall be allowed for. The first stage protection shall be by means of fail-safe circuits, while the second stage shall be energised on fault circuits. All circuits except overspeed shall be commissioned after a delay following engine startup.

The circuits for:-

(d) Lubricating oil pressure.

(e) Water temperature.

(f) Spare.

shall be either alarm, or alarm and shutdown. The latter shall be achieved by means of a link within the control panel.

The circuit for engine overspeed shall give simultaneous alarm and shut down.

When the engine has a fault condition, the protection circuits shall still accept further faults. Once a shutdown signal has been given, the protection circuits shall be locked on as:

(i) not to give further fault indication as engine stops.

(ii) to give indication of fault condition even when the engine has stopped.

The fault circuit shall be reset by pushing the "reset" button.

One audible alarm mute shall be provided for each fault channel. This shall mute the alarm for the fault causing the alarm, but shall leave the Klaxon prepared for further faults.

Switching section

A suitably fused switching section for engine functions as per list below shall be provided:

- Fuel rack solenoid (start or stop)
- Starter motor solenoid via a repeater

Indication

Indicator lamps as per list below shall be provided:

(a) Engine running and protection circuits commissioned - green.

(b) Fault parameters - all red.

The indication circuits shall have a lamp test pushbutton by means of which the lamp filaments can be tested.

Control switching

A rotary switch with off/on positions, to switch the control circuit supplies. In the `ON' position the engine shall be started by depressing a push button and stopped by depressing a `Stop' push button.

The indicators, switches and push buttons shall be mounted on the front face of the chassis unit

Alarm

The subcontractor shall supply and install a Klaxon which is loud enough to be heard even when the engine is running. The supply for this Klaxon shall be obtained from the control cubicle through suitably rated fuses.

Mains detection

A mains detection unit which can register a mains voltage failure under the following conditions shall be provided:

(e) Failure of any one or more phases

(f) Incorrect phase sequence

(g) Low volts on any individual or all phases - i.e. below 85% of normal voltage.

(h) Excessive frequency change i.e. +/- 3Hz

The failure condition shall be used to produce a start signal for the standby engine after a delay. The delay shall be adjustable and shall ensure the failure is not a transient condition.

Mains detection units shall receive their sensing supplied from the busbars feeding the load.

Instrumentation and controls

The following equipment shall be provided by the Generator supplier:

(a) Moulded case air circuit breaker, triple pole and neutral, with magnetic release to provide alternator short circuit protection, trip free handle and shunt trip.

(b) One bolted neutral link.

(c) Alternator voltage trimmer regulator.

(d) 3No., one per phase, flush mounting ammeters.

(e) 1 No., flush mounting voltmeter.

(f) 1 No., voltmeter rotary selector switch.

(g) One set of control circuit instruments and the accompanying fuses.

(h) All internal wiring, terminals, cable lugs, legends and one main earthing bar.

(i) 1 No., frequency meter, vibrating leaf type.

(j) 1 No., governor motor raise and lower switch.

(k) Cable boxes and glands to suit.

(l) 1 No. Kilowatt-hour meter.

Terminations

All internal wiring terminations shall be numbered and marked with ferrules.

Earthing

The subcontractor shall be responsible for ensuring that the earthing of the generator neutral is carried out efficiently and that the resistance of the generator neutral from the earth does not exceed one ohm.

Earth pit provision has been given under builder's works for the installation of an earth mat but the subcontractor shall be responsible for the supply and installation of an earth rod 2m long by 15mm diameter, extensible type as "copperweld" 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 subcontractor shall ensure that the earthing system of the generator is adequately bonded to the permanent earth system of the `normal' supply.

All earthing shall be carried out in accordance with the appropriate section of the I.E.E. or KEBS Regulations.

Trickle charger

The trickle charger shall have rating and service parameters such as to keep the engine start batteries fully charged and ready for service whenever required. When the engine is running the batteries shall be charged form integral dynamo.

Hours counter

The subcontractor shall allow for the installation of an hours counter on the control panel for the generator.

Automatic Changeover Contactor unit

(a) A contactor unit shall be provided in the main switch-room. On failure of the normal electricity supply the change-over panel will automatically initiate the starting of and effect the transfer of load to the standby generator. The unit shall contain power contactors and ancillary apparatus as specified.

A control cable shall be laid between the changeover panel and the generator control panel in the new generator room.

(b) Failure of normal supply shall mean complete loss of voltage or the falling below 85% of the normal voltage between any two phases or phase and neutral.

(c) The power circuit shall consist of two contactors feeding a common busbar to which the load will be directly connected. One contactor shall control the normal supply, the other standby supply; they shall be electrically and mechanically interlocked so that they cannot both be closed at the same time.

(d) On failure of the normal supply, the unit shall operate in the following manner:

(i) After a delay, adjustable from 0 to 5 seconds (to avoid operation by a transient dip in voltage) a signal shall be given to start the standby generating set.

(ii) On receipt of a signal from the standby generating set that it is ready to take the load and providing that the failure of the normal supply still persists, the normal supply contactor shall close. If the normal supply still persists, the normal supply contactor shall close. If the normal supply has been restored before the changeover has taken place, the contactors shall not operate and the starting delay contacts shall open to initiate the shutting down of the standby generating set.

(e) When the standby supply is in operation and the normal supply is restored and remains within 10% of rated voltage on all phases for a preset time (adjustable to 30 seconds) the standby contactor shall open and the contacts shall then open to shut down the standby generating set.

Provision should be so made that automatic return to normal supply can be prevented if required.

Once a start signal has been sent to the standby generating set, the engine starting sequence shall be allowed to continue until the set is ready to take the load before a stopping signal is sent.

By addition of external connections, the following facilities shall be available:

- Remote starting of the standby generating set and transfer of the load to it.
- Restoration of the normal supply on failure of the standby generating set.

Each switch shall be labelled with its duty and each position shall be marked. The following switches shall be fitted:

- Contactor control switch, with make before break contacts and `Hand" and `Auto' positions. In the `Hand' position the unit shall be controlled the "Contactor Hand Control Switch". In the "Auto" position the unit shall operate automatically irrespective of the position of the "Contactor Hand Control Switch".
- A contactor Hand Control Switch: with `Standby' and `Normal' position.
- An Auto Return Switch; having `ON' and `OFF' positions. In the `ON' position the return to normal supply shall be automatic when the normal supply is restored.
- Contactor by-pass switches: shall be provided to enable the essential load circuits to be served direct from the normal supply to enable the generator and/or the control equipment to be serviced. The by-pass switches shall be provided with a suitable and conspicuous label warning against leaving the generator in the disconnected position.

Indicating lamps shall be provided. They shall be appropriately labelled, easily visible and shall give the following information:

- Normal supply available.
- Standby supply available.
- Normal supply in use.
- Standby supply in use.

A push button labelled ‘Test’ shall be provided to enable a failure of normal supply to be simulated. If the button is pressed and released the equipment shall complete the starting sequence and when the set is ready to take the load it shall be shut down. If the button is held depressed the equipment shall change over to the standby supply when the set is ready to take load.

The control circuit supply shall be either 12 volts or 24 volts D.C. depending upon the starting battery and charger.

No current shall be drawn from the control supply when the unit is accepting the normal power supply.

SCHEDULE NO. 1.2

SUMMARY OF INFORMATION FOR TENDERER

The Tenderer is advised to read the relevant section of the Specifications for full details of the items summarised below:

Item		**Requirements**	**Ref. clause**
1.	Operating conditions		
	Site	Proposed Uvuvi House	1.2
	Altitude	1,795 m, above sea level	
	Temperature range	19.50 ºC	
	Relative humidity	........% - 90%	
	Range to operate in	Unheated building	
	Dust conditions	Dust laden atmosphere	
2.	Duty	Mains failure unit and standby power	3.7
		10 starts per hour	2.14
3.	Performance	500kVA 415 volts, 3 phase 50 Hz	3.8
4.	Set arrangements		
	Weather proof roof and side panels	not required	
5.	Remote governor control	not required	2.8
6.	Aspiration	Natural or turbo-charged	3.5
7.	Manual start	required	
8.	Sump heater	not required	
9.	Silencer:	details of additional pipe work and fittings if required	2.11 (a)
10.	Daily service tank:	.... capacity if other than 24 hours	
		.... hours/24 hours	2.11 (b)
		Transfer pump/ hand pump	... 2.11 (d)
11.	Auxiliary fuel tank:		
	Siting	required	
	Capacity	…………….	
12.	Fuel Jettisons cock for		
	(a) Daily service tank		
	(b) Auxiliary fuel tank	required	
13.	Engine instruments:		
	details if not as standard		2.10
14.	Cooling system	required	2.12

Schedule No. 1.2 (contd.)

	Item	Requirements	Ref. clause
15	Electrical control panel:		
	mains switch	circuit breaker	4.9
	Provision for parallel running	required	
	Kilowatt - hour meter	required	4.9
16.	Lockout remote indication circuit	required	4.2
17.	Fire service terminals	required	
18.	Earth fields	required	
19.	Building drawing	required	
20.	Maintenance period	12 months	

SCHEDULE NO. 1.3

27.9.1 TECHNICAL DETAILS OF THE SET OFFERED BY TENDERER

Item		**Details**
1.	Diesel Engine	
	Make	____________________
	Type	____________________
	Bore	__________ mm __________
	Stroke	__________ mm __________
	Net continuous rating (B.S. 649)	
	(a) at sea level	__________ kVA __________
	(b) site	__________ kVA __________
	Speed	__________ rev/min __________
	Year this type put into service	____________________
	Total number sold	
	(a) Worldwide	____________________
	(b) in East Africa	____________________
	(c) in Kenya	____________________
	Supercharger:	
	Make	____________________
	Type	____________________
	Number in use	____________________
	Thermometers:	
	Make	____________________
	Type	____________________
	Pyrometers:	
	Make	____________________
	Type	____________________

SCHEDULE No. 1.3 (Cont'd)

Item	**Details**
Air cooling: Quantity of air required	__________ cu.m/sec __________
Details of ducting	____________________
Water cooling: details of water cooling circuits`	____________________
Radiator: Make	____________________
Type	____________________

Length	__________ mm __________
Bread	__________ mm __________
Height	__________ mm __________
Aspiration: Method	____________________
Quantity of air required	__________ m^3/sec __________
Noise Level	__________ dBA at 10 m __________

SCHEDULE No. 1.3 (Cont'd)

