VOLUME II OF II: TENDER NO. KCAA/011/2019-2020

PROPOSED CONSTRUCTION OF REGIONAL CENTER FOR AVIATION MEDICINE

F O R

AT

JKIA EMBAKASI, NAIROBI

BILLS OF QUANTITIES - SPECIFICATIONS

VOLUME II

(Contents page, Signature page, Appendices - Schedule of drawings, Architects, Structural engineers, External works, P.C. & Provisional sums preambles, Plumbing & drainage, Electrical, HVAC, Lift , Generator, Low current, Borehole drilling & Water feature specifications)

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NOVEMBER, 2019

VOLUME II OF II: TENDER NO. KCAA/011/2019-2020

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BILLS OF QUANTITIES

FOR

PROPOSED EAC REGIONAL CENTER FOR AVIATION MEDICINE

FOR KCAA

AT

JKIA EMBAKASI, NAIROBI

VOLUME 2

Prepared by: Davson and Ward,
Quantity Surveyors and
Building Economists,
P.O. Box 46611,
NAIROBI.

July, 2019

The Contract for the above mentioned works, entered into on the ....day of...........................20…………... by the undersigned parties refers to these Bills of Quantities comprising 312 pages numbered 'Contents', Signature Page, A/1 – A/4, B/1 – B/23, C/1 – C/29, D/1 – D/4, E/1 - E/2, F/1 – F/56, G/1 – G/36, H/1 – H/10, I/1 – I/14, J/1 – J/13, K/1 – K/90, L/1 – L/11, and M/1 – M/18 inclusive, which shall be read and construed as part of the said Contract.

....	....
EMPLOYER	CONTRACTOR
Date:	Date: ....

SPECIAL NOTE

The Contractor is required to check the numbers of the pages of these Bills of Quantities and should he find any missing or in duplicate or the figures indistinct he must inform the Quantity Surveyor at once and have the same rectified.

Should the Contractor be in doubt about the precise meaning of any items or figures for any reason whatsoever he must inform the Quantity Surveyor in order that the correct meaning may be decided before the date for submission of tenders.

No liabilities will be admitted nor claim allowed in respect of errors in the Contractor's tender due to mistakes in the Bills of Quantities which should have been rectified in the manner described above.

SIGNATURE PAGE

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SECTION B

ARCHITECTS SPECIFICATION

GENERAL

DISCREPANCIES IN DESCRIPTIONS

Descriptions of materials and workmanship contained in the Bills of Quantities measured items shall take precedence over descriptions contained in Appendices in the event of discrepancies between the two, unless the Architect shall otherwise direct.

DISCREPANCIES IN DRAWINGS

Drawings shall take precedence over the Bills of Quantities, for construction purposes, in the event of discrepancies between the two, and the Architect must be notified immediately any such discrepancy becomes apparent.

TESTS AND SAMPLES

Unless otherwise described in the Bills of Quantities, the Contractor will be responsible for all the costs involved in testing materials as described hereinafter. He will also be responsible for all the costs involved in supplying samples of materials or workmanship as required hereinafter to the satisfaction of the Architect. The cost of replacing materials fixed or placed in position which do not comply with the required test results or approved samples shall be borne solely by the Contractor.

KENYA STANDARDS

All materials and goods supplied for incorporation in the works must comply with any relevant current standards issued by the Kenya Bureau of Standards. Where these are not established or are unclear the latest British Standards and Codes of Practice shall be applied.

EXCAVATION AND EARTHWORKS

SITE CLEARANCE

See Structural Engineers Specification.

GRUBBING

See Structural Engineers Specification.

EXCAVATION

See Structural Engineers Specification

WATER IN EXCAVATIONS

The Contractor shall excavate sumps, cut drains, provide and place all necessary materials and provide and work pumps, plant and apparatus for dealing with any water which may find its way into the excavation from any source whatsoever.

The responsibility for draining away, pumping, or otherwise removing water from the excavations shall rest with the Contractor throughout the duration of the Contract, but methods employed shall be subject to the agreement of the Architect.

Provision has been made in the Preliminaries and General Conditions of these Bills of Quantities for the Contractor to insert a price against this item.

HARD ROCK

See Structural Engineers Specification

FOUNDATION EXCAVATIONS

See Structural Engineers Specification.

SURPLUS SOIL DISPOSAL

See Structural Engineers Specification.

TOP SOIL FOR SPREADING

See Structural Engineers Specification.

FILLING UNDER SURFACE BED IN BUILDINGS

See Structural Engineers Specification.

FILLING OBTAINED FROM THE EXCAVATIONS

See Structural Engineers Specification.

MATERIALS FOUND IN EXCAVATIONS

See Structural Engineers Specification.

CONCRETE WORK

See Structural Engineers Specification.

WALLING

CEMENT

All cement used for making mortar shall be Portland Cement complying with B.S. 12.

SAND

All sand used for making mortar shall be clean well graded silicone sand of good sharp quality equal to samples which shall be approved by the Architect. 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 Architect.

LIME

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

Quick lime shall be run to putty immediately after delivery to site in a pit dug on the site or in approved containers. 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.

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.

CEMENT MORTAR

The cement mortar (1:3) shall be composed of 42.5 kgs. of Portland Cement to 0.085 cubic metres of sand. The cement mortar (1:6) shall be composed of 42.5 kgs of Portland Cement to 0.17 cubic metres of sand measured in specially prepared gauge boxes and thoroughly mixed in an approved mechanical mixer or mixed dry on clean and approved mixing platforms with water added afterwards until all parts are completely incorporated and brought to a proper consistency. The use or retempering of wholly or partly set mortar will not be allowed.

Foundation walling up to ground floor slab 1 part cement to 6 parts sand.

GAUGED LIME MORTAR

Gauged lime mortar shall be composed of 2 parts by volume of lime putty to 12 parts by volume of sand measured in specially prepared gauge boxes and mixed dry on clean and approved mixing platforms with water added afterwards until all parts are thoroughly incorporated and brought to a proper consistency.

The mortar shall be mixed 7 to 10 days before it is required for use and shall be stacked in a neat heap well smoothed off, covered with wet sacks and allowed to mature.

Immediately before use 1 part by volume of Portland Cement shall be added to 9 parts by volume of lime mortar, the whole being remixed with the addition of extra water until all parts are completely incorporated and brought to a proper consistency.

The gauged mortar must be used within 45 minutes of being mixed and the use or retempering of wholly or partially set mortar will not be allowed.

Above ground floor slab 1 part cement to 3 parts lime to 15 parts sand.

CONCRETE BLOCKS

Concrete blocks shall be hollow or solid as required and shall be hard, true to size and shape with sharp arrises in accordance with B.S. 2028 type 'A'. They are to be obtained from an approved manufacturer and shall be equal in every respect to a sample to be deposited with and approved by the Architect. Blocks must be cured at least 4 weeks before delivery to site and the Contractor is to order his entire stocks as soon as the Contract is signed. Before bulk delivery commences and thereafter, if the Architect so directs, the Contractor shall dispatch twelve sample blocks to the M.O.W. Materials Testing Laboratory. Should tests indicate that the blocks do not comply with the Specification, the batch from which they were taken shall forthwith be removed and re-executed or otherwise rectified at the Contractor's expense. Blocks shall be generally 390mm long, 190mm high and of the thicknesses required for the walling to be built. Blocks of other sizes will, however, be required to form proper bondings at corners, around openings, etc. and the like positions and the Contractor must make or cut blocks to all the varying sizes required for these purposes.

LOAD BEARING CONCRETE BLOCKS

Blocks described as load bearing shall have the minimum compressive strengths specified for each block, determined and tested in accordance with the appropriate B.S. and to the entire satisfaction of the Architect. Blocks of the various strengths shall be differentiated by means of an approved colour code marking.

COLOURED CONCRETE BLOCKS

Concrete blocks described as coloured shall contain colouring pigment mixed integrally with the materials to produce the required tint or shade. The mix of materials contained in the blocks is to be adjusted as and if necessary to maintain the materials to produce the required tint or shade. The mix of materials contained in the blocks is to be adjusted as and necessary to maintain the specifications of strength etc. Unless otherwise described blocks are to be laid jointed and pointed in mortar containing pigment mixed integrally to produce a tint or shade matching that of the blocks. The mix of materials contained in the mortar is to be adjusted as and if necessary to maintain the specifications of strength, etc.

HOLLOW CLAY BLOCKS

Hollow clay blocks are to be hard, well burnt, true to size and shape with sharp arises and keyed faces and joints in accordance with B.S. 1190 Type 'A'. They are to be equal in every respect with a sample to be deposited with and approved by the Architect. The hollow clay blocks are to be bedded and jointed in gauged mortar.

FAIR FACED CONCRETE BLOCKWORK

Fair faced concrete blockwork shall be built in ordinary blocks selected for their uniformity and appearance and shall be free from holes or any other deformities and shall have clean, sharp arises. The blocks shall be built in mortar as described and raked out and pointed with a neat flush joint as the work proceeds, unless otherwise stated. All arises shall be plumb and square, and all joints properly bonded and true to line.

STONE WALLING

The stone for walling shall be sound and hard throughout free from all defects and shall be obtained from a quarry approved by the Architect. Samples shall be submitted for approval and, if approved, shall be regarded as the standard for the work generally. All stone rejected by the Architect shall be removed immediately from the site. Stones shall be laid on their natural beds and properly lapped and bonded and thoroughly wetted before laying and again after laying for at least three days. Stones shall be chisel dressed into true rectangular blocks with each surface even and at right angles to all adjoining surfaces and shall generally be not less than
390mm long, 190mm high and of the thickness required for the walling to be built. Extra over for fair face shall mean 'fine or medium butched chisel dressed' to an even surface, built with a fair face and raked out and pointed with a neat recessed joint as the work proceeds. All arrises shall be plumb and square and all joints properly bonded and true to line. Fine or medium butched chisel dressed walling shall be in regular courses.

If required by the Bills of Quantities, coloured stone walling and fair face dressings shall be as described below:-

1) Fine butched stone shall be either chisel dressed or machine dressed - dress the external face of each stone to the finest face practically obtainable and finish to a fine rubbed plane surface.

2) Medium butched chisel dressed stone - chisel dress the external face of each stone so that chisel marks are approximately the same width, with ridges between adjacent marks approximately in the same plane.

3) Quarry faced stone - do not work the external face of each stone.

4) Random rubble stone facing - stones of random shape, colour and size as facing to backing wall.

5) Random squared medium butched chisel dressed stone - stones of random shape, colour, size and thickness squared and dressed as before described.
6) Stone walling of approved colour - walling to be built using grey and mixed blue and grey coloured stones.
7) Stone walling of variegated colours - walling to be built using multi colour stone approved by the Architect and mixed in proportions approved by the Architect.
8) Machine dressed stone facing shall be 25mm or 50mm thick as required by the Architect. Machine rotary blade cut stones facing on backing wall.

The finished mortar joint for fine or medium butched chisel dressed stonework is to be 10mm wide and generally 5mm back from the face of the stone. Where directed by the Architect the mortar will be coloured to match the stones.

Stone walling described as load bearing shall have a minimum crushing strength of 10 Newtons per square mm.

On completion all stonework is to be scrubbed down with a wire brush.

BRICK FACINGS

Brick facings shall be of hand scratched bricks size 65mm high x 65mm deep x 230mm long as manufactured by Clayworks Ltd., P.O. Box 48202, Nairobi, with 10mm horizontal joints only raked out 10mm deep as the work proceeds. Wall ties shall be 18 gauge butterfly shaped galvanised mild steel wire staggered at 450mm centres vertically and 900mm centres horizontally. Supports at heads shall be with approved steel angles. Strict supervision of quality will be maintained by the Architect and all work will be in accordance with a sample panel to be approved by the Architect prior to the start of facing works.