ITEM		DETAILS		
2.	Auxiliaries	Make	Type	Other Relevant Details
	Lubricating oil circuits			
	Filters			
	Coolers			
	Primary pumps			
	Tachometer and drive			
	Governor			
	Cold start devices			
	Running hours meter			
	Safety devices:			
	High temperature			
	Low pressure (lubricating oil)			
	Cooling water flow trip			
	Over speed trip			
	Speed sensing devices			
	Lubricating oil thermometers:			
	Number			
	position (s)			
	Water thermometer:			
	Starting Battery			
	Immersion heater			

SCHEDULE No. 1.3 (Cont'd)

3.	**27.9.2 Lubrication**

	Recommended oil (s)	Grade	Quantity (litres)
	Sump		
	Elsewhere (state where)		

27.9.3

4. **27.9.4 Alternator and Exciter**

Make and Type ____________________

Bearings * ball/roller/plain

____

Insulation Class (BC.2757) ____________________

* Delete as necessary

SCHEDULE No. 1.3 (Cont'd)

	ITEM	DETAILS Make Type Rating
	27.9.5	
5.	**27.9.6 Electrical Control Panel**	________________________________
		________________________________
	Main circuits breaker	__________Amps________________
	Bypass switches	________________________________
		_______Amps________________
	Changeover contactor	__________Amps________________
	Automatic voltage regulator	________________________________
	Control switches	________________________________
	Control fuse - No..........*	___________Amps______________
	Relays	___________Amps______________
	Indicator lamps - No..........*	________Volts____Watts____________
	Ammeter switch	________________________________
	Voltmeter switch	________________________________
	KWh meter	________________________________
	Frequency meter	________________________________
	Ammeters - No..........*	_____________Amps_____________
	Voltmeters - No...........*	_____________Volts_____________
	Power factor meter	________________________________
	Other equipment - give Details	________________________________
		________________________________
		________________________________

SCHEDULE No. 1.3 (Cont'd)

6. **Performance data**

Fuel Consumption	**27.9.6.1 Rated Output -** **%**	**27.9.7 Consumption** **kg/kWh**
	110	
	100	
	75	
	50	
Maximum output	**Ambient Temp. (^{0}C)**	**Out-put (kVA)**
	40	
	30	
	20	
	10	

SCHEDULE No. 1.3 (Cont'd)

6. Performance data

	Item	27.9.7.1.1.1 **Details**
	Critical speed - rev/min.	____________________
	Cyclic irregularity	__________%__________
	Voltage regulation	__________%__________
	Frequency regulation	
	Time to accept 75% full load from 5^0C	__________Seconds__________
	Time to accept 100% full load from 5^0C	__________Seconds__________
7.	27.9.7.1.1.1.1 **Physical Details**	
	Daily service tank for 24 hour operation - capacity	__________Litres__________
	Size	.... mm long .... mm wide .... mm high
	Total weight of set	____________________
	Overall dimension of set	____________________
	Weight of Heaviest component	__________kg__________
	Weather proofing	____________________

SCHEDULE No. 1.3 (Cont'd)

8.	**27.9.8 Operational Details**	
	Description of Operation	
	Details of drawings, literature etc, included with the tender	
9.	**27.9.9 Delivery Details**	
	Time in weeks from acceptance of tender to delivery of all equipment to site	______________________________
	Time in weeks from acceptance of tender to commissioning tests	_____________Weeks_____________
10.	Noise level in engine room	__________decibels______________

SCHEDULE NO. 1.4

DEVIATION FROM THE SPECIFICATION

The tenderer shall give below details of any equipment which does not meet the specification, or any other deviations, omissions, additions or alternatives in respect of the set which he is offering.

If none, write none.

SCHEDULE NO. 1.5

27.9.10 LIST OF TOOLS TO BE SUPPLIED WITH THE SET

The following tools shall be handed over to the Engineer before completion of the contract:-

Item	Details	Price (KSh.)
1.	Metal tool box with lock and 2 keys	
2.	Set of 8 No. Chrome Vanadium ring spanners in size to suit the set	
3.	Ditto open ended spanners	
4.	Set of 3 screwdrivers, 75mm 200 mm and 300 mm plus 200 mm Philips type.	
5.	One set of feeler gauges	
6.	One greases gun to suit greasing points	
7.	One oil can, trigger type	
8.	One Hydrometer and plastic filler bottle with pouring spout	
	Total carried forward to Summary on Page 3	

The tenderer shall give below details of any special tools which he recommends should be purchased as an optional extra.

	Details	Price (KSh.)
	Total carried forward to Summary on Page 3	

Signed (as in tender) ....……………………………..

Date ....…………………

SCHEDULE NO. 1.6

LIST OF SPARE PARTS AND LUBRICANTS TO BE SUPPLIED WITH THE SET

The following items shall be handed over to the Engineer before completion of the Contract. They shall not be used by the Contractor to carry out his normal maintenance.

Item	Details	Price (KSh.)
1.	Oil filters 12 No./3 No	
2.	Air filters 12 No.3 No.	
3.	One injector to suit the set	
4.	One set of fan belts comprising .... belts	
5.	One set of indicator lenses comprising.........bulbs	
6.	One set of indicator lenses comprising lenses	
7.	One overall kit	
8.	One set of fuses	
9.	One 200 litre drum of sump oil of grade.........	
10.	One 2 kilogram tin of grease of grade............	
11.	One 10 litre plastic container of distilled water	
	Total carried forward to Summary on Page 3	

The tenderer shall give below details of any other spares which he recommends should be purchased as an optional extra.

	Details	**27.9.11 Price (KSh.)**
	Total carried forward to Summary on Page 3	

Signed (as in tender) ....……………………………..

Date ....…………………

SCHEDULE NO. 1.7

FUEL STORAGE TANKS

The tenderer shall insert his prices for the following items.

ITEM	DETAILS	PRICE (KSh.)
1.	Generator set fuelling enough for 9 hours running	
2.	Daily service tank 1800 mm x 900 mm x 1500 mm full of fuel 2430 litres.	
3.	Auxiliary Fuel tank 2400mm x 1000mm x 1500mm for future fuel storage and located in fuel storage room.	
4.	Fuel transfer pumps-one located in generator room and another located in fuel storage room.	
5.	50mm diameter pipe 40m long complete with plugs for fuel transfer from both fuel storage room and generator room.	
	Total carried forward to Summary on Page 3	

Signed (as in tender) ....……………………………

Date: ....

SCHEDULE NO. 1.8

EARTHING

The tenderer shall insert his prices for the following items. The configuration of the earth field shall be as directed by the Engineer on site.

Item	Details	Price (**KSh.**)
1	Supply and install 1000mm x 1000mm copper tape mesh 25mm x 3mm in 1200mm x 1200mm x 800mm earth pit and allow for the filling of pit with red soil and charcoal.	
	Total carried forward to Summary on Page 3	

Price per additional earth mat................KSh. ....

Prices per additional metre tape............... KSh..

Signed (as in tender) ....

Date: ....

28 SECTION 28- TECHNICAL SPECIFICATIONS (PLUMBING & DRAINAGE)

28.1 TECHNICAL SPECIFICATIONS (PLUMBING & DRAINAGE)

28.1.1 GENERAL SPECIFICATION - GENERAL REQUIREMENTS

28.1.1.1 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.

28.1.1.2 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.

28.1.1.3 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.

28.1.1.4 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 constrains 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.

28.1.1.5 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

28.1.1.6 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.

28.1.1.7 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.

28.1.1.8 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.

28.1.1.9 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.

28.1.1.10 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 fitments arrangement, etc.;

(b) System schematic diagrams; and

(c) 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

28.1.1.11 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 of 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.

28.1.1.12 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.

28.1.2 INSTALLATION METHODOLOGY

28.1.2.1 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-syphon 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 20 and 25 32 40 and 50 65 and 80 125 and 150	2400 3000 3000 3600 4500 5400	1800 2400 2700 3000 3600 4500
UPVC	Up to 25 32 40 and 50 65 to 150	1500 1800 2000 2500	750 900 1000 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

<u>Sumps</u>

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 is 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.

28.1.2.2 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

28.1.2.3 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.

28.1.2.4 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.

28.1.2.5 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 hosereel 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

28.1.3 INSPECTION, TESTING AND COMMISSIONING

28.1.3.1 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.

28.1.3.2 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.

28.1.3.3 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.

28.1.3.4 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.

28.1.3.5 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.

28.1.3.6 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 a n d 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.

28.1.3.7 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)

28.2 TECHNICAL SPECIFICATIONS (FIREFIGHTING)

28.2.1 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.

28.2.2 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 Operation 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.

28.2.3 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.

28.2.4 PIPEWORK VALVES AND FITTINGS

Steel Tubes and Fittings for Exposed Pipework

All tubes and fittings up to and including 150 mm diameter shall, unless otherwise specified, be galvanised mild steel of at least medium grade to BS 1387 / ISO 65 Steel tubes and tubulars for screwing to BS 21 / ISO 7/1 pipe threads. All other fittings shall be to BS 1740.

All tubes and fittings above 150 mm diameter shall, unless otherwise specified, be ductile iron to BS EN 545 Class K12 cold bitumen coated externally and internally to BS 3416 Type II.

Where specified for operation in high pressure from 1600 kPa, all tubes shall be suitable for pressure from 1600 kPa shall be carbon steel of ERW 320 to BS 3601 - carbon steel pipes and tubes with specified room temperature properties for pressure purposes, and shall have dimensions to BS 3600 - Specification for dimensions and masses per unit length of welded and seamless steel pipes and tubes for pressure purposes. All fittings shall be butt-welding type carbon steel for pressure purposes to BS EN 10253-1. All tubes on or below 150 mm diameter for high pressure from 1600 kPa shall be galvanised mild steel pipe of heavy grade to BS 1387/ ISO 65.

Copper Pipework

Copper pipework, where specified, shall comprise seamless hard drawn copper tubes manufactured to BS EN 12449 Table Z and of appropriate gauge to suit the working pressure of the system.

Underground Pipework

Pipe laid underground shall conform to one of the following specifications: -

a) BS 1387 / ISO 65 - Steel tubes and tubular of heavy grade for screwing to BS 21 / ISO 7/1 pipe threads.
b) BS EN 545 - Ductile iron pipes and fittings, Class K12.

If not specified in the Particular Specification, ductile iron pipes and fittings shall be of Class K12 to BS EN 545.

Mechanical pipe couplings shall be used for joints in underground pipes. Suitable mechanical pipe coupling of approved type that can provide the required allowance for angular deflection and contraction and expansion shall be used.

Pipe Sizes

Where pipe sizes are stated in this General Specification, this is intended to be the nominal bore in the case of steel tubes and the nominal outside diameter in the case of copper tubes.

Joints in Steel Pipework

Joints in steel pipework shall be made in accordance with the following general requirements, using only the highest quality materials and skilled labour.

Mechanical pipe couplings shall be employed for steel pipes of diameter larger than 65mm up to 150 mm unless otherwise specified. The pipes and fittings shall have grooved or shouldered ended suitable for the mechanical pipe couplings. It shall be a positive watertight couple providing some allowance for angular pipe deflection, contraction and expansion. The coupling assembly shall be securely held together by bolts and nuts with a water sealing gasket so designed that the internal water pressure increases the water tightness of the seal. Pipe couplings shall be of malleable iron castings and galvanised, or ductile iron castings. Pipe grooves may be cut or rolled without the removal of any metal. The entire coupling installation shall be in accordance with the published selected manufacturer’s recommendations and designed to withstand two times of normal operating pressure. Where the pipes are laid underground, suitable mechanical pipe coupling of approved type that can provide the required allowance for angular deflection and contraction and expansion shall be used.

Flanged joints and flanged fittings shall be used for steel pipe of diameter larger than150 mm. For aboveground steel pipes with normal operating pressure higher than 1600 kPa, flanged joints and flanged fittings shall be used for pipes of diameter larger than 65mm. For pipes exposed in public accessible areas, flanged joints and flanged fittings shall be used for pipes of diameter larger than 65mm. If prior approval is obtained from the Engineer, mechanical pipe couplings may be used for steel pipes at such exposed locations up to 150 mm.

Steel pipes less than or equal to 65 mm shall be jointed with screwed fittings, screwed flanges, or screwed unions. Screwed joints shall have tapered threads to BS 21 / ISO7/1 and shall be made with approved jointing material. Where the process of cutting of threads removes galvanization, the Contractor shall apply an approved cold galvanising finish to restore the integrity of the pipe protective finish. Fittings shall be galvanized. Screwed fittings other than sockets shall be of galvanized malleable iron.

The pipes shall be fitted with screwed flanges for jointing valves and other equipment having flange connections.

Where flanged joints and flanged fittings are specified, the flanged joints and fittings shall be of factory applied flange joints for galvanized steel and ductile iron pipes.

Welded flanges are permitted for carbon steel pipes. Flanges shall be raised face to BS 4504. Flanges for steel pipe work shall be wrought iron or annealed steel, machined full face and galvanised, suitable for the working pressures to which they will be subjected. For flanged joint pipes, facilities and provisions shall be provided in the pipe system to absorb thermal movement, vibration and water hammering.

Jointing of steel pipes by welding is only permitted where specified or with the expressed permission of the Engineer. Only ungalvanised pipes of 50 mm bore or larger may be joined by welding.

Dismantling Facilities

All pipe runs shall be arranged for ease of dismantling and re-erection. Disconnecting flanges, mechanical pipe coupling or screwed unions, as applicable, shall be supplied and installed at suitable locations and at valves and equipment. Unions shall be of ground-in spherical seated type. Unions for steel pipes shall be of forged steel heavy duty pattern and unions for copper pipes shall be of gunmetal. Unions shall have hexagon bodies.

Pipework Installation

Pipework installation shall be carried out in accordance with the following general requirements.

Pitcher tees, bends, twin elbows, etc. shall be of the same size as the pipework connected to them. Bushings shall not be used. Square tees shall only be used where short sweep fittings would cause air to be trapped.

Bends shall be of long radius wherever possible. Short radius bends and elbows may be used for pipe sized up to 65 mm diameter or for pipes installed inside false ceiling or concealed ceiling void. Use of short radius bends and elbows of larger size in areas other than false ceiling and concealed ceiling void are subject to the Engineer’s approval on consideration of space available for installation. Square elbow is not permitted.

Tubes shall be reamed after cutting and shall be free from burrs, rust, scale, and other defects and shall be thoroughly cleaned and treated for corrosion protection before and after erection.
Open ends left during the progress of the work shall be properly blanked off with approved metal or wood plugs or blank caps or counter flanges.

Joints shall not be made in the thickness of any wall, floor or ceiling.

Where pipes pass through ordinary walls or floors, the Contractor shall, unless otherwise specified,

a) Cast or build in galvanised mild steel pipe sleeves with 2 to 25 mm clearance to allow for expansion and movement of pipe.

b) Finish sleeves flush with the finished face of walls unless concealed inside false ceiling.
c) Project sleeves at least 100 mm above finished floor level.
d) Fill the annular space between pipe and sleeve for the full length with approved fireproof materials and non-flammable type sealant.
e) Provide loose chromium plated steel cover plates where 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.

When pipes pass through fire rated walls or floors, the Contractor shall, unless otherwise specified,

a) Cast or build in fire rated pipe sleeve with 2 to 25 mm clearance.
b) Finish sleeves flush with the finished face of walls unless concealed inside false ceiling.
c) Project sleeves at least 100 mm above finish floor level.
d) Fill the annular space between pipe and sleeve for the full length with approved fireproof materials of fire rated period not less than that of the wall and the floor through which the pipe penetrates.
e) Provide loose chromium plated steel cover plates, where 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.

Where pipes pass through building roofs, the Contractor shall, unless otherwise specified,

a) Cast or build in fire rated pipe sleeves with 2 to 12 mm clearance projecting 150 mm above roof finish.
b) Caulk space and void at both ends for the full length with approved fire rated sealant, e.g. mastic sealant.
c) Cover top of sleeves with watertight stainless steel collars or similar cover as per roofing specification.
d) Pipework shall not be embedded in the concrete structure or “grouted in” or otherwise installed in such a way as to make subsequent alterations difficult at a later date.

Pipework Supports

All pipework shall be properly supported with substantial hangers, anchors, brackets, saddles, guide, etc. to BS 3974 with adequate provision for expansion and contraction and for corrosion protection.

Pipework supports shall be arranged as close as possible to joints and changes of direction and each support shall take its share of the load. The spacing of the supports shall not exceed the centres given in the following table: -

Spacing of pipework support for mild steel pipes

Nominal Pipe Size (mm)	Spacing of Vertical Run (m)	Spacing of Horizontal Run (m)
15 20 and25 32 40&50 63 & 80 100 125	2.5 3 3 3.5 4.5 4.5 5	2 2.5 3 3 3.5 4 4.5
150 200	5 7.5	5 7.5

Vertical rising pipework shall be supported at the base or as indicated to carry the total weight of the riser. Branches from risers shall not be used as a means of support for the riser.
Where pipework up to 50 mm is fixed to solid structure, brackets may be of the screw-on or long shank built-in type. Fixings to timber or to light-weight structure shall be of screw-on pattern. Brackets and supports for mild steel tube shall be galvanised steel or malleable iron and galvanised. Brackets for copper tubes shall be brass or gunmetal.

The pipe clip shall be detachable without disturbing the fixing.

Brackets screwed to walls shall be securely fixed by expanding plugs of adequate size or other purpose-designed fixing devices of non-combustible material. Wood plug is not permitted.

Pipework of 65 mm size and larger subjected to expansion and contraction shall be suspended on swivel hangers or hangers having equivalent functions and performance to cater for expansion and contraction. The pipe hangers and supports shall be galvanised steel or approved materials for supporting the load of the pipes.

Unless otherwise specified, hangers for horizontal pipework at high level shall be supported from angle or channel galvanised irons supplied and installed by the Contractor and suitable for building-in or otherwise secured to the structure. Tee hangers supported on two legs instead of angle hangers shall be used. Adjustable galvanised steel hangers shall be used. Pipe rings shall be of malleable iron or fabricated steel and galvanised, made in halves and secured by bolts or machine screws.

Alternatively, galvanised malleable iron hinged pipe rings may be used. Calliper type hook is not permitted.

Where integral pipe hangers are required for housing the fire service pipes and pipes for other services, the integral pipe hangers shall be of a type approved by the Engineer and supplied by one manufacturer with all the accessories. Structural calculation shall be submitted for approval. The laying of pipes on the integral pipe hangers shall be fully coordinated with other parties before installation.

Expansion Joints

Expansion joints shall be supplied and installed for all pipework passing through any building expansion joint and where necessary as specified. They shall be of axial pattern bellow type and shall have screwed or flanged ends as appropriate to facilitate replacement. They shall incorporate internal liners if required and shall be manufactured from 18/8 stainless steel or better material to the approval of the Engineer and shall be designed to withstand at least two times of the system pressure.

External protective sleeves shall be fitted. Each joint shall be securely held by guides on both sides. All expansion joints shall have a working life of not less than twenty years. Unless otherwise approved by the Engineer, flexible connector of single sphere or double sphere type made from rubber, EPDM or similar materials shall not be used as expansion joint.

Protection of Underground Pipework

Underground pipes shall be protected against corrosion and against mechanical damage. Pipework shall be cleaned after jointing and treated with two coats of good quality bituminous paint and wrapped with corrosion and water resistance self-amalgamating tapes and mastics having 55% overlapping before laying, and bedded in washed sand free of all salts or sieved soil before the trench is back filled. All joints and supports shall be appropriately wrapped. Pipework shall be hydraulically tested before the trench is back filled. Underground pipework shall be provided with suitable and approved couplings which provide allowance for angular deflection, contraction and expansion. Anchor blocks shall be made at appropriate locations to the approval of the Engineer for thrust bearing. Anchor block, trench, backfilling of trench and sand bed are included under the builder’s works.

Pressure Gauges

Pressure gauges shall conform to BS EN 837-1 and shall have brass cases with dials not less than 100 mm diameter. They shall be calibrated in kPa to a maximum of not less than 1-1/3 times and not more than 2 times the operating pressure. Divisions of scale shall not exceed 20 kPa for a maximum scale value of 1000 kPa, 50 kPa for a maximum scale value of 1600 kPa and 100 kPa for maximum values in excess of 1600 kPa. An isolating valve/cock shall be supplied and installed for each pressure gauge.