WALLING GENERALLY

The Contractor shall provide proper setting out rods and set out all work on same for courses, openings, heights, etc., and shall build the walls, piers, etc., to the widths, depths and heights indicated on the drawings.

Concrete blocks shall be thoroughly wet before being laid and shall be kept wet during that day. Where unfinished work is continued, the completed walling shall be wetted before laying mortar.

All walls throughout the work shall be carried up evenly in 200mm courses, no part being carried up more than 1m higher at one time than any other part, and in such cases the jointing shall be made in long steps so as to prevent cracks arising, and all walls shall be levelled round at each stage. All faces of walls to be plastered are to have all the joints raked out as key for plaster.

Alternate courses of walling at all angles and intersections shall be carried through the full thickness of the adjoining wall. All walling shall be built up entirely solid in blocks, without voids. All perpends, reveals and angles of the walling shall be built strictly true and square and all walling shall be flushed up and grouted solid as the work proceeds.

All putlog holes shall not be less than one course deep and carefully filled with a block cut to fit size of opening with beds and joints filled with mortar well tamped in after scaffolding is removed and if in fair faced wall to match facings.

All walling 150mm thick and under is to be reinforced with one layer of 25mm x 16 B.W.G. hoop iron built into every second course well lapped at joints and intersections and carried at least 115mm into abutting walls at junctions.

Where concrete and stone walling are bonded together at intersections or heading joints the horizontal cement mortar beds shall not exceed 15mm thickness and vertical joints are to be staggered.

DAMP PROOF COURSES

The damp proof course is to consist of a 25mm screed of cement and sand (1:2) laid over the area of the walls and finished to a level surface and covered with and including an approved fibre based bituminous damp proof course weighing not less than 2.7 kgs. per square metre and lapped 225mm at all joints and intersections. All walls are to be carefully cleaned and wetted before the screed is laid.

OTHER TRADES

Close co-operation with electrical and plumbing Sub-Contractors must be maintained from the beginning of the job to avoid chases being cut in hollow block or 100mm solid block work or across any fair faced work. If necessary, conduits should be run down the jambs of the door openings behind the door frame and taken to the switch position through a horizontal joint in the masonry.

ROOFING

SCREEDS

Roof screeds where specified shall be as described in 'Floor, Wall and Ceiling Finishes'.

GUARANTEE

The Contractor and the Roofing Sub-Contractor are to leave all the roofs complete and watertight, unmarked with cement or bitumen particularly flashings and external finishes and with joints in straight and even lines.

The Contractor must submit to the Employer a ten year guarantee for the roof coverings against leakage. If a Sub-Contractor is to execute the roofing the Contractor is responsible for obtaining this guarantee for them for submission to the Employer.

ALUMINIUM EMBOSSED CAP SHEET ROOF COVERING

The cap sheet covering shall be Cabro 42 S.W.G. aluminium embossed cap sheet covering with underlayers of saturated felt, as manufactured by Cabroworks Ltd., P.O. Box 98567, Mombasa, and laid by an approved Sub-Contractor in strict accordance with the manufacturer's printed instructions.

MASTIC ASPHALT ROOFING

All asphalt roofing shall be manufactured and applied in accordance with B.S. 988 Mastic Asphalt for Roofing (Limestone Aggregate). Proportions of component ingredients shall be generally within the limits laid down in the B.S. but the ratio of bitumen to Lake asphalt shall be appropriate for use in tropical climates. The asphalt shall be applied in two coats each of 10mm thickness laid to the falls formed in the screeds, by an approved Sub-Contractor.

The first coat of all horizontal work shall be laid on a single layer of black sheathing felt complying with B.S. 747, Table 4A (i) laid and lapped in accordance with the manufacturer's instructions. Rates for asphalt shall include for underlay.

All vertical surfaces, tops of parapets, gutter sides and bottoms shall be finished with one coat of bituminous aluminium paint. All other surfaces shall have a 12mm layer of black trap chippings graded from 6 - 12mm, laid loose.

MASTIC ASPHALT TANKING

All asphalt tanking shall be manufactured and applied in accordance with B.S. 1097 by an approved Sub-Contractor.

ASBESTOS CEMENT SHEETING

Asbestos cement roof sheeting and accessories shall be as manufactured by Kenya Asbestos Cement Co. Ltd., P.O. Box 90662, Mombasa, and fixed strictly in accordance with their printed instructions and generally in accordance with International Standard 459.

The sheeting will be fixed to steel purlins with galvanised hook bolts and patent P.V.C. combined capping, rubber washer and metal nut.

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

Ridges and other accessories shall be fixed to timber purlins as above described.

Fixed bolts and screws shall comply with B.S. 1494.

Side laps shall be minimum one and a half corrugations and end laps shall be as specified.

GALVANISED CORRUGATED IRON SHEETING

Roof sheeting and accessories shall be pre-painted galvanised steel as manufactured by Galsheet Kenya Ltd., P.O. Box 78162, Nairobi, and fixed strictly in accordance with their printed instructions and generally in accordance with international standards.

ROOFING TILES

The roofing tiles shall be as specified, of approved quality and manufacture, uniform in size, shape and colour, free from twist or other defects to be obtained from an approved manufacturer, supplied and fixed in accordance with the manufacturers specifications and recommendations.

The ridge and hip shall be socketed tiles of approved quality, shape and manufacture, to match the roofing tiles in colour with rebated joints and free from twist and other defects.

The roofing tiles shall be hung on timber/concrete battens and shall be laid to accurate gauge and each roof shall be set out to take an exact number of tiles without cutting.

Hip and ridge tiles to be bedded and jointed in cement mortar (1:4) and pointed at joints and ends and intersections in coloured cement to match colour of tiles. All angles and intersections shall be neatly cut and rubbed to form a close joint.

CARPENTRY, JOINERY AND IRONMONGERY

QUALITY OF TIMBER

The qualities of timber stated hereinafter are to be in accordance with the Grading Rules (Third Edition) dated 8th April, 1959, approved by the Forest Department of Kenya.

All timber described as 'Sawn Podocarpus' shall be Second (Select) Grade Sawn Podocarpus Gracilior.

All timber described as 'Sawn Cypress' shall be Second Grade Sawn Cupressus.

All timber described as 'Wrot Cypress' shall be First (Prime) Grade Wrot Cupressus.

All timber described as 'Wrot Cedar' shall be First (Prime) Grade Wrot Red Cedar (Juniperus Procera).

All timber described as 'Wrot Meru Oak' shall be First (Prime Grade Wrot Meru Oak).

All timber described as 'Wrot Camphor' shall be First (Prime) Grade Wrot Camphor specially selected for straight grain and colouring. No joinery work is to be put in hand until the Architect has seen and approved the colour and grain of the timber.

Where hardwood is specified it shall be Mvuli, Mahogany, Mninga, Camphor, Rosewood, Blackwood or Meru Oak as selected by the Architect at the letting of the contract and all tenders will be deemed to have allowed for this.

When employed for carpentry work the above timbers shall be well seasoned to a moisture content not exceeding 18% of the dry weight.

When employed for joinery work the above timbers shall be well seasoned to a moisture content not exceeding 6% of the dry weight.

GENERALLY

All timber for permanent work in the buildings shall before use, be dry and be approved by the Architect for quality in accordance with the foregoing specification for its respective grade. All structural timber shall be in accordance with C. P. 112.

All Carpenter's work shall be left with sawn surfaces unless particularly specified to be wrot. Scantlings and boarding shall be accurately sawn and shall be left uniform in width and thickness throughout. All Carpenter's work shall be accurately set out together and securely fixed in the best possible manner with properly made joints. Provide all brads, nails, screws, bolts, etc. as necessary. Nails shall comply with B.S. 1202 and bolts with B.S. 916.

Knotting shall comply with B.S. 1336

Variations from specified dimensions of scantling shall not exceed the tolerance stated in the aforementioned Grading Rules. Boards 25mm thick or less shall hold up to the specified sizes. All timber shall be as long as possible and practicable to eliminate joints.

Ends of timbers required to be built into walls shall have 12mm space between same and walling. All ends of timbers to be strapped with hoop iron and primed.

All Joiner's work shall be wrot unless otherwise specified.

All mouldings shall be accurately run and finished and all arrises shall be slightly rounded. Framed work shall be cut out, properly tenoned, shouldered, etc., and framed together as soon after the commencement of the works as is practicable but should not be wedged up until required for fixing in position and any portions that warp, get in winding, develop shakes or other defects shall be replaced with new. As soon as required for fixing in position the framing shall be glued together with best quality glue and properly wedged or pinned, etc., as described.

Unless otherwise described oval or round brads will be used for fixing all face work, all heads shall be properly punched in. Where described as pellated work shall be countersunk screwed and the screw heads covered with timber pellets to match the adjacent timber.

Should any of the Carpenter's or Joiner's work shrink, warp, wind or develop any other defects within six months after the completion of the works, the same shall be removed and new fixed in its place together with all other work which may be affected thereby, all at the Contractor's cost and expense.

INSECT DAMAGE

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

DIMENSIONS

(a) Timber not specified to be wrought shall be as from the saw and full to the nominal dimensions stated. No undersizes shall be permitted but oversize to the following tolerances may be allowed:-

(i) 1.5mm oversize on dimensions up to 25mm

(ii) 3mm oversize on dimensions up to 50mm

(iii) 6mm oversize on dimensions over 50mm.

(b) Where 'nominal' dimensions are stated for wrot timber a tolerance of 3mm shall be allowed for each wrot face.

Before putting in hand any joinery work, whether built-in or fixed later, the joiner is to ascertain and check on site all dimensions which affect or govern the joinery work.

PRESERVATION OF TIMBER

All timber described as impregnated shall be vacuum pressure impregnated with Tanalith or Celcure preservative in accordance with Specification No. 1/56 (Buildings) for the Vacuum/Pressure Impregnation of Timber with Hickson's 'Tanalith' wood preservative issued by Hickson's Timber Impregnation Co. (G.B.) Ltd., or other approved source. Where timber is cut or bored after impregnation the exposed surfaces are to be liberally swabbed with Wolmanol.

SPECIES OF TIMBER

Only those timbers specified in these Bills of Quantities are to be used for the works, unless alternatives are authorised by the Architect.

SEASONING OF TIMBER

All carpentry timbers are to be seasoned to a moisture content of not more than 18% of the dry weight. All joinery timbers are to be seasoned to a moisture content of not more than 6% of the dry weight. The Contractor is to make available on site a meter for testing moisture content of all timber delivered.

PREPARATION AND PROTECTION OF TIMBER

(a) All timber necessary for the works is to be purchased immediately the Contract is signed, and when delivered is to be open stacked for such further seasoning as may be necessary. Preparation of the timber is to be commenced simultaneously with the commencement of the works generally.

(b) All timber and assembled woodwork is to be protected from the weather and stored in such a way as to prevent attack by decay, fungi, termites or other insects.

CLEARING UP

The Contractor is to clear up and destroy or remove all cut-ends, shavings and other woodwaste from all parts of the buildings and the site generally as the work progresses and at the conclusion of the works.

TIMBER IN MASONRY, ETC.

Ends of timber built into walls shall be thoroughly brush treated with creosote or other approved preservatives and clean air space maintained around the timbers where they adjoin the walls.

PRIMING WOODWORK

All woodwork which is to be painted or hidden from view, backs of door frames, etc. are to be primed and painted one coat before fixing. Allow for touching up priming during progress of works.

JOINTING

(a) All joints must be made as specified or detailed and the execution of all jointing shall be to the satisfaction of the Architect.

(b) Joining surfaces of all connections exposed to the weather are to be thickly primed except where glueing is specified. Surfaces are to be in good contact over the whole area of the joint before fastenings are applied.

(c) No nails, screws or bolts are to be placed in any end split. If splitting is likely or is encountered in the course of the work, holes for nails are to be pre-bored at diameters not exceeding 4/5ths of the diameter of the nails. Clenched nails must be bent at right angles to the grain. Lead holes are to be bored for all screws.

(d) Where the use of bolts and washers are specified the holes are to be bored from both sides of the timber and are to be a diameter D + 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.

(e) 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, sprigs,etc., are to be punched and puttied.

(f) Loose joints are to be made where provision must be made for shrinkage, glued joints where shrinkage need not be considered and where sealed joints are required. All glued joints shall be crosstongued or otherwise reinforced.

(g) Glues for load-bearing joints or where conditions may be damp must be of the resin type. For non-load-bearing joints, or where dry conditions can be guaranteed, casin or organic glues may be used.

JOINERY

(a) All joinery shall be accurately set out on boards to full size for the information and guidance of artisans with all joints, ironwork and other works connected therewith fully delineated. This setting out shall be submitted to the Architect and approved before the work is commenced.

(b) All joinery shall be executed with workmanship of the best quality in strict accordance with the detailed drawings. All mouldings, shall be accurately and truly run and all work planed, sand-papered and finished to the approval of the Architect.

(c) All framed work shall be cut out, properly tenoned, shouldered etc., and framed together as soon after the commencement of the building as is practicable but shall not be wedged up until th building is ready for fixing the same and any portions that warp, wind, develop shakes or other defects shall be replaced with new. As soon as required for fixing in the building the framing shall be glued together and properly wedged or pinned, etc., as directed.

(d) Should any of the joinery shrink, warp, wind or develop any other defects within the maintenance period specified in the Contract the same shall be removed and new fixed in its place together with all other work which may be affected thereby. All at the Contractor's expense.

TOLERANCE

Reasonable tolerance shall be provided at all connections between joinery works and the building carcass, so that any irregularities, settlement or other movements shall be adequately allowed for.

SCRIBING

All cornices, architraves, frames and other joinery works shall be accurately scribed to fit the contour of any irregular surfaces against which they may be required to form a close butt connection. In particular, architraves are to be cut to fit against side walls and maintain proper mitres at top corners.

SHRINKAGE

The arrangement, jointing and fixing of all joinery shall be such that shrinkage in any part and in any direction shall be compensated for and not impair the strength or appearance of the work or cause damage to adjacent structures

VENEERS

All veneers are to be specially selected for grain and colouring and no veneered work shall be put in hand until the Architect has approved the sample of grain and colour.

NATURAL FINISH

When natural finish is specified, the timber in adjacent pieces shall be matched and uniform or symmetrical in colour and grain. The surface finish is to be as specified.

FLUSH DOORS

Flush doors shall be 3mm plywood faced doors with solid or semi-solid cores, in accordance with B.S. 459 Part 2, obtained from a manufacturer approved by the Architect and equal in every respect to a sample to be submitted to and approved by the Architect. Doors shall be lipped with hardwood strips on all edges and shall be finished for painting on both faces unless otherwise stated. Plywood for use on external doors shall be of exterior grade as described later.

The proportion of solid area in semi-solid doors shall not be less than 50% of the total and shall be evenly distributed throughout the door.

CHIPBOARD

Chipboard shall comply in all respects with B.S. 2604 for medium density resin bonded wood chipboard and shall be veneered or not as shown on the drawings and as described in the Bills of Quantities. Chipboard of non-British origin shall comply with the tests enumerated in the said B.S. and samples shall be submitted to the Architect for this purpose and for his approval.

BLOCKBOARD

Blockboard is to be of approved quality, solid and glued throughout. Where described as faced it shall be faced with an approved veneer of the timber specified.

PLYWOOD

Plywood shall be in accordance with B.S. 1455 and shall be of second grade and that for use externally shall be of external grade conforming at least to Clause 138 of the B.S.

HARDBOARD

Hardboard shall be oil-tempered or otherwise as specified of the thicknesses specified and is to be glued and fixed with the special hardboard nails supplied by the manufacturer. Sheeting is to be wetted the day before fixing. All sawn edges to be carefully sandpapered.

SOFTBOARD

The softboard is to be of approved quality and manufacture, fixed with galvanised clout nails or an approved adhesive as necessary, or both as specified.

PLASTIC LAMINATE

Plastic laminate shall be as manufactured by Formica Ltd. or other equal and approved and shall be worked and fixed strictly in accordance with the manufacturer's instructions with the adhesive recommended by the manufacturer. Colours shall be selected by the Architect from samples to be submitted early in the Contract.

PLUGS

All plugs described as fixing for joinery etc., shall be approved plugs such as Rawlplugs or Philplugs set into holes drilled in masonry in accordance with the manufacturer's instruction. No wooden plugs are to be used.

PROTECT JOINERY

Any fixed joinery which is liable to become bruised or damaged in any way shall be properly cased and protected by the Contractor until the completion of the works.

SITE DIMENSIONS

Before putting in hand any joinery work, whether to be built in with the carcass or fixed later, the joiner is to ascertain and check all dimensions on the site which affect or govern joinery work.

BILLS OF QUANTITIES DIMENSIONS

All wrot timber dimensions given in the Bills of Quantities are finished sizes unless otherwise stated.

IRONMONGERY

The Contractor is to check consignments of ironmongery upon receipt and store them in safe keeping until required for fixing.

All ironmongery shall be fitted and fixed in accordance with the manufacturer's instructions. Rates for fixing are to include for all cutting, sinking, boring, morticing and fitting in hardwood or softwood and for supplying all necessary and matching screws. Rates for door furniture shall also include for fixing before painting, removal during painting operations and afterwards fixing and for labelling all keys with door references and handing to the Architect upon completion.

All locks, springs and other items of ironmongery with movable parts shall be properly tested, cleaned and adjusted where necessary and left in perfect working order upon completion of the works by the Contractor who shall include for this in his prices for fixing.

GENERALLY

All pencil marks are to be removed before oiling or varnishing joinery work. Leave all joinery work perfect and clean without nail holes; clean up all waste and protect finished work from staining or damage. Oil all locks and adjust to give a perfect fit and leave clean.

METAL WORK

GENERALLY

All materials shall be of the best of their respective kinds and conform at least to the relevant B.S. where such exists. All work shall be carried out strictly as directed and approved by the Architect before fixing.

WELDING

Welding shall comply with the provisions of B.S. 538.

MILD STEEL

Shall be of approved manufacture complying with the requirements of B.S. 15. Welding to comply with the requirements of B.S. 538, 938 and 1856. Screws, bolts, washers, etc., to comply with the requirements of B.S. 916 and 1494.

GALVANISED STEEL SHEET

Shall be of approved manufacture, free from all defects and shall hold up to the gauge specified. Galvanising shall be to B.S. 729 Part 7.

BOLTS AND SET SCREWS

All bolts to be the best screw bolts with hexagonal heads and nuts and round washers.

Set screws to be similar but with circular flat slotted head for screwing or with round countersunk slotted head, similar to a wood screw, the threaded end suitable for screwing into tapped steel to the required depth.

ALUMINIUM

Aluminium sheet shall comply with the requirements of B.S. 1470 and be suitable for the purpose required.

Extruded aluminium sections shall be obtained from an approved source and be equal to samples to be submitted to and approved by the Architect. The surface finish shall be matt.

HOOP IRON.

Provide 25mm wide 24 gauge hoop iron reinforcement and anchors to be laid where specified under masonry, and anchored in ring beams.

PRICING INFORMATION

Prices for all welded work shall include for preparing, welding and grinding to a smooth finish.

FLOOR, WALL AND CEILING FINISHES

GENERALLY

The whole of the plasterwork and other wall, floor and ceiling finishes shall be executed to the entire satisfaction of the Architect and any work rejected shall be taken down and re-executed by the Contractor at his own expense. All scaffolding, temporary rules and screeds, tools or special appliances required shall be furnished by the Contractor.

CEMENT

Shall be as described in 'Walling'

LIME

Shall be as described in 'Walling'

SAND

Shall be as described in 'Walling'

WATER

Shall be as described in Structural Engineers Specification.

WORKMANSHIP

All concrete beds or slabs shall be thoroughly brushed, cleaned, hacked if necessary and well wetted and flushed over with a cement and sand (1:1) grout immediately before screeds or pavings are laid.

Screeds and cement pavings shall be laid in accordance with the relevant B.S. Code of Practice and in alternate bays generally not exceeding 3m x 3m with neat butt joints and shall be damp cured with sand or sawdust and kept damp for at least 7 days after laying.

Adequate time intervals must be left between successive coats in two coat work in order that the drying shrinkage of the under-coat may be substantially complete. All internal and external angles shall be pencil rounded.

BOARD MARKED FINISH

Board marked finish is to be provided where shown on the drawings and shall be priced against the formwork item of 'Extra over formwork for board marked finish'.

The shuttering boards shall be heavily grained knotty cypress, or similar and approved, well seasoned and free of wind and shakes. The boards shall be in 100mm widths fixed vertically or horizontally as directed. The edges shall be butt jointed to maintain a flat surface. Unless otherwise approved, boards shall have a maximum of four uses and between each use shall be carefully cleaned from adhering grout and lightly oiled with an approved non-staining mould oil.

Every care and attention shall be paid to obtaining and maintaining throughout the course of the works a satisfactory visual appearance, free from blow holes, hungry patches and other blemishes and uniform in colour and texture.

Construction joints shall be as shown on the drawings or otherwise the pour each day shall be as directed by the Engineer.

Samples panels will be required for approval of the Engineer before work commences.

Protective covering is to be applied as necessary where finished concrete is liable to damage or staining.

CEMENT AND SAND PAVING.

Cement and sand paving shall be composed of one part cement to one part sand to three parts of 6 - 3mm gauge black trap grit, applied in two coats to the thickness shown on the drawings. The Contractor shall allow for finishing surfaces perfectly smooth and hard with a steel trowel and dead level or to true falls if so desired.

SCREEDS AND BACKINGS

Screeds and backings shall be composed of one part of cement to three parts of sand unless otherwise specified in the Bills of Quantities by volume and shall be trowelled hard and smooth to the texture required by the finish to be applied.

WATERPROOFING AGENT

Screeds and pavings described as incorporating waterproofing agent shall have Lillington's No. 1 Metallic Liquid or similar mixed in. Mixing and application shall be strictly in accordance with the manufacturer's instructions.

BONDING LIQUID

The bonding liquid shall be Sealocrete Sealobond high P.V.A. content brushed on. Surfaces to be treated shall be thoroughly cleaned down and be free from all loose material, dust, mould, oil, grease and any other foreign matter. The bonding liquid shall be allowed to dry before screeds and renderings are applied. All mixing and application shall be carried out strictly in accordance with the recommendations of the manufacturers, Sealocrete Products Ltd.

HARDENING AGENT

Screeds and pavings described as incorporating hardening agent shall incorporate Sealocrete Double Strength Premix Plus S.R.A. mixed with the gauging water at the rate of 2.3 litres of Sealocrete to every 50 kgms. of cement. Mixing and application shall be carried out strictly in accordance with the recommendations of the manufacturers, Sealocrete Products Ltd.

TERRAZZO AND GRANOLITHIC WORK

The whole of the terrazzo and granolithic work is to be carried out by a specialist Sub-Contractor who is to be specifically approved by the Architect and the Contractor will be required to make arrangements for the execution of this work and bear all expenses incurred. No change in the rates for this work inserted by the Contractor in these Bills of Quantities will be allowed.

The materials used and method of construction for terrazzo work are to be in accordance with the B.S. Code of Practice C.P. 204/1951.