Electric Alarm Pressure Switches

Electric alarm pressure switches shall have contact sets of silver or approved alloy rated to suit the working voltage and current of the circuits controlled and shall have independent adjustments for the cut-in and cut-out points and for the operating differential. Electric alarm pressure switches shall be of LPCB approved type or approved by similar widely recognised independent regulatory body. The maximum working pressures of all pressure switches shall be at least 300 kPa above the maximum pressure of the water inside the pipework at the points of installation of the switches. Pressure switch shall be supplied and installed with necessary ancillary facilities and isolating valves for maintenance and hydrostatic pressure test purpose complying with NFPA 13. All isolating valves where provided shall be complete with padlocks.

Water Flow Alarm Switches

Water flow alarm switches shall be of magnetic type having the water side completely separated from the electrical side. Contacts shall be suitable for the working voltage and current of the circuits controlled, and shall be of silver or approved alloy. Water flow alarm switches shall be of a type approved by LPCB or approved by similar widely recognised independent regulatory body. They shall be capable of standing a test pressure of minimum 1500 kPa for six (6) hours without showing any sign of leakage.

Pipeline Strainers

Water strainers shall be installed in all pipelines upstream of all water pumps. For pipelines of nominal bores between 15 mm and 50 mm diameter inclusive, strainers shall be screwed gunmetal or bronze body “Y” type with brass or stainless steel screen. For pipelines of nominal bores of 65 mm diameter or above, strainers shall be flanged with “Y” type cast iron body, brass or stainless steel screen. Strainer screen shall have straining holes of 2 mm diameter.

Ball Float Valves

Ball float valves up to 50 mm shall be of cast gunmetal or bronze body. Ball float valves over 50 mm shall be of cast iron body. They shall be with nickel alloy and stainless-steel working parts. They shall be of a slow closing type and of PN10 pressure rating.

Vortex Inhibitors

Vortex inhibitors shall be LPCB approved type or approved by similar widely recognized independent regulatory body for PN16 and flanged. They shall be used for operation under positive head conditions.

Orifice Plates

Orifice plates for system balancing, pump churning water circuits, where applicable, shall be supplied and installed as required for proper commissioning of the systems. Wherever necessary to suit the pump or system performance or in respect of system balance, an orifice plates shall be supplied and installed even if they are not indicated on Drawings.

Orifice plates shall be generally constructed and installed according to LPC Rules for Sprinkler Installations. They shall be manufactured by factories producing LPCB approved equipment and UL listed sprinkler equipment or equipment approved by similar widely recognised independent regulatory body, and acceptable to the local government regulations.

Orifice plate that has been factory calibrated and produced by a factory with a quality control system in place can also be used if they are acceptable by the local government. The flow characteristic data of the orifice plate shall be included in the operation and maintenance manual.

Cleaning and Draining

All piping shall be cleaned and shall be free of scale, dirt, etc., before installation. During the course of the installation, all open ends of pipes shall be plugged or capped to prevent ingress of dirt. After installation and sealing of joints, all piping shall be thoroughly flushed with clean water under pressure, to the satisfaction of the Engineer.

Water used for this purpose shall be discharged as directed. Any temporary pipework and equipment necessary for the above cleaning work shall be provided by the Contractor.

28.2.5 HYDRANT AND HOSE REEL SYSTEM

General Requirements

The general requirements of the hydrant and hose reel system and the individual equipment installations shall comply with KS Code (2009) and local administrative authorities and Circular Letters.

The fire service inlets, hydrant outlet valves and hose reels shall comply with KS Code (2009).

Fire Service Inlets and Hydrant Outlets

Fire service inlets shall be of twin type comprising screw-down globe type stop valve with male screwed outlet of suitable bore and two 65 mm horizontal male instantaneous inlet connections complete with integral spring loaded resilientseated non-return valves.

Hydrant outlets shall be single or double type comprising screw-down globe type stop valve for each outlet branch and with male screwed inlet of suitable bore and 65 mm female instantaneous outlets. Outlet branches shall incline at 70° from the centre line of the hand wheel, and at 90° to each other where applicable. The coupling control shall be located at the side of each outlet branch. A bronze blanking cap held captive by a suitable chain shall be fitted to each female outlet.

The fire service inlets and hydrant outlets shall be of all gunmetal construction except for the handwheel which shall be of cast iron or hard aluminium alloy.

The inlet and outlets fittings shall be supplied and manufactured to the quality of material, construction, and dimensions as detailed in the following British Standard Specification: -

a) Hydrant assembly to BS 5041 Part 1.
b) Major valve components of gunmetal to BS EN 1982.
c) Globe & check valve of service rating 1000 kPa to BS 5154.
d) Male and female instantaneous terminals of 65 mm diameter to BS 336.
e) All fittings shall be tested to at least 2000 kPa.

Venting and Draining

All hydrant risers shall be supplied and installed with automatic air vents of 25 mm size at the highest points and drain valves at the lowest points of the systems as specified in Clause 6.4

Pressure Reducing Hydrant Outlets

Pressure reducing hydrant outlet shall be supplied and installed at outlet locations where the static and pump pressure exceeds 700 kPa.

The pressure reducing hydrant outlet shall be in the form of a parity valve incorporated in the hydrant outlet and valve assembly and connected to a drain pipe not less than 40 mm diameter. Alternatively, where specified, the pressure reducing hydrant outlet can be in the form of self-contained type without the use of the parity valve and drain pipe. It shall be capable to reduce the running pressure and satisfy the flow test requirements. The pressure reducing mechanism of the valve shall be located at downstream of the valve seat. Pressure reduction shall be achieved by means of hydraulic pressure balancing with metal diaphragm. An 100% effectiveness pressure reducing performance shall be maintained at all times of operation.

Hose Reels

Hose reels shall be of fixed or swing-out type to suit the site installation conditions of the site. The construction, testing, performance, working pressure, etc. shall be to KS Code (2009). The length of hose shall be 30 m and bore 19 mm.

Drums shall be constructed of diecast light alloy, hydraulically balanced, free from denting and twisting, and finished in red enamel. The hub and shaft shall be of brass, fitted with a device to prevent overrun of the hose, having a glandless centre seal.

The entire assembly shall be drip free. Hoses shall be of reinforced rubber or P.V.C. tubing complying with KS Code (2009) and shall be fitted with a copper alloy nozzle having slow closure type lever-operated cock.

A hose guide complete with nylon or similar runners shall be supplied and installed adjacent to fixed type hose reels to enable the hose to be run out in any direction as required.

For the wall fixed pattern, wall-mounting brackets of substantial construction capable of supporting the entire weight of the hose reel and tubing under all operating conditions are required.

For the swing-out pattern, the support brackets and the swing-out arm shall be so designed as to enable the whole hose reel assembly be swung through 180^{o} in a horizontal plan.
Each hose reel nozzle shall be housed inside a glass fronted metal box. The box shall be fabricated from sheet metal not less than 0.8 mm thick with a hinged door with front break glass and padlocking facility. The metal box shall be painted and finished to the satisfaction of the Engineer. The break glass shall be of fragile type not more than 1.5 mm thick. The break glass shall be easily replaced. Common key shall be used for the padlocks. Five common keys shall be provided. A metal or plastic striker

Cabinets

Cabinets for the housing of fire service inlets, hydrant outlets and hose reels will be provided by the Building Contractor unless otherwise specified. The Contractor shall furnish all necessary information to enable these cabinets to be designed and constructed including proposed dimensions for the cabinets and the dimensions, weights, etc. of the equipment supplied by him. All information supplied shall be based on BS 5041 Part 4.

Where hose reels are located in cabinets or recesses to which doors are fitted, the doors shall bear the words “FIRE HOSE REEL ( )” in both English and Swahili characters prominently and easily identifiable from all lines of sight in the surrounding. In the case of doors which can only be opened by pushing in first, they shall also be annotated “PUSH TO OPEN ( )” in both English and Swahili. Hose reel cabinets fitted with doors shall not be locked and shall be easily identified and opened at time of emergency. All doors and markings will be provided by the Building Contractor unless otherwise specified.

External Hydrant System

External hydrants shall be of pedestal type manufactured of cast iron. The construction of the street hydrants shall comply with the requirements of KS Code (2009)

The hydrant, when tested in accordance with the provision of BS 1042 with one 65 mm outlet working, shall be capable of delivering not less than 2000 litres per minute (33.3 l/sec.) with a minimum running pressure of 170kPa at the outlet. The minimum output and pressure as stated above shall be made available from two 65 mm outlets of the system delivering at the same time, i.e. a total output of not less than 4000 litres per minutes (66.7 l/sec.) at 170 kPa. Where the minimum standards are not possible from direct town mains, the water supply shall be augmented by water tank and booster pumps. The Contractor shall submit to the Engineer for approval soonest after the test proposal for providing booster pumps and tanks for the street hydrant system if the water supply pressure and flow from town mains are not adequate to meet with the requirements of KS Code (2009)

Controls

The control system, where applicable, shall comply with Section 7.8, SANS 10400T and Circular Letters. All associated electrical wiring and installation shall comply with Section 7.9

28.2.6 AUTOMATIC SPRINKLER SYSTEM

Types of Systems

Types of sprinkler systems are as defined in the LPC Rules for Sprinkler Installations.

Classification of Fire Hazard

The LPC Rules for Sprinkler Installations has defined various classes of fire hazard according to the occupancy of the building to be protected.

Grading of Sprinkler Systems

Sprinkler systems are graded according to the number and type of water supplies available. Reference shall be made to the LPC Rules for Sprinkler Installations.

Sprinklers

Sprinkler for general application shall be of LPCB approved conventional type or approved by similar widely recognized independent regulatory body. Spray sprinkler shall be used where specified and approved. The sprinkler shall not be altered in any respect nor have any type of ornamentation or coating applied after leaving the production factory. Unless otherwise specified, sprinkler shall be quick response type approved by LPCB or approved by similar widely recognized independent regulatory body. For sprinkler system designed to high hazard group, the sprinkler shall in addition be designed to provide appropriate water droplet sizes for the type of hazard and goods they protected.

Sprinkler shall be constructed with the appropriate characteristics, to suit each particular application. The sprinkler shall be of pendant, upright or side wall type to suit the installation requirements in accordance with the LPC Rules for Sprinkler Installations and FSD Requirements and Circular Letters. Each sprinkler may be defined by any of the following characteristics: -

a) Nominal Size of the orifice
b) Type of heat operated element
c) Operation Temperature
d) Type of Detector

Unless otherwise specified, glass bulb sprinkler shall be constructed with heat sensitive quartzoid bulb with temperature rating of 68^0C. Sprinklers installed in heated rooms e.g. kitchen cooking area, autoclave room, etc. shall have a temperature rating of 93^0C or as required by the FSD unless otherwise specified.