The surface finish to terrazzo or granolithic is to be brushed, ground or polished as specified. These textures are to comply with samples approved by the Architect.

The terrazzo topping is to be 20mm thick with imported white cement and 12mm marble aggregate, rolled and trowelled to a dense even surface and rubbed down at completion t a grit finished surface free from holes and blemishes. Colours shall be as selected by the Architect. The paving is to be laid in squares divided by plastic strips anchored securely in the screed and having their top edges truly level with the finished floor surface. The terrazzo work is to be laid and finished complete to the approval of the Architect. The screed between the terrazzo topping and the concrete floor is to be cement and sand (1:3) laid by the Sub-Contractor.

The granolithic topping is to be 15mm thick and shall consist of one part coloured cement to two parts aggregate to 6mm gauge mixed with 15% fine dust. Aggregate is to be 70% black trap and remainder approved local coloured stone. Colours shall be as selected by the Architect. Paving is to be rolled and trowelled to a dense even surface and rubbed down at completion to a grit finished surface free from holes and blemishes. The paving is to be laid in squares divided by plastic strips anchored securely in the screed and having their top edges level with the finished floor surface. The granolithic work is to be laid and polished complete to the approval of the Architect. The screed between the granolithic topping and the concrete floor is to be cement and sand (1:3), laid by the Sub-Contractor.

The Contractor is to twice scrub the topping with soap and water before twice wax polishing and handing over.

MARBLE

Marble floor paving or wall cladding shall be compact and dense with a density of 2700 Kg/m3 as manufactured by Athi River Mining Ltd., P.O. Box 41908, Nairobi or other equal and approved, fixed in accordance with BS CP 298:1972 and manufacturer's instructions all to the Architect's approval. For floor paving, marble must be hardwearing and non-slip.

The marble supplier shall prepare fully dimensioned drawings from details supplied by the Architect and from site survey. Key numbers of each store shall be shown, together with details of all metal anchorages. No marble shall be fixed/laid until these drawings are approved by the Architect and the Contractor and local authority if necessary.

Exposed surfaces shall be finished in accordance with an approved sample.

Cramp holes and mortices shall be carefully drilled or cut to avoid stunning or fracture of the material adjacent to the hole or mortice.

The fixing cramps shall be adequately inset into the supporting background, preferably with under cut dowel holes and grouted in (1:3) cement/sand mortar, or other equal and approved epoxy/polyester resin mortars. A cavity between cladding and backing of 20mm minimum should be maintained except where dabs of weak mortar or lime putty are required to position the slabs. The back of slabs shall be coated with "shellac" or other equal and approved paint.

Metal anchorage shall be made from suitable non-ferrous metal and shall be of such size and dimension adequate to support loads imposed on them.

The length and height dimensions of individual dimension of slabs shall be $\pm$ 1mm of the specified sizes. Thickness shall be within 3mm from that specified except on the exposed ends.

Internal wall cladding shall be fixed with tight joints and external cladding shall have 3mm joints. All joints to be filled with coloured cement and sand mortar to match marble. Paving shall be bedded solid on cement and sand screed.

The whole of marble work is to be executed by an approved Sub-Contractor.

QUARRY TILES

Where indicated lay approved clay quarry tiles bedded in cement. Joints to be 10mm wide and slightly recessed pointed in pigmented cement colour to match colour of quarry tiles to the approval of the Architect. Quarry tiles are to be laid as skirtings to these areas. Cement must not be smeared over the face of the tiles which must be selected for variety of colour and evenness of size.

VINYL ASBESTOS FLOOR TILES

Vinyl asbestos floor tiles shall be of the thickness specified as manufactured by Dunlop Kenya Ltd., or other equal and approved, and of colours to be selected by the Architect and shall be bedded in suitable mastic to a square pattern.

The whole of the floor tiling is to be executed by an approved Sub-Contractor.

Screeds must be perfectly smooth level clean and dry before laying commences and tiling must be laid strictly in accordance with the manufacturer's instructions. Tiles shall comply with B.S. 3260 and 3261 respectively. Prices shall include for giving the floor coverings two coats of an approved emulsion wax floor polish or other approved protective coating.

PARQUETRY

Parquetry is to be 8mm thick on building paper or similar backing bedded in hot bituminous mastic. After laying remove backing paper, sand to a smooth surface and finish with three coats of Polyurethane matt clear sealer.

The whole of the parquetry is to be executed by an approved Sub-Contractor. Screeds

must be perfectly smooth level clean and dry before laying commences and parquetry must be laid strictly in accordance with the manufacturer's instructions.

DIVIDING STRIPS

Dividing strips shall be 3mm thick and of a similar height as the paving in which they are embedded. Strips shall be cut to lengths and embedded in the pavings to form margins or bays to a detailed pattern or between differing floor finishes.

Prices for dividing strips are to include all necessary cutting required to ensure a flush level surface with the paving.

NON-SLIP POLISHED PAVINGS

Where pavings are described as non-slip they shall have carborundum dust sprinkled evenly over the surface at the rate of one kilogram per square metre lightly trowelled in whilst still green.

LIGHTWEIGHT SCREEDS

Lightweight screeds shall be composed of cement, sand and approved lightweight vermiculite (1:4:8) finished with a minimum 12mm thickness of cement and sand (1:5) laid whilst the base course is still green and trowelled smooth to the satisfaction of the roofing or flooring Sub-Contractor. Alternatively an approved pumice aggregate screed may be used to the approval of the Architect.

The Architect reserves the right to delete the lightweight screeds from the Contractor's work and to order their execution by a Nominated Sub-Contractor. No claim for loss of profit will be entertained in this eventuality.

DUST PROOFING COMPOUND

Concrete surfaces to be dust proofed shall have two coats of Sealocrete Concrete Surface Dressing applied in accordance with the manufacturer's instructions.

PLASTERING AND RENDERING GENERALLY

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 arrises 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.

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 Architect after which all plastering executed in the work shall conform to the respective approved samples.

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.

Rates for plastering and rendering are to include for raking out joints of walling or hacking concrete to form a key. Instead of hacking the Contractor will be permitted to treat concrete surfaces, at his own expense, with bonding fluid, such as 'Plastaweld' manufactured by I. Manger and Son Ltd., or other equal and approved applied in strict accordance with the manufacturer's printed instructions.

INTERNAL PLASTER

Internal plaster shall be applied in two coats as follows, overall 12mm thick unless otherwise described:-

(a) 9mm First coat consisting of cement, and sand (1:4) well scratched, wetted and keyed to receive finishing coat.

(b) 3mm Finishing coat consisting of cement and lime putty (1:5) skim coat finished with a steel trowel to a smooth and even surface. Adequate time intervals must be left between successive coats in order that the drying shrinkage of the under coat may be substantially complete. All internal and external angles shall be pencil rounded.

EXTERNAL RENDERING

External rendering shall consist of cement and sand (1:8) applied in one coat and finished with a wood float as specified. Unless otherwise described rendering is to be 12mm thick applied in one coat. Rendering described as 20mm thick or over shall be applied in two coats.

TYROLEAN RENDER

Tyrolean render shall be composed of Colocrete or Snowcrete coloured or white cement and a special aggregate supplied as Cullamix and mixed in the proportion of two and a quarter to two and a half parts Cullamix to one part water applied with an approved hand operated machine. A finished thickness of 6mm should be obtained in stages until the crisp texture is obtained completely obliterating the background surface and as approved by the Architect. An equivalent made-up mixture with an approved aggregate similar to Cullamix may be used with the Architect's approval.

JOINTS

At junctions of structure frame and panel walling, cut through the entire thickness of plaster with a trowel leaving a gap of not more than 1mm width.

CRACKS AND DEFECTS

The Contractor shall cut out and make good all cracks, blisters and other defects and leave the whole of the plastering and rendering perfect at completion. When making good defects the plaster shall be cut out to a rectangular shape with edges undercut, to form dovetailed kay, and all finished flush with the face of the surrounding plaster.

BAGGING

All internal and/or external surfaces specified as bagged are to be treated with a complete covering of 1:4 liquid cement/sand wash thoroughly rubbed in with an old sack to fill all cavities.

CERAMIC TILES

Ceramic tiles shall be from an approved manufacturer, and shall conform with the requirements of B.S. 1281. Tiles shall be of standard quality and unless otherwise specifically described shall be size 200 x 250 x 6mm thick for walls and 200 x 200 x 8mm thick for floors. Tiles shall be laid with continuous 2mm wide straight joints with plastic spacers and internal angles shall be butt jointed. Plastic edge beads shall be used at all external angles and at edges of panels. Tiles shall be well soaked in water, bedded in approved tile adhesive, pointed in white cement, and cleaned and polished on completion.

SAMPLES

The Contractor shall without charge prepare samples of work as directed until the quality, texture and finish required are obtained and approved by the Architect, after which all work executed shall conform to respective approved samples.

APPROVED SUB-CONTRACTORS

The Contractor shall state on the form provided and included as a tender document, the names of the Sub-Contractors he proposes to employ, and he shall not employ any other Sub-Contractors for the work without the written permission of the Architect.

PRICING INFORMATION

Prices for paving, beds and screeds shall include for the preparation of the concrete floor and painting with cement grout, as described; for any extra thickness consequent upon the concrete floor not being finished to true levels; and for laying over electrical conduits including reinforcing as necessary to the approval of the Architect.

Prices for plastering and rendering shall include for the preparation of the surfaces including raking out joints of brickwork or blockwork and hacking surfaces of concrete to form key, and for any extra thickness or dubbing out consequent upon any irregularities or inaccuracies in the surfaces to be covered.

Prices for terrazzo and granolithic work shall include for beds and backings, executing in the colours selected by the Architect, laying to panels and designs as may be directed, and for polishing at completion. Dividing strips forming panels and designs will be measured and paid for separately.

Prices for external finishings shall include for executing work at any height above ground and for any necessary additional scaffolding, ladders, cradles, etc.

If required by the Architect, or if indicated on the drawings prices for internal plastering and external rendering shall include for forming a fair splayed edge at all junctions with fair faced concrete surfaces and for forming 12mm wide grooves with fair splayed edges at junctions of walls with structural members and at soffits of slabs etc. Prices shall also include for V-grooves or rounded grooves, not exceeding 12mm wide, in external rendering to form decorative panels.

Prices for beds and backings are to allow for a true and even finish with a steel float, which is to be scraped clean by the Contractor before receiving the finish, to the satisfaction of the finishing Sub-Contractor.

PROTECTING FLOOR FINISHINGS

The Contractor is to allow for protecting all floor and staircase finishings after laying, whether executed by himself or a Sub-Contractor and will be held responsible for any damage to the finishings after laying. All floors are to be cleaned on completion of the building before handing over.

GENERALLY

Protect all fittings, joinery and finishings from plaster and other finishings and clean up all marks on completion.

GLAZING

GENERALLY

All glass shall be of approved manufacture in accordance with B.S. 952, and free from flaws, bubbles, specks, and other imperfections cut to size to fit the opening for which it is required with not more than 1.6mm tolerance all round. All glass to be delivered in proper containers with maker's name, guarantee, type of glass and thickness or weight of glass attached to the outside of the container.

The clear sheet glass shall be Ordinary Glazing (O.Q.) quality sheet glass.

The obscured glass shall be of a pattern approved after the Contractor has submitted samples to the Architect at the beginning of the Contract.

Tempered glass shall be of the thicknesses specified.

The putty for glazing shall be tropical putty of approved manufacture suitable for glazing to metal or wood frames as hereinafter specified.

All putty shall be delivered on site in the original manufacturer's sealed cans or drums. The putty is to be removed from the drum well kneaded with the minimum of linseed oil and left for 24 hours before using.

The rebates and backs of handle brackets to metal windows shall be painted one coat before puttying. Before glazing the rebates of all windows shall be adequately back puttied.

Within 14 days the putty must dry and harden without wrinkling of the surface or caking and shall adhere satisfactorily to the surface of the glass and the frame.

The washleather strip shall be approved by the Architect and shall be cut to fit the exact line of bead.

The wires of Georgian wired glass, in adjacent panes, are to align both ways.

PRICING INFORMATION

Prices for glass shall include for all cutting and glazing to frames as described.

PAINTING AND DECORATING

GENERALLY

The whole of the work shall be executed to the entire satisfaction of the Architect, and all work rejected is to be re-executed by the Contractor at his own expense.

Subject to the foregoing, the methods of application adopted i.e. brush, spray, roller, etc. are at the discretion of the Contractor, unless otherwise described.

All paints shall be Grade A in accordance with the Ministry of Works approved paint list.

Sumps and drains shall not be used for the disposal of waste or dirty water.

MAINTENANCE

The Contractor shall make good after other trades have carried out maintenance work. In cases where the defective work is not caused by, or the responsibility of, the Contractor, or his Sub-Contractors, he should make arrangements for payment with the party concerned. Where cracks have been made good, apply two coats to the new filling and one coat to the whole wall in which the crack has appeared.

MATERIALS

Any deviation from the materials and makes specified must be approved in writing by the Architect to whom application must be made before decoration starts.

IRONMONGERY

All ironmongery already fixed is to be removed before painting doors and refixed on completion of the finishing coat. If any paint should get on to ironmongery, it must be removed with chemical solvents and not scratched off.

APPROVED SUB-CONTRACTORS

The Contractor shall arrange for the painting and decorating work to be executed by an approved Sub-Contractor. The Contractor shall state on the form provided and included as a tender document the name of the Sub-Contractor he proposes to employ and he shall not employ any other Sub-Contractor for the work without the written permission of the Architect.

MIXING

All materials shall be delivered on site intact in the original containers and shall be mixed and applied strictly in accordance with the manufacturer's printed instructions. No addition will be allowed to be made locally without the express permission of the Architect.

COLOURS

The priming, undercoats, and finishing coats shall each be of differing tints, the priming and undercoats shall be the correct brands and tints to suit the respective finishing coats, in accordance with the manufacturer's instructions. All finishing coats shall be of the colour and type specified by the Architect.

The Contractor will be required to paint trial panels and will be required to adjust tints as necessary.

AREAS TO BE READY FOR PAINTING ETC.

Before the painting or decorating is started the Contractor shall arrange that all other trades have been completed and other tradesmen removed from the vicinity of the area to be painted. All plaster, mortar, concrete, oil or stains of any kind shall be removed by the Contractor from work to be decorated before painting commences.

PREPARATION

Plastered and rendered surfaces to be decorated shall be allowed to dry for a minimum of four weeks before decoration commences.

Plaster finished with a steel trowel and fair face concrete surfaces shall be well rubbed down filled and made good as necessary and thoroughly cleaned down immediately before decoration is applied.

Plaster finished with a wood float or other rough textured surface of a similar nature shall be made good as necessary and thoroughly brushed clean immediately before decoration is applied.

Insulating board or similar surfaces shall be filled and made good as necessary and lightly brushed down to remove all dirt, dust and loose particles.

Metal work to be painted shall be scaled clean and thoroughly wire brushed.

Woodwork to be painted shall be well rubbed down. All knots shall be covered with good knotting before priming and all defects shall be filled with hard stopping after priming. Plywood shall be brush filled over the entire surface

Woodwork to receive finishes other than paint shall have all stains and pencil marks removed, be well rubbed down and have all defects levelled up with hard stopping of a colour to match the adjoining surface.

Woodwork to be clear varnished shall be well rubbed down and the varnish is to be applied with a chamois leather pad, rubbed back with fine graded steelwool between coats and afterwards buffed up to produce an approved finish.

All woodwork to be varnished is to have all pencil and other marks removed and surfaces smoothed down prior to application.

PAINTS

All paints used should be obtained from one of the following manufacturers after obtaining the Architect's approval and of the product specification hereinafter described.

a) Robbialac

b) Crown Paints

c) Dulux Paints

d) Sadolins

PLASTIC EMULSION PAINTS

Plastic emulsion paint for internal and external application shall be of a manufacture approved by the Architect.

BITUMINOUS SOLUTION

Bituminous solution for use on coated pipes shall be obtained from a manufacturer approved by the Architect.

PRIMERS

Unprimed steelwork shall be primed with a Red Lead Primer.

Galvanised steelwork shall be treated with a mordant solution and primed with a Zinc Chromate Primer.

Woodwork shall be primed with a Pink Wood Primer.

UNDERCOATING

The undercoat for use under enamel finishing coats shall be an approved undercoat.

PRODUCT SPECIFICATION FOR PAINTS

Product specification for paints shall be in accordance with the composition requirements and may be required to be tested by the M.O.W. Materials Testing Branch.

	1st Quality Emulsion Paint	2nd Quality Emulsion Paint	1st Quality Alkyd Gloss Paint
Non-volatile(B.S Content3900 B2)	Must not exceed 50% by weight	Not more than 60% by weight	Less than 50% by weight
Pigment Volume Concentration	Not more than 5%	Not more than 70%	Less than 25%
Resin type	Vinyl Acetate/ Acrylic Ester Copolymer	Vinyl Acetate/ Acrylic Ester Copolymer	Long Oil Alkyd minimum oil length not less than 60%
Opacity requirement (contrast ratio to B.S. 3900 D4)	Not less than 80%	Not less than 70%	Not less than 90%
Pigment/ Binder Ratıo	Not more than 2.25:1	Not more than 2.75:1	Not more 2.25:1

PRICING INFORMATION

The numbers of coats stated in the descriptions in these Bills of Quantities shall be applied in addition to any primers, stoppers, fillers, sealers, knotting, stopping, etc. required. The Contractor's prices shall be deemed to include for supplying and applying all such preparatory materials as may be required by the Standard Specification as recommended by the manufacturer of the finishing coat for the particular surface to be covered. The Contractor's prices shall further include for all other preparatory.

SECTION C

STRUCTURAL ENGINEERS SPECIFICATION

GENERAL

ARCHITECT OR ENGINEER

Where the word 'Engineer' is used in these descriptions of Materials and Workmanship, it shall in all appropriate cases be used and construed as the 'Structural Engineer'. For this purpose the Engineer shall be deemed vested with the duties of and be the representative of the Architect.

DISCREPANCIES IN DESCRIPTIONS

Descriptions of materials and workmanship contained in the Bills of Quantities measured items shall take precedence over descriptions contained in Appendices in the event of discrepancies between the two, unless the Engineer shall otherwise direct.

TESTS AND SAMPLES

Unless otherwise described in the Bills of Quantities, the Contractor will be responsible for all the costs involved in testing materials as described hereinafter. He will also be responsible for all the costs involved in supplying samples of materials or workmanship as required hereinafter to the satisfaction of the Engineer. The cost of replacing materials fixed or placed in position which do not comply with the required test results or approved samples shall be borne solely by the Contractor. Samples of materials shall be submitted as soon as possible after the Contract is let. No deliveries in bulk shall be made until the samples are approved by the Engineer.

STANDARDS

All materials and goods supplied for incorporation in the works must comply with any relevant standards issued by the Kenya Bureau of Standards or by the British Standard Institution.

EXCAVATION AND EARTHWORK

SITE CLEARANCE

Site clearance shall include the cutting down of all trees, stumps, bushes, vegetation and rubbish, burning the debris arising in approved locations, and carting remaining material to a tip provided by the Contractor.

GRUBBING

Grubbing up roots etc. shall include the following and disposal shall be as described under the foregoing clause :-

1. Stumps and roots of large trees shall be completely removed.
2. Stumps and roots of small trees, bushes or other vegetation shall be completely removed to a depth of at least 600mm below formation.
3 Smaller stumps and roots of vegetation up to 25mm thick shall be completely removed to a depth of 230mm below formation.
4. Fine roots shall be removed to as great depth as is practicable by hand.

Except where the area of grubbing is to be excavated, all resulting holes shall be filled up solid with approved material compacted to the same relative density as the surrounding material.

EXCAVATION

The Contractor is advised to visit the site and ascertain the nature of the ground to be excavated and he shall price accordingly and no claim will be allowed for want of knowledge in this respect.

Rates for excavation shall include for excavation in soil, earth, black cotton, sandy soil, murram, tuff, soft rock, boulders or whatever other subsoil is encountered, except hard rock as defined below.

HARD ROCK

Any rock or other hard materials encountered in excavating to the required depths which in the opinion of the Architect or Engineer can only be removed by wedges, compressed air or other special plant, or explosives shall be paid for as an extra and the price shall include for trimming and levelling. No blasting will be allowed without prior permission. Material which can be removed by pick or traxcavator, ripper or similar mechanical plant will not be classed as rock.

FOUNDATION EXCAVATIONS

(a)The foundation trenches and column bases shall be excavated to the widths and depths of the concrete foundations shown on the drawings or to such widths and depths as the Engineer may instruct after examination of the excavations. Quantities of all excavations shall be measured and valued by the Quantity Surveyor and any difference between such measurements and the measurements herein given shall be dealt with as a variation of the Contract. If, however, the Contractor excavates to any greater depths than shown in the drawings or as instructed by the Engineer, then he shall at his own expense fill in such extra depth of excavation with concrete as specified for the foundations, to the satisfaction of the Engineer. The Contractor shall not be paid for the cost of any excavation executed deeper or wider than shown on the drawings or instructed by the Engineer nor for the cost of back filling such excavation or disposing of surplus.

(b) The Contractor shall report to the Engineer when secure bottoms have been obtained to the excavations and are ready to receive the foundation concrete. Any concrete or other work put in before the excavations have been inspected and approved by the Engineer shall, if so directed, be removed and new work substituted in accordance with the specification after excavations have been approved, all at the Contractor's expense.

(c) The bottoms of all foundation trenches and column bases shall be trimmed square and level. The Contractor shall form such steps on bottoms of foundation trenches as the Engineer may consider necessary in such positions and to such depths as he may direct.

SURPLUS SOIL DISPOSAL

Excavated material not required for subsequent refilling shall be removed to areas off site which will be approved by the Architect.

TOP SOIL FOR SPREADING

Where required in the Bills of Quantities, top soil required for subsequent spreading over finished work shall be especially selected and shall be dumped in special heaps as indicated by the Architect. Such top soil shall be reasonably free from vegetation to the satisfaction of the Architect, and shall be compacted as little as possible in the heaps.

FILLING UNDER SURFACE BEDS IN BUILDINGS

Murram Filling

Murram for filling as base course shall be from an approved source and of the highest quality. It shall be laid in layers not less than 150mm thick and not greater than 230mm thick prior to compaction. Water will be applied to O.M.C. and each layer will be thoroughly compacted by at least 8 passes of a 10 tonne smooth wheeled roller or a 2 tonne vibrating roller until all movement ceases and 100% M.D.D. is obtained.

Hardcore Filling

Hardcore filling shall be crushed rock, broken brick, broken concrete or other approved hard granular materials 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 less 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 230mm. Where rolling by 10 tonne smooth wheeled roller or 2 tonne vibrating roller is impossible, compaction shall be by hand or mechanical tampers. Each layer shall be compacted by at least 8 passes of the roller.

The top surface of the hardcore shall be levelled or graded to falls as required and blinded with similar material broken to 25mm gauge and surfaced with stone dust and well wetted before consolidation by the roller. The surface so obtained shall be to the Engineer's approval.