Sprinkler installed at the false ceiling shall be of flush pattern, pendant type and be supplied and installed with an adjustable screw type escutcheon and adaptor to be installed flush with the false ceiling with the yoke and heat sensitive element exposed below the false ceiling line. Sprinkler heads shall be installed at the centre line of the ceiling tiles. The sprinkler head assembly including the yoke arm, escutcheon, adaptor and cover plate installed in exposed locations shall be chromium plated or finished to a polyester white colour or a colour to be approved by the Engineer. The sprinkler head concealed inside false ceiling shall be of natural brass finish or of the same finish as the sprinklers in exposed locations.

Dry pendent sprinklers where specified for pre-action system shall be of adjustable standard or recessed type providing vertical adjustment needed for accurate fit to false ceiling level. The escutcheon shall match the other sprinklers.

Dry pendent sprinklers shall consist of a valve mechanism which utilizes the centre strut in compression principle to seal water and air from the sprinkler pipe until the sprinkler is operated. Water shall then flow freely through the operated sprinkler and distributed by its deflector.

The sprinklers shall cover all areas in the sprinkler-protected building including staircases, common corridors and toilets except plant rooms/D.G. stores/cold storage and other special areas that are provided with other fire service systems acceptable to KS Code (2009)

Sprinkler Guards

Sprinklers shall be protected by approved metal guards at locations where they are installed at a height less than 2 metres from ground level or liable to accidental or mechanical damage or required by the KS Code (2009). Sprinkler guards shall be made from brass, wax coated or products having equivalent functions and performance for corrosion resistance. It shall be of size not more than 65 mm high.

Spacing and Location of Sprinklers

Spacing and location of sprinklers shall be in accordance with the LPC Rules for Sprinkler Installations.

The Contractor shall check the actual site conditions before and during installation works to ensure that the sprinkler installation complies with the LPC Rules for Sprinkler Installations. The Contractor shall inform the Engineer well in advance of any necessary change of pipe sizes or sprinkler layout in order to suit the finished engineering layout. The Contractor shall be held responsible for the taking down and refixing works without charges if he/she fails to check and inform the Engineer in good time about such alterations

The Contractor shall supply and install metal baffles of the correct size between sprinklers wherever required by the LPC Rules for Sprinkler Installations.

Spare Sprinklers

The Contractor shall supply and install a cabinet containing a minimum number of spare sprinklers for each type of sprinklers as recommended by the LPC Rules for Sprinkler Installations or as specified. Sprinkler spanners as supplied by the manufacturers of the sprinklers shall also be provided and kept in the cabinet. Where quick response sprinklers or fast response sprinklers are provided in the Works and adequate quantities of spare quick/fast response sprinklers shall be supplied and maintained as recommended by the LPC Rules for Sprinkler Installations or as specified. Where conventional sprinkler heads and quick response / fast response sprinkler heads are provided in an installation, the number of spare sprinklers for each type of sprinkler head shall be considered separately and each shall comply with the recommendation in the LPC Rules for Sprinkler Installations for any hazard class.

Pipework Installation

Pipework installation for sprinkler systems shall be installed in accordance with the LPC Rules for Sprinkler Installations and as detailed in Clause 6.2.

Pressure Gauges, Valves and Alarm Devices

Pressure gauges, various types of valve and alarm devices shall be installed in accordance with the LPC Rules for Sprinkler Installations.

Cabinets for Control Valve Sets and Sprinkler Inlets

Cabinets for housing the sprinkler control valve sets and sprinkler inlets will be provided by the Building Contractor unless otherwise specified. The Contractor shall furnish all necessary dimensional information to enable these cabinets to be designed and constructed.

Subsidiary Stop Valves

Electric monitoring type subsidiary stop valves shall give visual signals back to the fire alarm control and indicating panel to indicate the open/close state.

Audible signal shall also be given when the valve is not in fully open position.

Sprinkler Control Valve Sets

The control valve set comprising the associated pressure gauges, valves, alarm devices, water motor gongs, testing facilities, retarding chambers, etc. shall be in accordance with the LPC Rules for Sprinkler Installations. Electric monitoring device shall be fitted at each valve to give signals back to the fire alarm control and indicating panel to indicate the open/close state of the valve. Audible signal shall also be given when the valve is not in fully open position. Drain connection to the system shall be led to conspicuous positions as approved by the Engineer and comply with the requirements of the Water Supplies Department. Sprinkler control valve set shall be of duplicate alarm valve arrangement or of alarm valve with bypass arrangement, and with alarm monitoring facilities.

Pre-Action System

Pre-action system shall be supplied and installed where specified. There are two types of pre-action installation as follows:

a) Type 1, which shall be installed only to prevent a premature discharge of water from pipework or sprinklers that have suffered mechanical damage; and

b) Type 2, which shall be installed only to facilitate an early discharge of water from a dry pipe installation by opening the installation main control valve, thus filling the installation control pipework with water, upon operation of a fire detection system.

For Type 1 system, the water shall normally flow into the pre-action pipework when the sprinkler is opened and the fire detection system is operated. For Type 2 system, the water shall fill the pre-action system pipework upon operation of a fire detection system before the sprinkler is operated.

Unless otherwise specified, Type 2 shall be used for pre-action system.

The sprinkler installation pipework shall be normally charged with air under pressure, and monitored to give a warning indication on reduction of the air pressure. Complete loss of air pressure shall initiate the visual and audible indications for a fire alarm.

The fire detection system shall automatically give an alarm at the fire alarm control and indicating panel, pre-action system control panel and any repeater panels and shall operate two independent LPCB certified solenoid valves or actuator mechanisms either of which shall release (Type 1 or Type 2) pre-action alarm valves. The solenoid valves or actuator mechanisms may be energised or de-energised to operate a pre-action valve control system.

The pre-action system control panel shall incorporate the necessary relays, timers, key types switches, alarm and trouble lights essential to the operation of the system. The control panel shall employ printed circuit boards for the components and shall be completely factory-wired and ready for connection on site. The control panel shall comply with Section B8 where relevant and the following:

a) The duration of the battery stand-by power supply shall be at least seventy- two (72) hours. At the end of the 72- hour stand-by period, the stand-by power supply shall be capable of operating the pre-action control panel and solenoid valve or actuator to release the pre-action alarm valve.

b) The pre-action control panel shall initiate operation of the pre-action alarm valve immediately in the event of a fire alarm system fault (including a failure of the primary and stand-by power supplies) which may result in failure to execute the appropriate actions in the event of fire

The pre-action control panel relays and circuitry operating the pre-action alarm valve solenoid valves or actuator mechanisms shall be duplicated and wired such that no single fault or failure shall render the installation inoperable.
Monitoring devices shall be supplied and installed to give: -

a) indication that any stop valves down-stream of the installation control valve set are fully open;

b) audible and visual warnings at the pre-action control panel that any monitored stop valve is not fully open;

c) audible and visual warnings at the pre-action control panel that the cover to a condition indicator switch has been removed;

d) audible and visual warnings at the pre-action control panel of short circuit or disconnection of the leads of any solenoid valve or actuator which is energised to open;

e) audible and visual warnings at the pre-action control panel of short circuit or disconnection of the primary power supply, the secondary power supply or any battery charger associated with the operation of the pre-action system.

The fire detection system used to activate a pre-action sprinkler system shall comply with FOC Rules for AFA Installations where appropriate and the following: -

a) Each room or compartment protected by sprinklers shall have sufficient fire detectors to initiate release of the pre-action installation without the operation of any detectors external to the room or compartment or located within equipment.

b) Fire detection systems employing coincidence connection (requiring a response from two detectors to initiate operation of the pre-action alarm valve) may be used with Type 1 and Type 2 pre-action installations. Consideration shall be given to actuation of the pre-action alarm valve on operation of a single fire detector where fast-developing fires may occur.

c) Any two detectors of a group of detectors that may initiate the operation of the pre-action alarm valve shall be separately connected to independent wiring circuits (coincidence connection).

Consideration shall be given to the nature of the occupancy, building height, sprinkler thermal sensitivity, air movement and the recommendations of the FOC Rules for AFA Installations and the Technical Bulletin TB 21 of the LPC Rules for Sprinkler Installations

28.2.7 TANKS AND PUMPS

Water Tanks

Water tanks forming part of the building construction will be provided by the Building Contractor unless otherwise specified.

Water tanks shall be constructed in compliance with the FSDCOP, LPC Rules for Sprinkler Installations, SANS 10400-T Requirements and Circular Letters.

Puddle flanges for inlet and outlet pipes shall be supplied by the Contractor and installed by the Building Contractor unless otherwise specified. All other piping connections and valves shall be supplied and installed by the Contractor except overflow, drains and inlet piping which will be supplied and installed by Building Contractor unless otherwise specified.

The Contractor shall check the construction drawings for water tanks for fire service installation and verify their correctness for installation purposes, or submit proposals for modification to the design, as necessary, and shall assist in the supervision of their construction, in order to ensure their suitability and proper functioning.

Water Pumps

Water pumps for sprinkler systems shall comply with the LPC Rules for Sprinkler Installations. Water pumps for hydrant/hosereel systems shall comply with the FSDCOP, SANS 10400-T and Circular Letters, and BS 5306 Part 1 wherever applicable. Pumps shall be manufactured by a manufacturer possessing certified ISO 9001/9002.

Sprinkler pumps shall be LPCB certified pumps or approved by any similar widely recognised independent regulatory body acceptable by the Ministry of Defence. Test certificate shall be submitted at the time of delivery.

There shall be at least one standby pump in addition to the duty pumps for each pump set. In addition, there shall be at least one jockey pump in each sprinkler pump set.

Pump Operation

Pumps with stable characteristics for fire service installation shall be selected to suit the design requirements for capacity (flow rate) as specified and shall discharge at a pressure which shall produce running pressures within the statutory requirements at the location concerned. In addition, the required net positive suction head of the selected pumps shall be compatible with the available net positive suction head in the installations. The design figures given on the Particular Specification and/or drawings are for guidance only. No adjustment in cost will be entertained if the actual required duty points (pressure and flow rate) are different from the specified figures. Close valve total pressure head shall not exceed 140% of the rated head.

The Contractor shall be responsible for carrying out a final accurate calculation of operating heads based upon the characteristics of the pipework systems including fittings, equipment and accessories as actually installed by him. Certified performance curves for the pumps shall be provided with the operating range clearly indicated.