MATERIALS FOUND IN EXCAVATIONS

All materials classified as rock may, if approved by the Architect or Engineer be used as hardcore filling and the measured quantities of imported filling will be adjusted accordingly; all rock so used must be broken to the required size as before described before being used.

No sand, aggregate, murram or other material found in the excavations is to be used in the works without the written permission of the Engineer.

FILLING OBTAINED FROM THE EXCAVATIONS

Filling obtained from surplus excavated materials is to be free from all weeds, roots, vegetable soil or other unstable materials and is to be filled in layers each of not more than 230mm finished thickness. Each layer to be well wetted and consolidated as described herein.

INSECTICIDE TREATMENT

Where described, the top surface of filling shall be treated with Gladiator Pesticide (manufactured by Dow Agrosciences Ltd.) to be applied by Rentokil Ltd., P.O. Box 44360, Nairobi, or other equal and approved firm, in accordance with the manufacturer's instructions and subject to a twenty year guarantee to the satisfaction of the Architect.

DIOTHENE SHEETING

Diothene sheeting shall be produced by an approved manufacturer. Joints in sheeting shall be treble folded with a 150mm fold and taped at 300mm intervals with 50mm wide black plastic adhesive tapes. The sheeting shall not be stretched but shall be laid with sufficient wrinkles to permit shrinkage up to 15%.

CONCRETE WORK

ARCHITECT/ENGINEER

For the purpose of the concrete structure the Structural Engineer shall be deemed vested with the duties of and be the representative of the Architect.

CODE OF PRACTICE

All workmanship, materials, tests and performances in connection with the reinforced concrete work are to be in conformity with the latest edition of the appropriate British Standards where not inconsistent with these specifications.

SUPERVISION

A competent person approved by the Engineer shall be employed by the Contractor whose duty will be to supervise all stages in the preparation and placing of the concrete. 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 and 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 specifications, the Bills of Quantities or the drawings require specific procedures to be followed, such requirements are not to be construed as prohibiting 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 provisions or requirements contained in these specifications governing the quality of the materials or of the finished work.

LEVELS AND FOUNDATIONS

The foundations of the work shall be carried down to depths as may be 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 solid ground excepting 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.

TOLERANCES

On all setting out dimensions of 6m and over a maximum non-accumulative tolerance of plus or minus 6mm will be allowed. On all setting out dimensions under 6m a maximum non-accumulative tolerance of plus or minus 3mm will be allowed. On the cross sectional dimensions of structural members, unless otherwise required by the drawings, a maximum tolerance of plus or minus 3mm will be permitted.

The top surface of concrete floor slabs and beams shall be within 6 mm of the normal level and line shown on the drawings. Columns shall be truly plumb and non-accumulative tolerance of 3 mm in each storey and not more than 12 mm out of plumb in their full height will be permitted. The Contractor shall be responsible for the cost of all corrective measures required by the Engineer to rectify work which is not constructed 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 specifications 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 or construction do not comply with the requirements of these specifications, 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 Portland Cement of a brand approved by the Engineer and shall comply with the requirements of B.S. 12, and a manufacturer's certificate of test in accordance with B.S. 12 shall be supplied for each consignment delivered to the site. Provided that the approval of the Engineer is obtained, the cement may vary from B.S. 12 in that up to 10% of the total weight may be reactive volcanic ash and the quantity of insoluble residue may exceed that specified by B.S. 12.

Should the Contractor require to use cement of the rapid hardening variety, he shall obtain the approval of the Engineer and also obtain any instructions regarding modifications to these specification caused thereby. Any additional cost that may be caused by the use of rapid hardening cement shall be at the Contractor's expense.

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 is to be stored in a weatherproof 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 1.50 metres in height.

If delivered in bulk the cement shall be stored in a weatherproof silo either provided by the cement supplier or by the Contractor but in either case the silo shall be to the approval of the Engineer.

AGGREGATES

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

The grading of fine aggregates shall be 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 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 F or M of Table 2 of B.S. 882. Sea sand will not be accepted.
Coarse aggregate for concrete Classes '30', '25', and '20' shall be black trap, Mazeras, or similar basaltic stone to the approval of the Engineer and coral aggregate will not be accepted. It shall be hard, clean and of good shape, free from dust, decomposed stone, clay, earthy matter, foreign substances or 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 if he so directs at the Contractor's expense,

Aggregates shall be delivered to the site in their prescribed sizes or gradings and shall be stockpiled 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.

WATER

The water used for mixing concrete shall be from an approved source, clean, fresh and free from harmful matter, and comply with B.S. 3148.

EXPANSION JOINT FILLER

Expansion joint filler shall be 'Flexcell' as manufactured by Expandite Ltd., or 'Resilex' as manufactured by Evomatics Ltd. or equal and approved.

JOINT SEALER

Sealers shall be 'Pli-astic' or 'Seelastic' as described, both manufactured by Expandite Ltd., applied in accordance with the manufacturer's printed instructions and prices shall include for temporary battens or fillets and afterwards withdrawing to form grooves as necessary.

'Seelastic' shall be applied by gun and where more than 12mm deep shall include filling the groove with loose packing yarn to within 1mm from outer face.

'Pli-astic' shall be Grade 88 and applied hot. With the Engineer's prior approval 'Polevomastic' fillers of the appropriate grade as manufactured by Evomastics Ltd. may be substituted for 'Seelastic' and 'Pli-astic'.

CONCRETE STRENGTHS

Classes '30', '25', and '20' concrete shall have the minimum strengths as given by works cube tests shown here below.

Classes lower than those given shall be of the following nominal mixes and may be measured by volume or weight. No cube tests will be required for these classes.

Nominal mix by volume	1:3:6 (Class 15)	1:4:8 (Class 10)
Cubic m. fine aggregate per 50Kg. bag of cement	0.12	0.16
Cubic m. coarse aggregate per 50Kg. bag of cement	0.24	0.32

Max. size of coarse aggregate	40mm	40mm

MEASURED PROPORTIONS OF CONCRETE

Cement

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

Aggregate (i) For Classes '30', '25', and '20' concrete shall be measured by weight in a weigh batching machine as described hereafter.

(ii) For lower Classes concrete, aggregates may be measured by weight or by volume. Where by volume, approved gauge boxes of such a size as will give the correct proportions shall be used.

WEIGH BATCHING MACHINE

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

CONCRETE CLASSES - '30', '25', and '20'

The weights of fine and coarse aggregate to be used in concrete classes '30', '25', and '20' shall be limited in accordance with the table below. The proportions of fine to coarse aggregate and cement which the Contractor proposes to use for the mix specified shall first be approved by the Engineer. 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 of at least 25% higher than the strengths specified for work cube tests. If the Contractor is unable to produce specified cube strengths, he will be required at his own cost to increase the cement of the mix until satisfactory results are produced.

Minimum Crushing Strengths

Age	Class 30	Class 25	Class 20
7 days	21.0 N/mm2	17.5 N/mm2	14.0 N/mm2
28 days	31.0 N/mm2	26.5 N/mm2	21.0 N/mm2

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

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 strength or improved workability and providing that the total proportions of aggregate to cement remain unchanged, no claim for additional cost will be considered.

Concrete shall be poured to the classes as follows:-

The mixes given below e.g. 1:3:6 shall mean concrete composed by volume one part Portland cement, three parts sand or fine aggregate and six parts of coarse aggregate. All other compositions shall be interpreted in a like manner.

Class '30' concrete 1:1$^1/_2$:2	using 5mm to 20mm coarse aggregate
Class '25' concrete 1:1$^1/_2$:3	using 5mm to 20mm coarse aggregate
Class '20' concrete 1:2:4	using 5mm to 20mm coarse aggregate

Unless otherwise specified concrete shall be used as follows:-

High stress reinforced concrete	CLASSES '30'
Normal reinforced concrete	CLASSES '25' & ’20’
Reinforced concrete member of thickness 75mm or less	CLASSES '20'
Surface beds, threshold, concrete surface channels and mass concrete fill	Concrete 1:3:6 mix
Concrete benching to cupboards and fittings and filling where described	Concrete 1:4:8 mix

MINIMUM CEMENT CONTENT - CLASSES ' '30', '25', and '20'

The minimum cement content by weight shall be limited to :-

Mix.	'30'	'25'	'20'	1:3:6	1:4:8
Minimum cement content (kg/m3)	300	300	260	220	150

WATERPROOF CONCRETE

Where 'waterproof concrete' is specified, the system may be an approved surface applied product, or waterproofing additives of a type approved in writing by the Engineer are to be added to the mixing water strictly in accordance with the manufacturer's instructions. Not more than 25 litres of water per 50Kg. bag of cement are to be used unless otherwise approved by the Engineer.

WATER BAR

Water bar shall be P.V.C. water bar as manufactured by Expandite Limited, or other approved type and shall be provided in width and at the positions indicated on the drawings.

Joints shall be heat welded in accordance with the manufacturer's instructions and where the water bar is to be fixed vertically, metal clips as manufactured by the supplier of the water bar or of other approved design shall be provided to suspend the water bar from the reinforcement.

Where waterproof concrete is used the Contractor shall adhere strictly to the position and type of construction joints as detailed on the drawings. Any deviation from this procedure or the provision of additional construction joints will require the prior approval of the Engineer and any additional water bar so required will be at the Contractor's expense.

Formwork shall be designed with sufficient timber formers and blocking pieces to support the water bar and to ensure that it is not displaced during concreting. In the case of horizontal joints in vertical walling and similar members the formwork shall be so constructed as to permit the starter or upstand of concrete surrounding the lower half of the water bar to be poured in the same operation as the slab or other concrete from which it springs. Formwork to walls or similar members where water bar is positioned at the base of the lift shall have sufficient openings not less than 300mm square at approximately

150mm to 300mm above the level of the water bar to permit checking that the water bar is correctly positioned and not displaced during concreting.

No concreting will be permitted to portions where upstand starters form an integral part until the formwork to the starter has been fixed and approved.

<u>SEALOCRETE SUPERCOAT WATERPROOFER</u>

Where specified 'Sealocrete Supercoat Waterproofer' shall be applied to concrete or blockwork surfaces strictly in accordance with the manufacturer's instructions. The surfaces must be well wire-brushed to remove dirt, efflorescence, adhering mortar and all foreign matter. It shall then be cleaned with fresh water. When absolutely dry a generous coat of Sealocrete Supercoat shall be applied by brush or spray gun. Surfaces so treated shall be protected from damage or staining as described elsewhere.

<u>TESTING EQUIPMENT</u>

The Contractor shall provide the following equipment for carrying out control tests on the site :-

(a) Straight edges 3.00m and 1.20m long for testing the accuracy of the finished concrete;

(b) A glass graduated cylinder for use in the silt test for organic impurities in the sand;

(c) Slump test apparatus;

(d) Four 150mm steel cube moulds with base plates and tamping rods to B.S. 1881.

<u>WORK CUBE TESTS</u>

Work cubes are to be made at intervals such that one set of four cubes shall represent no more than 50m3 of concrete in the works or 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 British Standards.

Four cubes shall be made on each occasion, from each batch, the concrete being taken from the point of deposit.

Each cube shall be marked with a distinguishing number (numbers 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) <u>7-day Test</u>

Date
Strength required

(e) <u>28-day Test</u>

Date
Strength required

Cubes shall be forwarded, carriage paid, to an approved Testing Authority, in time to be tested, two at 7 days and one at 28 days and the fourth at the discretion of the Engineer. No cube shall be despatched within 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 better aggregates so as to give concrete which does comply with the requirements 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.

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 of test cubes and no claim in respect of his not so doing will be allowed.

MIXING 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 0.33 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 two 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% 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 B.S. 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. Slump shall be 75 $\pm$ 25mm, unless otherwise instructed by the Engineer.