Pump drive motor output power shall be rated to give 20% for hydrant system and 10% for sprinkler system more power in addition to the hydraulic power required for the rated flow of the system. Pump speed shall not exceed 50 rps.

Pumps shall be capable of running under conditions of zero or low “draw-off” continuously without overheating. This may be achieved either by pump design or by an automatic by-pass circuit arrangement. Details of this shall be shown on the Contractor’s Installation Drawings. Overheat alarm devices may be supplied and installed if necessary but these shall not be arranged to shut down the pump automatically.

Pumps shall have acceptable low noise level and good energy efficiency to the approval of the Engineer especially for the jockey pumps.

Pump Construction

Pumps shall be of centrifugal, horizontal end suction type unless otherwise specified having casings of close-grained grey cast iron to BS 1452 Grade 180.

Horizontal split casing pump or multi-stage centrifugal pump shall be supplied and installed in lieu of the end suction type if necessary or as specified.

Flanges shall be to BS 4504 PN16. Impellers shall be of stainless steel to BS 970 Part 1 Grade 316S31. Shaft shall be of stainless steel to BS 970 Part 1 Grade 316S31 statically and dynamically balanced after assembly. Impeller rings shall be of cast iron and renewable secured from relative movement by stainless steel end rotation ring.

Salt water pumps if specified shall be generally of the similar type and construction to the fresh water pump, and the impellers and shafts shall be of stainless steel to BS 970 Part 1 Grade 316S31.
Pump seals shall be of the stuffing box gland type of appropriate depth to prevent leakage. Low pressure stuffing boxes shall be water sealed to prevent air leakage. Glands shall be of cast iron or bronze.

Bearings shall be of ball or roller type having an adequate safety factor to ensure long life. Housings shall be easily removable for servicing.

Grease nipples shall be provided on the pump casing adjacent to each bearing for lubrication of the bearings.

Pump Set Installation

The pump and motor shall be directly coupled and mounted on a substantial machined base plate of cast iron or of fabricated mild steel. Couplings shall be flexible of steel pin and synthetic rubber bushing type, accurately aligned, and fitted with guards.

Pumps shall be complete with all necessary water seal connections, vents, drains and priming plugs, and all installation materials including foundation bolts and anti-vibration mountings. Drain pipework shall be of copper and shall run to a nearby drain gully or as specified. Automatic priming equipment shall be included where necessary to ensure that the pumps are primed at all times.

The exposed shafts, couplings and moving parts of pumps shall be provided with suitable galvanised iron mesh guards coated with primers and finishing paint and shall be stoutly constructed and easily removable complete with lifting handles.

Each pump shall be provided with pressure gauges installed to indicate the suction and discharge pressure. The gauges shall be neatly mounted on a rigid wooden or metal board adjacent to the pump or rigidly fixed in-line with suction and discharge pipework. Suitable permanent labels in English and Swahili shall be affixed for each gauge to indicate its function.

Duty/standby selector, manual start/stop buttons, voltmeters, ammeters, high/low level alarm, and associated indications shall be supplied and installed at the starter panel inside the pump room. Except the manual stop buttons, similar provisions shall also be supplied and installed at the main and/or repeating fire alarm control and indicating panels as specified in the Particular Specification. A lock-off type emergency stop shall be supplied and installed adjacent to each pump set. Visual and audible indication shall be provided on the pump control panel indicating the pump is stopped and locked by the emergency stop and shall remain on until the emergency stop is reset.

Except for the proprietary package pump set and proprietary starter panel complying with SANS 10400-T and with ISO 9001/9002 quality system, the starter panel shall be made from minimum 1.6 mm thick stainless steel to BS 970 Part 1 Grade 316S31.

The pumps shall be actuated at the pump room and the fire alarm control and indicating panel.

Maintenance Facilities

Pump installation shall be complete with adequate facilities for maintenance and future replacement of base plate. Lifting eyes shall normally be provided upon pumps, motors, and engines. Details of any requirements for overhead run-ways, hoists, etc., required for installation and maintenance shall be submitted to the Engineer for approval. Where there is a Building Contractor carrying out the building work for a particular project, the overhead run-ways, hoists and hoisting beam will be carried out in the building work by the Building Contractor provided that the Contractor shall submit in good time to the Engnieer for approval, full details of such requirements, so that due consideration may be given before the Building Contractor commences work in the areas concerned. Where there is no Building Contractor, all facilities for maintenance shall be supplied and installed by the Contractor.

Motors for Pump Drives

Electric motor for pump drives shall be of the drip proof or totally enclosed fan- cooled (TEFC) squirrel cage induction motor to BS 4999 and BS 5000 Part 10 with Class F insulation. Drip proof motors shall be fitted internally with an anti - condensation heater of single phase pattern arranged so that the heater will be switched off automatically when the motor is started and switched on automatically after stopping.

Totally enclosed fan-cooled motors shall be dust and moisture protected to IP 54. In damp situations or in underground pump houses, motor terminal boxes shall be of weather-proof type. The power factor of the motor shall not be less than 0.85 lagging under all normal operating conditions. Noise level of all motors shall be in accordance with or better than the recommendation of BS EN 60034-9 and shall comply with Environmental Protection Department's requirements. Motor and pump shall be properly balanced and aligned to avoid excessive vibration.

Motor Starting

The method of motor starting shall be selected according to the characteristics of the pump and shall comply with the Electricity Supply Co.'s limitations on starting current. The type of starter shall be as follows, unless otherwise specified: -

<u>Condition 1 : For supply arrangement from company's overhead line</u>

Up to 3.8 kW	Direct-on-line
3.8 kW to 22 kW	Star/delta
Above 22 kW	Automatic-transformer 60% tapping or star/delta

<u>Condition 2 : For supply arrangement from company's non-overhead line system</u>

Up to 11 kW	Direct-on-line
11 kW to 25 kW	Star/delta
Above 25 kW	Automatic-transformer 65% tapping or star/delta

Starters

Starters shall be air break triple pole electromagnetic contactor type and shall comply with and be tested to BS EN 60947-4-1. Any no-volt release mechanism must be of the automatic resetting type such that on the restoration of the supply the motor can restart automatically. Magnetic and thermal overload trips are not allowed. A phase failure protective device shall be incorporated. Utilization category shall be AC-3 of intermittent duty Class 0.1, 60% on-load factor. Each starter shall comprise on/off controls and indications.

Starters shall be supplied and installed complete with enclosures except where required to be mounted upon composite control panels and shall be in accordance with BS EN 60947-4-1. Enclosure shall provide protection of person against contact with live or moving parts inside the enclosure, protection against ingress of dust and liquid and protection against mechanical damage in accordance with BS EN 60947-1, BS EN

Star/delta and auto-transformer starters shall have approved timers for automatic transition, calibrated and adjustable.

All components shall be of non-hygroscopic, non-corroding material and tropicalized. Operating coils shall be wound on nylon or similar and vacuum impregnated with nonorganic varnish or plastic encapsulated.

Pump Set Isolation Mountings

Unless otherwise approved by the Engineer, motor driven pump set shall be mounted upon a common base plate supported by approved spring-type isolation mountings on concrete plinth. Where package fire pump set is specified, the fire pump, motor, couplings, controls, etc. shall be pre-assembled on the common base plate with spring type isolation mountings by manufacturer in a factory possessing ISO 9001/9002 quality system.

Jockey Pumps

Jockey pumps complete with TEFC driven motor for maintaining hydraulic pressure shall be of the multi-stage horizontal or vertical centrifugal type having construction generally in compliance with Sections B4.5 and B4.8 with stainless steel shaft and impellers. Alternatively, reciprocating pumps capable of performing the same duty may be acceptable. Reciprocating pumps shall be with stainless steel piston rod and piston, synthetic rubber seals and oil bath lubrication, mounted on a common base plate with the electric motor drive.

Factory Test and Certification

All sprinkler pumps before delivery shall be factory tested and certified on the performance. A factory test certificate and record shall be submitted. Where the manufacturer does not have an approved test facilities required by LPCB for the test in the factory, the Contractor shall, before delivery, arrange the test to be carried out by an independent testing organization approved by LPCB or approved by any similar widely recognised independent regulatory body acceptable to the Engineer.

Site test shall not be accepted as a substitute for the factory test.
Package fire pump set shall be factory tested and certified similar to the sprinkler pump. Where specified, factory test and certification shall be required for other pumps similar to the sprinkler pump.

28.2.8 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 SABS. 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.

Fire Detection and System Control - Automatic Release

Fire detection in the protected area shall be by means of smoke or heat detectors as specified. Sufficient detectors shall be supplied and installed to give duplicate coverage of the whole of the protected area and connected in cross-zones.

Activation of a detector on one zone shall cause alarm bells to sound. Activation of detectors on two zones shall cause a siren or an approved horn to sound and red or amber flashlights in the protected area to light warning that the extinguishing agent is about to be discharged if the system is in the automatic mode. These warning signals will also be activated by the operation of the manual release before the discharge.

The gas extinguishing control panel shall control and monitor the gas release system.
It shall include an automatic/manual lock-off unit controlled by key switches at each entrance to the protected area. Any one key switch shall be capable of switching the system on or off. The manual release mechanism will remain operative whether the system is on or off. A time delay unit which is adjustable in the range of 15 to 30 seconds shall be supplied and installed. Relays shall be supplied and installed to shut down ventilation and air-conditioning, to close openings and to switch off equipment as necessary. These relays will operate immediately when two zones of the fire detection system are activated or when the manual release is operated. Release of the gas will follow after the pre-set time delay.

The gas extinguishing control panel shall comply with Clause 7.8 where relevant and with battery backup. The battery supply shall be able to actuate the system at the end of the standby period.

Manual Release

A manual release unit shall be supplied and installed in a suitable position outside each entrance to the protected compartment. The manual release unit shall consist of a pull handle or push button mounted in a box with “break glass” cover. The box shall be so designed that its glass front may be readily replaced and that its front cover can be opened with a key for the purpose of operating the switch without breaking the glass.

Emergency Release

An emergency release handle with direct mechanism shall be supplied and installed in an accessible position at or near the gas cylinders. The emergency release shall require no power supply to operate and it shall be supplied and installed with a removable pin to prevent accidental release of gas. Provision shall be made for operation of the emergency release to activate the relays to cause simultaneous shutdown of ventilation, air-conditioning, equipment etc. and to sound the alarm.

Gas Release Mechanism

The operation of the gas release mechanism shall require minimum power from an external electrical, pneumatic or mechanical source and shall preferably be operated by a falling weight device. No springs shall be used in any position where their failure or fracture would prevent the correct operation of the gas release mechanism or cause the inadvertent release of the gas.

All release devices and mechanisms shall be designed for the working conditions they will encounter and shall not readily be rendered inoperative or susceptible to accidental operation. They shall have proper protection from mechanical, chemical or other damage that would render them inoperative.

Gas Distribution System

All pipework shall be non-combustible and able to withstand the expected pressures and temperatures without damage. Specification of materials and installation shall conform to the relevant international standards for the respective gas extinguishing agent used.

Other standards adopted for proprietary systems that are in compliance with SANS 10400-T can also be used when approved by the Engineer.

Pipes up to 100 mm shall be screwed and socketed, pipework over 100 mm shall use screwed flanges.

Threaded steel pipework and fittings shall be free of burrs and rust and shall be galvanised inside and outside. Screwed threads shall conform to the dimensions specified in BS 21. Screwed joints shall be made with P.T.F.E. tape or products having equivalent functions and performance but chemically inert to the extinguishing agent used. Compressed fibre gaskets free of asbestos shall be used for flange joints.

Pipe work shall be painted signal red as specified and illustrated in BS 381C in accordance with the requirements of BS 5252. Brass fittings shall be left unpainted.

Gas Discharge System to be Securely Fixed and Guarded

The gas discharge system including cylinders, pipework and nozzles shall be securely fixed to the structure with correctly spaced saddles or brackets in according with SANS 10400-T Requirements and Circular Letters. All components shall remain in place when subjected to the pressures and forces produced during discharge. Fixings shall allow for movement due to thermal expansion.

The system shall be guarded so that the operation of any moving parts shall not be obstructed.

Indicator Lights, Warning Notices and Labels

All gas storage compartments and compartments protected by a gas extinguishing system shall have a warning notice fixed on each entrance door to the compartment. The notice shall be made of sheet metal plate not less than 1.6 mm thick or of material approved by the Engineer.

The manual/automatic lock off key switches, the manual release units and the emergency release handle shall all be labelled in English and Swahili so that it is clear what their purpose is and how to operate them.

System Odoriser

Odorisers where specified shall be capable of automatically treating the gas after releasing from the cylinder and shall be of citrus odour type, so that hazardous atmosphere can be recognised at once. Where odorisers are installed, a suitable notice to the effect that anyone detecting the citrus odour should leave the area immediately and report the occurrence to a responsible person. The notice shall be worded in English and Swahili.

28.2.9 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 of 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 frame s and installed in appropriate locations in the rooms

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28.2.10COMMISSIONING 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 times 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 of1000 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.

28.2.11GENERAL 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.

28.2.12 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.

28.2.13 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.

28.2.14 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.

29 SECTION 29- TECHNICAL SPECIFICATIONS (HVAC)

29.1 TECHNICAL SPECIFICATIONS (HVAC)

29.1.1 GENERAL SPECIFICATION - GENERAL REQUIREMENTS

Installations to Comply with This General Specification

The HVAC 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.

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 HVAC 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 HVAC 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 HVAC 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 HVAC 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 HVAC 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 HVAC Contractor. The HVAC 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 HVAC Contractor's failure to comply with the above requirements are recoverable by the Employer from the HVAC 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 HVAC 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 HVAC 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 HVAC 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 HVAC Contractor shall coordinate the Installations with those works of the Building Contractor and any other contractors and sub-contractors of the Building Contractor. The HVAC 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 HVAC 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. HVAC Contractor shall prepare section as required to demonstrate all constrains 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 HVAC 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 HVAC 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 HVAC 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 HVAC 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 HVAC Contractor shall submit to the Engineer for approval a sample board of essential components proposed to be used in the Contract. However, the HVAC 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 HVAC Contractor shall deliver the board to the site office for reference.

The following items shall be included in the sample board as a minimum:

iv. Duct work, fittings and their support complete with fixing accessories;
v. Disk Valves
vi. Grilles; and
vii. 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 HVAC Contractor that the original equipment offered cannot be obtained, the Engineer may consider and accept, in writing, alternative equipment and materials proposed by the HVAC 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 HVAC 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 HVAC Contractor shall submit a detailed installation drawing submission schedule and programme to the Engineer. The HVAC Contractor shall allow reasonable time in the programme for vetting of the installation drawings by the Engineer and for drawing resubmissions as necessary.

The HVAC 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 HVAC 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 HVAC Contractor shall only be of standard sizes from A0 to A4 or B1 size as stipulated in ISO 5457:1999.

HVAC 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 HVAC 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, such as coils, heater elements, thermometers, thermostats, fan shafts and fan blowers, cleaning and replacement of tubes, removal of guards, etc.;

e) Ductwork Installation Drawings

Prior to the commencement of any manufacture, fabrication, or installation, the HVAC 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 fans, disc valves, flexible ducts and their 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 ductwork in relation to the building structure and other pipework and equipment. The position of all disc valves, fans, dampers, etc. shall be shown together with clearances necessary for their removal.

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 HVAC Contractor's equipment constitutes the major item involved (i.e. as in the case of pump room), the HVAC 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 HVAC 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 HVAC 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 HVAC 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 HVAC 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 HVAC Contractor within 42 days from the date of submission of the HVAC Contractor’s draft prints with comments. The HVAC 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 HVAC 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 HVAC 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 HVAC 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 of 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.

29.1.2 INSTALLATION METHODOLOGY

Installation Duct work

General Duct work

A complete range of supply and extract ducting, including plant connections shall be supplied.

The galvanized ductwork shall be complete with dampers, bends, branch connections, tapers, transformations, inspection openings and any special pieces necessary to complete the system. All positions of ducting and plant shall be checked on site and detailed working drawings shall be submitted to Engineer for approval before manufacture is commenced.

All bends and take-offs shall be designed to keep resistance to air flow to a minimum, and where fittings having a mean radius ratio of less than 1:1 are unavoidable, internal guide vanes of approved design shall be provided. Transformation or taper pieces shall, where possible, be constructed so that the angle for any one side does not exceed 15° to the axis of a duct.

Rectangular bends and take-offs are not permitted. Multi-leaf volume, control and isolating dampers shall be supplied and fixed wherever necessary and shall be complete with lockable operating lever quadrant and open/shut indicator plate. After final regulation and balancing the position of the damper lever shall be marked on the damper quadrant in the red paint and locked in position.

Except where fire dampers are built into the structure, ductwork passing through floors, walls, etc. shall be provided with 1.20 mm thick galvanized steel sleeves flanged to the building structure, the annular fully packed and tightly compressed with slag wool 1000°C grade, to provide a fire stop and to eliminate movement of air between the duct and the sleeve and transmission of noise from one area to another. Duct shall not come into direct contact with the fabric of the building and shall maintain adequate clearance with other services to permit full insulation and vapor sealing.

All nuts and bolts shall be sherardized. The fastening of electrical cables (other than equipotential bonding) and other equipment to ductwork will not be permitted.

Test holes shall be provided in the ducting system at all main and branch ducts and wherever necessary to ensure satisfactory commissioning of the system and these holes shall be provided with suitable permanent covers. Rubber plugs or taped sealers will not be accepted. Holes required for thermometer bulbs and thermostats, etc. shall also be provided complete with sliding union collar fixture.

All joints and connections throughout the ducting systems shall be airtight to the requirements of HVCA/DW142. Branch connections shall be supplied with gaskets and all joints shall be packed with suitable fire resistant sealing compound of approved make.

Flexible duct joints shall be provided at inlet and outlet of each fan and packaged unit. The joint material shall be flame retardant.

All the supply and extract galvanized ductwork shall be designed for low velocity and except where specified otherwise, shall be constructed and stiffened to standards contained in the Heating and Ventilating Contractors Association (Ductwork Group) Specification DW/142 and the Practical Guide DW/143.

Each and every section of ductwork shall be provided with an earth bonding and equipotential brass stud or studs and cable fixing to suit the earthing systems.

All ductwork shall be adequately stiffened where necessary by external angle iron or cross-breaking and large ducts internally by bracing arranged to present minimum resistance to air flow. Internal bracing to ducts shall be of similar material to the ducting.

Approved slip joints may be used but sufficient flange joints shall be provided to facilitate the stage by stage erection and where sections of ductwork have to be installed in advance to accommodate the building programme. Engineer shall reserve the right to decide where flange joints are required. All joints shall be sealed in an approved manner. Access doors to the ductwork shall be fitted where necessary for cleaning and where called for in the Specification. They shall be of the wing nut bolted-on type except where hinge types are indicated.

Access doors and door openings in the ductwork shall be adequately stiffened and made airtight with a neoprene gasket. Access doors installed to systems required to be insulated shall be of the double skin pre-insulated type, thickness of insulation to match with the adjacent duct insulation.

Duct connections to builder’s work duct and openings shall be provided with suitable angle frames to stiffen the ducts and ensure that the connections remain airtight. Bends and off-sets shall have a throat radius equal to the width of the duct.

Where short radiused elbows are indicated or are agreed by Engineer as necessary due to site limitations, the dimensions and internal vanes shall be in accordance with HVCA (Ductwork Group) specification DW/142, 1982.

Supports shall comply generally with HVCA specification DW/142. Where cantilever brackets or other special forms of support are indicated they shall be structurally strong enough to take the load and to transfer the load to the building structure without distortion. The final position of the ductwork and the proposed method and material for supports must be shown on the working drawings submitted for approval and coordinated with all other services in conjunction with the Main Contractor before submission to Engineer.

Any part of galvanized ductwork where the galvanizing is damaged during manufacture or erection shall be painted with two coats of aluminum, zinc rich corrosion resisting paint to the satisfaction of the Engineer.

Sizes of ducting indicated upon the drawings shall be the airway internal dimension.

Grilles shall be provided with boot neck sections to keep the grille clear of the duct air stream in all cases.