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. 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 or pumping for placing concrete is subject to the prior approval of the Engineer.

Concrete shall be placed from a height not exceeding 1.5m 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 1.4m deep in walls or similar members.

Concrete in columns may be placed to a height of 4.00m with careful placing and vibration and satisfactory results. Where the height of the column exceeds 4.00m 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 of the 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 positions hereinafter specified shall be made. If stopping of concreting be unavoidable elsewhere, a construction joint shall be made where the work is stopped. A record of all such joints must be made by the Contractor 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 runways be allowed to rest on the reinforcement.

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

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

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

COMPACTION

At all times during which concrete is being placed, the Contractor shall provide adequate 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 nor 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, spading, slicing and vibration. Vibration is required for all concrete of classes '30', '25' and '20'

Care shall be taken to fill every part of the forms, to work the concrete under and around the 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 be removed.

Internal vibrators shall have a frequency of not less than 7,000 cycles per minute and shall have a rotating eccentric weight of at least 0.7Kg., with an eccentricity of not more than 12mm. Such vibrators shall visibly affect the concrete within a radius of 230mm from the vibrator.

Internal vibrators shall not be inserted between layers of reinforcement less than one and a 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 500 mm centres and shall constantly be moved from place to place. 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 not 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 three cubic metres of concrete placed per hour and at least one spare vibrator shall be maintained on site in case of break-down 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 1224mm centres.

In addition to internal and external vibration the upper surface of suspended floor slabs shall be levelled 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.

CONSTRUCTION JOINTS

Construction joints shall be permitted only at the positions pre-determined on the drawings or as instructed on the site by the Engineer. In general they shall be perpendicular to the lines of principal stress 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 13 metres 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 concrete already hardened, the face of the old concrete shall be thoroughly hacked, roughened and cleaned, and laitance and loose material removed therefrom, and immediately before placing the new concrete the surface shall be saturated with water and covered with a coat of mortar at least twenty five mm in thickness composed of cement and fine aggregate in the proportions used in the concrete.

CURING AND PROTECTION

Care must be taken that 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 old cement bags, hession or other material in small pieces.

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 period than those specified hereafter.

FAULTY CONCRETE

Any concrete which fails to comply with these specifications, 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 made an inspection and issued instructions for the repair. The whole of the cost whatsoever, which may be occasioned by the need to remove faulty concrete shall be borne by the Contractor.

ROD REINFORCEMENT

The steel reinforcement shall be mild steel or high tensile steel as detailed on drawings or schedules and comply with the latest requirements of the following British Standards :-

Hot rolled bars for the reinforcement of concrete	to B.S. 4449 (metric units)
Cold worked steel for the reinforcement of concrete	to B.S. 4461 (metric units)
Hard drawn steel wire	to B.S. 4482 (metric units)

It shall be in metric sizes as detailed on the drawings.

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 scale or rust, grease, paint or other substances likely to reduce the bond between the steel and concrete.

FABRIC REINFORCEMENT

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

FIXING ROD REINFORCEMENT

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

Reinforcement shall be accurately placed in position as shown on the drawings and, before and during concreting, shall be secured against displacement by using No. 18 S.W.G. annealed binding wire or suitable clips at intersections, and shall be supported by concrete or metal supports, spacers or metal hangers to ensure the correct position and cover.

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

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 concretors to adjust and correct the positions of any reinforcement which may be displaced. The vibrators are not to come into contact with the reinforcement.

Where reinforcement projects from a concreted section of the structure and this reinforcement is expected to remain exposed for some time, it is to be coated with a 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.

POSITION AND CORRECTNESS OF 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 schedules and is fixed exactly in the positions shown therein and in the positions to give the prescribed cover. 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 schedules.

SPACING BLOCKS

Spacing blocks of approved size and shape made of concrete similar to that used in the surrounding construction and fixed to the reinforcement or 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 for providing sufficient such spacer blocks in his prices for steel reinforcement where a supplier has been nominated. Where composite blocks or other forms of rib construction are used, spacer blocks are to be provided as shown on the drawings. These will generally consist of concrete blocks as described above made to fit the width of the rib less 3mm tolerance and with single or double grooves (depending on the number of reinforcement bars used per rib) in the top surface with wire ties at each groove.

CONCRETE COVER TO REINFORCEMENT

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

Foundations	50mm
Columns and walls	40mm
Beams	25mm
Slabs	15mm

FIXING FABRIC REINFORCEMENT

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

In all ground slabs, unless otherwise specified a single layer of square mesh steel fabric shall be placed at a depth of 50mm below the top surface of the concrete. The fabric shall comply in all respects with B.S. 4483 and be of the size and weight specified or shown on the drawings.

The fabric shall extend to within 75mm of the expansion joints and shall have laps of at least 230mm at all joints in the fabric at junctions with reinforced concrete beams or other members. It shall be placed on top of the first layer of concrete as previously described and sufficient wire ties shall be provided to ensure that the fabric is held down securely.

FIXTURES AND INDENTATIONS IN CONCRETE

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

CHASES, HOLES, ETC. IN CONCRETE

The Contractor shall be responsible for the co-ordination with the Electrical and other Sub-Contractors for incorporating electrical conduit, 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.

POSITION OF ELECTRICAL CONDUIT

Unless otherwise instructed by the Engineer all electrical conduit 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.

The proposed position of all electrical conduits 25mm and over in diameter which are to be enclosed in the concrete shall be shown accurately on a plan to be submitted to the Engineer, whose approval shall be obtained before any such conduit is placed.

FORMWORK

The method and system of formwork which the Contractor proposes to use shall be approved by the Engineer 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 good sound clean sawn well-seasoned timber, free from warps and loose knots and of scantlings sufficiently strong for their purpose.

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 easing 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 be in consultation with the Engineer to 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 4000mm of each 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 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 beam forms 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 framework. 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, easing, striking and removing of all formwork must be done under personal supervision of a competent foreman, and any damage occurring through faulty formwork or its incorrect removal shall be made good by the Contractor at his own expense.

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. Any voids or honeycombing shall be treated as described in 'Faulty Concrete'.

STRIPPING FORMWORK

All formwork shall be removed without undue vibration or 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, walls and inclined columns (unloaded)	2 days
Slab horizontal soffits (props left under)	4 days
Beam soffits (props left under)	10 days

Removal of props (subject to 7 days concrete cube strength being satisfactory) to :-

Slabs	10 days
Beams	14 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 adopted at the Contractor's expense to ensure that the required concrete strength is attained before the forms are stripped.

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

FAIR FACE

Where fair face is specified the concrete shall be brought perfectly true smooth and even by rubbing with carborundum stone dipped in cement grout. Such work must be commenced within one hour of removing the formwork and be actively and rapidly persued until completed, the object being to complete the finish as soon as possible after the removal of the 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 joint 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

BUSH HAMMERED FINISH

The concrete surface prior to the tooling of this finish shall resemble in all respects that produced as 'Fair Face' above. Particular care is required to achieve complete compaction of the concrete.

The bush-hammering shall be carried out using approved tools and shall produce an even, tooled appearance. All arrises, projections, etc., shall remain true and sharp and no rounding off of edges shall be permitted. The Contractor is to take care that no reinforcement is exposed and that in any case no tooling penetrates the concrete surface by more than 10mm.

The Contractor shall, prior to any bush-hammering taking place, provide a sample measuring 1.00m square to the Engineer indicating the standard of bush-hammering to be achieved. This when approved by the Engineer will form the standard for the entire works. Any surface not complying with this standard shall be removed or made good to the Engineer's satisfaction at the Contractor's expense.

TAMPED FINISH

Areas so specified shall be finished at the time of casting with a tamped finish to the Engineer's approval produced by an edge board. Board marks are to be made to a true pattern and will generally be at right angles to the traffic flow. Haphazard or diagonal tamping will not be accepted.

WROT LINED FORMWORK

The shuttering shall be constructed of wrot tongued and grooved boarding, plywood or blockboard lined with approved laminated plastic sheeting to produce a concrete surface with truly flat surface completely free from all air bubbles, joint marks, honeycomb and other pittances and blemishes to the approval of the Engineer.

Should the Contractor desire to use alternative materials he should submit his proposals to the Engineer for approval.

Should the Contractor fail to obtain approval and the Architect subsequently rejects the work, the Contractor will at his own expense carry out all work necessary to attain the approval of the same.

BOARD MARKED FINISH

Where so directed or measured the finish shall be that of a board marked pattern in panels, the boards shall be arranged vertically or horizontally and of widths and sizes all as detailed on the drawings. All exposed concrete will be left unpainted and therefore every care and attention shall be paid to obtain a satisfactory visual appearance and the maintenance of the same throughout the building operation. The finished surfaces shall be free from blow holes, hungry patches and other blemishes, and a sample panel is to be provided and approved by the Engineer before work commences.

Unless otherwise specified, the formwork shall be rip sawn softwood to the Engineer's approval and shall have a sufficiently strong grain to impart a corresponding pattern to the concrete surface. Unless otherwise approved it shall have four uses only and shall be carefully cleaned from adhering grout after each use. It shall be lightly oiled with approved no-staining oil.

CHISEL DRESSED FINISH

Where specified a chisel dressed finish is to be carried out on any grade of concrete but not until it is at least 30 days old. The surfaces are to be fully chisel dressed to remove a maximum of 12mm (average 9mm) of the surface to expose the aggregate without excessive cracking or breaking thereon.

Where the drawings show details of arrises of columns, beams, etc., these are to be pre-formed with timber fillets set in the formwork and care must be taken in working up to those to preserve a clean line. For vertical surfaces of walls and columns, particular care must be taken to remove all sharp projections. For beam soffits this requirements is not necessary.

All chisel dressed surfaces are to have the margin chisel dressed by hand for a minimum width of 75mm commencing from the fillet edge. Thereafter mechanical chisel dressing may be used but the Contractor must ensure that a uniform texture and even plane surface is achieved. The use of pointed steel tools for both hand and mechanical chisel dressing is essential. Upon completion the surfaces are to be thoroughly wire brushed and washed down and protected during the course of construction from damage, dirt, cement grout, etc.

PRECAST CONCRETE

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

The maximum size of coarse aggregate in precast concrete shall not exceed 20mm except for thicknesses less than 75mm where it shall not exceed 12mm.

The compaction of precast concrete shall conform with requirements given elsewhere in these Specifications 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.

Steam curing of precast concrete will be permitted. The procedure for steam curing shall be subject to the approval of 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 in position. Where steam curing is used these times may be reduced to the approval of the Engineer.

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 units shall be replaced by the Contractor at his own expense.

Moulds for 'Fair Face' precast work 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.

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

COMPOSITE FLOOR OR ROOF SLABS

Concrete hollow blocks for used in the composite floor slabs are to be of the sizes required as shown on the drawings and with 30mm wall thickness and are to be of adequate strength to support the concrete during placing and consolidation by vibration. Blocks are to be manufactured in accordance with the procedure specified in B.S. 2028 and to be of a mix not weaker than 1:4:8 cement : sand : aggregate using maximum size aggregate.

Concrete blocks are to be cured for at least 28 days before use on the site. During the first seven days of curing, blocks are to be kept permanently damp and protected from exposure to sun and wind.

Concrete blocks are to be well wetted before the pouring of concrete.

COMPOSITE FLOOR CONSTRUCTION

The hollow block floor construction is generally to be as shown on the Engineer's drawings.

Care shall be taken in placing blocks to ensure that they are set out in accordance with the details shown on the drawings and that they run truly in line without encroaching on the width of the insitu ribs.

The open ends of hollow blocks, if adjacent to concrete to be placed insitu, are to be plugged or stopped to prevent the concrete from flowing into the void and the Contractor is to include for this in his prices.