Duct dampers

Volume control, isolating and balancing dampers shall be provided where required for balancing and regulation purposes and as deemed necessary. Dampers shall be opposed-blade multi-leaf type with double skin aerofoil section blades constructed in galvanized sheet steel, or aluminum and securely fixed to a central spindle. The blades shall be stiffened to prevent flutter. Spindles shall be carried in non-ferrous nylon or bronze bearings. Quadrants shall be made out of metal casting. All dampers shall incorporate neoprene rubber blade edges and leakage pass the dampers when fully closed shall be minimal. Damper frames shall be constructed from 16 mm gauge thick galvanized channel. Multi-leaf dampers shall be used in rectangular ducts having a short side in excess of 300 mm. No damper blade shall exceed 1200 mm width and where dampers are required for the greater width the damper sections shall be constructed in multiple frames. Individual damper blades shall not exceed 175 mm in height. Multi-leaf dampers shall operate on the opposed blade principle and provision shall be made for linkages to connect the multiple extended spindles and a suitable indicating device shall be provided on the outside of the damper section

Duct Access

Access openings shall be provided in the ductwork for purposes of cleaning and inspection and shall be positioned to the approval to the Engineer. Unless otherwise approved each access point shall have a minimum clear opening of 450 mm x 450 mm or equivalent area to suite the duct section.

Openings shall have rubber edge lip seals and be fitted with covers having turned down edges, and be secured with bolts and wing nuts into tapped holes unless hinged covers are to be provided. Covers and openings shall be adequately stiffened and shall be airtight. Inspection openings with cover plates shall be provided each side of all fit treatment devices, exchangers, adjacent to all dampers and all items of plant requiring periodic inspection, cleaning and for maintenance purposes. No inspection opening shall be more than 10 meters apart. Where ducts are to be thermally insulated, it is a requirement that the access door frame be extended beyond the face of the duct by a measurement at least equal to the thickness of the insulation and be so arranged that the insulation and finish can be dressed into the frame thereby ensuring that the opening is not concealed and that the edges of the insulation are protected from accidental damage. The access door should be double skinned and filled with insulation of the same thickness as the duct insulation.

Grilles and Diffusers (Supply and Extract)

Grilles and diffusers shall be designed to prevent draughts, air noise and staining of walls and ceilings. All duct mounted air supply diffusers shall be complete with an opposed blade volume control damper and designed to give the desired air pattern. The general air flow pattern shall be fixed by the air diffuser but means shall be provided to adjust the final air flow pattern and direction of throw. Extract grilles shall be mounted direct to the ducting and shall be of the fixed blade type with blades set at an angle of approximately 45° complete with a opposed blade damper behind the grille. Transfer grilles shall be of the non-vision type designed to pass the required air volume with a minimum of resistance. Transfer grilles shall be provided with two matching flanges and gaskets, one for each side of the door/wall structure. Where transfer grilles are fitted into fire doors they shall be complete with a purpose designed fire damper to match the door thickness and give the desired fire rating.

The Contractor shall supply and install, in the locations shown on the drawings, supply and return linear diffusers. The slot diffusers shall be suitable for horizontal discharge by the adjustment of the blades. Seal all outlets around the edges to prevent air leakage with proper gasket or sealant subject to Engineer approval.

Diffuse supply air velocities shall not excess of 0.25 m/s at 1.8 m floor level.
Diffusers shall be of diffusion and air mixing type. Diffusion shall be effected without objectionable air motion at a point within 1.8m above the floor line.

Unless otherwise stated all grilles and diffusers shall be constructed of aluminium with a standard satin aluminium finish. They shall be fixed into wood frames with cadmium plated wood screws to match or by other proprietary securing devices. As alternative, extruded aluminium with powder coated painting for the grills/diffusers may be considered. The air velocity through the supply air grilles and diffusers shall be the minimum to provide the necessary duty at the throw and with the minimum noise level which must be at least 5 dB below the room design noise level. Grills and diffusers shall not be positioned above the switchgears or control/relay panels.

External louvers

All fresh air inlet and exhaust louvers shall be designed to prevent rain and excess deposit entry at the operating velocities of the flesh air inlet louvers. All construction joints shall be fully weather sealed. Unless otherwise indicated all louvers in the external walls of the building required for exhaust or fresh air inlets to the systems shall be of mild construction heavily galvanized after manufacture and finally degreased, etched, printed and painted two coats of paint to approved colour. The blades shall be formed from not less than 1.63 mm thick sheet plate carried in a robust galvanized mild steel channel frame suitable for fixing direct to the building structure. The bottom channel of the frame shall be drilled at each end to receive a small bore copper weep pipe. The maximum length of louver blade shall not exceed 1.0 meter without intermediate bracing supports. Bird and vermin proof wire guards shall be fitted behind each louver. The louvers shall be designed for a maximum free area and designed to pass the required air volume with a minimum pressure drop. Sand louvers shall be manufactured in galvanized steel enclosed within a galvanized flanged holding frame. Louvers shall be complete with insect screen and sand collection gravity chamber. Sand louvers shall have an efficiency of 97 percent when tested particles between 150 to 450 microns. Face velocities shall not exceed 1.5 m/s. Wherever possible louver sub-frames shall be vertically hinged to permit ease of cleaning

Painting & Identification

All external ductwork supports shall be etch primed and painted with two coats of approved primer, and finished with two coats of chlorinated rubber based paint on all external faces.

A protective finish shall be applied to all mild steel internal ductwork sections (flanges, stiffeners, hangers, supports, etc.) before fixing, consisting of two coats of red oxide or zinc chromate paint.

All rotating plant shall be complete with 150 mm long arrows indicating the correct direction of rotation.

Arrows shall be situated in a position where they can easily be seen and not on the "blind" side of plant. This requirement shall also apply to plant identification labels and plates.

Letters and identification symbols shall be pro-coloured plastic, adhesive backed and purpose-made for the application.

Ductwork shall be identified with black or yellow PVC symbols in accordance with HVCA Code of Practice DW/142.

Ductwork within plant room's areas shall be identified at 6-meter intervals and at all “T 'junctions, mixing zones and terminations.

Ductwork external to plant rooms shall be identified as above but at maximum intervals of 15 meters, at all access points and where deemed necessary by the Engineer.

Pipe Work & Fittings

Each part of the piping system shall be complete in all details and provided with all central valves and accessories necessary for satisfactory operation.
The tender drawing indicates generally the size of all piping. While the sizes are not to be decreased, the contractor will check and change the runs and sizing of piping to accommodate conditions during construction subject to engineer approval.

All piping shall be grouped wherever practical and shall be erected to present a neat appearance. Pipes shall be parallel to each other and parallel or at right angles to structural members of the building and shall give maximum possible headroom.
All pipe drops shall be truly vertical. No joints shall be formed in thickness of walls, floor or ceilings.

Pipes shall generally be set around columns and shall follow the contour of the building whether so indicated on the drawings or not. Piping shall not pass in front of doorways or windows and shall be generally arranged so that it is at least 200 cm above finished floor level and at least 2.5 cm from finished wall face. Sufficient space is to be allowed for accessibility for servicing. Piping shall be perched for proper circulation and drainage.

Run outs shall be graded in such a manner to prevent air traps and to allow natural venting of horizontal piping to be installed with a Minimum slope of 0.2% upward pitch towards the vertical riser. U-shape routing of pipe work shall be avoided. Automatic vents are to be provided at high points, with isolating valves.

All drain piping shall pitch down in direction of flow. All low points of the system must be fitted with drain valves to permit the complete draining of the system. Bottoms of all risers must have dirt pockets of the size of riser at least 30 cm long with a drain valve fitted. All water piping to equipment shall be connected with either flanges or unions for dismantling and removal. All piping shall be seamed after cutting to remove all burns.

All reduction in sizes of piping in the direction of down ward pitch shall be installed with eccentric fittings to maintain bottom level.
Approved pipe fittings shall be used and bending of pipes will not be normally allowed. Piping shall not be installed passing through ductwork or directly under electric light outlets or extend beyond furring lines determined by the plans.
In placing pipes through sleeves, near wall, partitions or in chases, care must be taken to provide sufficient space for pipe covering or insulation.

29.1.3 INSPECTION, TESTING AND COMMISSIONING

General

Throughout the execution of the installation, the HVAC 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 HVAC 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 HVAC Contractor to provide, at no cost to the Employer, all necessary equipment, apparatus, tools and materials for carrying out of testing and commissioning works.

Before commencement of any tests, the Contractor shall obtain and schedule a list of commissioning information requirements which shall include the following:

i. full pre-commissioning check lists for all plant and equipment,
ii. all fan speeds and duties,
iii. all design air flow rates and pressures within ductwork systems,
iv. all supply and extract air design volumes,
v. all room temperature, humidity and air pressure requirements,
vi. sound levels in selected areas,
vii. design static pressure losses across dampers, air filters and silencers, etc.,
viii. power demands, starting currents, running currents and control logics,
ix. manufacturer's setting to work and operating instructions,
x. all other details necessary to identify the performance of the plant and equipment installed

The HVAC 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 HVAC 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 HVAC 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 HVAC 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 HVAC 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 HVAC 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 HVAC 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 HVAC 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 HVAC Contractor shall arrange for it to be commissioned, certified and tested by the manufacturer's skilled commissioning engineer and/or technician.

The HVAC 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 HVAC 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 HVAC Contractor at no cost to the Employer and the relevant part of the commissioning or testing procedure shall be repeated at the HVAC Contractor’s expenses.

The entire testing and commissioning procedure shall be undertaken by the HVAC Contractor's own competent specialist staff or by a competent Independent Commissioning Specialist nominated by and acting for the HVAC Contractor and approved by the Engineer.

Where specified in the Particular Specification, the HVAC Contractor shall nominate a competent independent Specialist to conduct commissioning work.

Where specified in the Particular Specification, the HVAC 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 HVAC 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 HVAC 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 HVAC 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 HVAC 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 HVAC Contractor at no additional cost to the Employer.

Test at Factory

The HVAC 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 HVAC 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 HVAC 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 HVAC 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 HVAC 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.

30 SECTION 30 - TECHNICAL SPECIFICATIONS (BOREHOLE)

30.1 TECHNICAL SPECIFICATIONS

30.1.1 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 advice 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 r 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.

30.1.2 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 down to a depth of about 230m 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 tame 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 freeof 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.

30.1.3 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 from	0	to	10	minutes of pumping
Every	2	minutes from	10	to	30	minutes of pumping
Every	5	minutes from	30	to	60	minutes of pumping
Every	10	minutes from	60	to	360	minutes of pumping
Every	15	minutes from	360	to	600	minutes of pumping
Every	30	minutes from	10	to	24	Hours of pumping
Every	60	minutes from	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^{-}, NO_3^{-}, SO_4^{--} and HCO_3^{-}

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.

30.1.4 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 Inclinometer, 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 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 ¾ 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 ¾ 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

31 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.