The Contractor should note that slip tiles are not to be used to the soffit of ribs and he is to take this into consideration in pricing the items of formwork to the soffit of hollow block floor construction.

Before concreting is carried out the blocks are to be thoroughly wetted.

Care should be taken during concreting that the width of ribs between the rows of blocks and the solid insitu concrete shown on the drawings adjacent to supporting beams is not encroached upon by the blocks.

It is essential that the concrete topping be poured at the same time as the ribs between hollow blocks.

Reinforcement shall be positioned accurately with required cover in accordance with the drawings and using the particular spacing blocks with wire ties as previously described. Spacer blocks shall be provided in ribs at not more than 1.2m centres. Care must be taken during concreting that the reinforcement is not displaced.

Where holes for services, etc. occur, the necessary holes or pockets shall be accommodated by the replacing of a hollow block by insitu concrete or the widening of a rib all in accordance with the Engineer's instructions.

Prices for holes, etc. through hollow block construction are to include the re-arrangement or substitution of the hollow block with sold concrete in addition to the actual formation of the hole.

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 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. 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 a hand or mechanical tamper weighing not less that 10Kg per meter run and having a tamping edge shod with a steel strip 75mm wide fixed to the tamper by countersunk screws. Immersion vibrator with 'spade' attachments will be permitted. Compaction shall be continued until a dense, sealed surface finish is achieved. Over-compaction causing an excessive amount of fines 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 crossfalls, as directed or shown on the drawings and shall be subject to the following tolerance :-

The level shall be within or - 6mm of the levels specified.

The falls shall be within 10% of the falls specified.

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

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

As soon as the surface has been finished, it shall be protected against too rapid drying by means of damp hessian, 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 further 21 days. The most critical period is the first 24 hours after placing and 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 shall be responsible for making it good.

EXPANSION JOINTS IN CONCRETE SURFACE BEDS

Expansion joints shall be positioned and constructed as shown on the drawings. The joints in the surface beds shall be absolutely square and true to line and position.

All joints in surface beds shall be formed to the patterns and shapes to coincide exactly with the joints in the surface finish or as otherwise indicated on the drawings. Formwork shall be manufactured from steel of heavy angle section and be to the Engineer's approval. The Contractor shall submit drawings of the forms he intends to use and obtain the Engineer's approval before fabrication. Panels shall be poured in alternate bays as agreed with the Engineer. No construction joints other than those indicated on the drawings shall be submitted.

NOTES CONCERNING MEASUREMENT AND PRICING

The Contractor must allow for all costs incurred during the 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 levelling 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.

Formwork (use and waste only) is measured net to the actual face of the concrete to be supported and the 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 and for bolting, wedging, easing, striking and removal. Prices for linear items such as boxings shall include for angles and ends. Strutting has been measured at varying levels to soffits only and prices for other items must include for strutting at any level.

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, providing all necessary tying wire, and supports and all extra material in laps.

Prices of all precast concrete shall include for all moulds, finishings 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. The sizes of weathered or moulded items stated are extreme sizes.

Prices for suspended hollow tile composite floor and roof slabs must be 'all inclusive' to include for concrete hollow tiles, in situ concrete ribs, concrete topping, concrete filling to open ends of hollow concrete tiles.

Concrete in main beams has been measured to the full width thereof and for full depth to top of slab level and composite slabs are measured separately, the net area between same. No adjustment will be made in these measurements for any projection of ribs, reinforcement, etc., into main beams or floors etc., to obtain bearings, which are deemed to be covered in the Contractor's rates.

Prices for expansion joints shall include for cutting to size and all temporary supports and prices for expansion joint sealers shall include for all temporary battens or fillets required to form the necessary grooves.

STRUCTURAL STEELWORK

APPROVED SUB-CONTRACTOR

The whole of the structural steelwork is to be executed by a specialist Sub-Contractor who is to be specifically approved by the Engineer and the Contractor will be required to make arrangements for the execution of this work and bear all expenses incurred. No change in the rates for this work inserted by the Contractor in these Bills of Quantities will be allowed

ARCHITECT/ENGINEER

For the purpose of the steel structure the Structural Engineer shall be deemed vested with the duties of and be the representative of the Architect.

QUALITY OF MATERIAL AND WORKMANSHIP

The quality of all materials and workmanship used in the execution of the works shall comply with the requirements of current relevant British Standard and Codes of Practice, including all the latest amendments.

BRITISH STANDARDS AND CODES OF PRACTICE

B.S. 4360......................…	Weldable Structural Steels
B.S. 5950	The use of Structural Steel inBuilding.
B.S. 4 (Part 1)	Hot Rolled Sections
B.S.4848 (Part2)........	Hot Rolled Hollow Sections.
B.S. 2994 & 1449	Cold Formed Steel Sections
B.S. 5135	General Requirements for the Metal Arc Welding of Structural Steel Tubes to B.S. 6222,(B.S. 5125 will be considered to apply to the requirements for weldingofhotrolled hollow sections to B.S. 4848 Part 2).

B.S. 6323 Parts 1 - 8	SteelTubesfor Mechanical, Structural & General Engineering Purposes.
B.S. 1856	General Requirements for the Metal Arc Welding of Mild Steel.
B.S. 639	Covered Electrodes for the Metal Arc Welding of Mild Steel
C.P. 2008	Protection of Iron & Steel Structures from Corrosion

TESTS

The Engineer may at any time require any materials to be tested in accordance with the requirements of the Standards listed above. The cost of all successful tests shall be borne by the Employer. The Contractor shall, if required by the Engineer, promptly supply at his own expense test pieces. The costs of tests on materials failing to comply with these Standards shall be borne by the Contractor. If in the opinion of the Engineer, faulty material and/or workmanship has been used in the works, the Contractor may be directed to dismantle and cut out the parts concerned and remove them for examination and testing. The cost of dismantling, cutting out and making good to the approval of the Engineer shall be borne by the Contractor.

FABRICATION

The standard of work and the general procedure to be followed during fabrication shall be in accordance with B.S. 449. The Contractor must ascertain all dimensions on the site prior to commencement of fabrication.

(a) Cutting & Bending - All members, plates, brackets, etc., shall be neatly and accurately sheared, sawn, or profiled to the required shape as shown on the drawings. Where steel is oxy-cut to shape, care shall be taken to preserve the full finished sizes required.

If members or plates are bent or set, the bends or sets shall be correctly made to the radii or angles specified without leaving hammer marks. The materials may be heated to permit this. Material that has been heated should be annealed to approval.

(b) Punching & Drilling - Holes for black bolts shall be drilled or punched 2mm larger in diameter than the bolt size. Holes for high tensile friction grip bolts shall be drilled or sub-punched and reamed to 2mm larger in diameter than the specified bolt size. All drilled holes shall be parallel sided and shall be drilled with the axis of the holes perpendicular to the surface. Badly drilled holes shall either be reamed out to approval and larger bolts fitted or otherwise as directed. All rough arrises shall be ground off. Holes for bolts in material thicker than 15mm must be drilled. When holes are drilled in one operation through two or more thicknesses of material, the parts shall be separated after drilling and all burrs removed before assembly. Holes for bolts shall not be formed by a gas cutting process. Holes formed or enlarged by oxy-cutting will not be accepted and must be filled to approval by electric welding and re-drilling.

(c) Bolting - All bolts used shall be of such length that at least one full thread is exposed beyond the nut after the nut has been tightened. Where a nut or bolt head would bear on an inclined surface, a bevelled washer of the correct shape shall be interposed between the two surfaces. Bevelled washers shall not be allowed to get out of position during fabrication and erection and for this purpose may be spot welded to the steel surface. Bevelled washers for use with high tensile bolts shall not be welded.

(i) Black Bolts, Nuts and Washers

Black bolts shall comply with the requirements of B.S. 916. (B.S.W. Threads).

(ii) Close Tolerance Bolts

Close tolerance bolts shall conform to B.S. 916.

(iii) High Strength Friction Grip Bolts

(a) General grade bolts to B.S. 3692.

(b) Load indicating bolts manufactured by G.K.N. Ltd. or any other approved manufacturer.

(c) High tensile bolts to B.S. 4395.

(iv) Rawlbolts

Rawlbolts shall be those manufactured by Rawlplug Company Ltd or any other approved manufacturer.

(v) Washers

Washers to B.S. 4320.
Washers for high strength friction grip bolts shall be appropriate to the type and quality of the bolt specified.

(vi) Rivets

The steel used for rivets shall be in accordance with B.S. 4360 and in the case of high tensile steel rivets shall be so manufactured that they can be driven and the heads formed and the physical properties not impaired.

(d)Pressed Steel Sections

Pressed or cold rolled steel purlins and girders shall be to the sizes indicated on the drawings and shall be formed from approved steel strip with a minimum yield strength of 175N/mm2.

The sections shall be manufactured straight and free from twist. The tolerance away from straightness shall not be greater than 2mm for every 2000mm in length along any folded edge.

(e) Electric Welding

All welding shall be carried out in strict accordance with the requirements of B.S. 5135 and B.S. 2624 as appropriate and electrodes shall comply with B.S. 639. Only approved and certified welders shall be used

Fusion faces shall be free from irregularities such as tears, fins, etc., which would interfere with the deposition of weld metal.

Fusion faces shall be smooth and uniform and shall be free from loose scale, slag, rust, grease, paint and other deleterious material.

All welds shall be of approved type and finished size as specified. Welding shall be carried out in such sequence that minimum distortion of the parts welded results.

Preparation of edges for welding shall be carried out by planing or machine flame cutting. Manual flame cutting will not be permitted.

Parts to be welded shall be maintained in their correct relative positions during welding, preferably by jigs.

Multi-run welds shall be carried out with each run closely following the previous run but allowing sufficient time for the proper removal of slag.

The Contractor shall ensure that each run is inspected and any unsatisfactory weld cut out and remade to approval.

Welds in material 25mm or greater in thickness shall be made by the Argon arc or similar approved process, and special precautions shall be taken to prevent weld cracking.

Unless otherwise specified, the minimum size of fillet shall be 6mm.

On completion, welds shall present a smooth and regular finish. Weld metal shall be solid throughout with complete fusion between weld metal and parent metal and between successive runs throughout the joint

Defects shall be cut out and made good to approval in sound weld metal.
The external faces of butt welds are to be ground smooth on completion to the approval of the Engineer.

SHOP AND FIELD CONNECTIONS

(a) Rolled Sections

All shop connections shall be electric welded or bolted with high tensile bolts.

No bolts used shall be less than 12mm diameter and no weld less than 40mm in length. At least two bolts shall be used in connections transmitting loads unless otherwise indicated by the Engineer.

No weld of length less than four times the nominal fillet size shall be deemed capable of carrying load.

Beam to column connections not detailed shall be on 'Standard' top and bottom cleat connections with the load carried on the bottom cleat. 'Standard' web connections shall be used for connecting beams to beams.

Field connections shall be as detailed, i.e. bolted with high tensile or black bolts in drilled holes. Black bolts in punched holes will only be permitted for connections carrying a designed load or for connections to timber members.

(b) Structural Hollow Sections

Hollow sections shall be connected by electric welding unless specified otherwise.

The designs of welds shall be in accordance with Clause 6.6 of B.S. 5950.

Butt welds in tension members will not be permitted unless the prior approval of the Engineer in writing has first been obtained.

Butt welds where permitted, shall be made with the fusion surfaces of the ends of each member properly prepared and the member properly aligned.

ASSEMBLY

(a) Trusses and Portal frames

Trusses and portal frames shall be carefully set out to the dimensions shown on the drawings.

Where it is required that trusses be cambered, such camber shall be provided by bending the bottom chord to an arc of a circle.

Not withstanding any dimensioned spacing of purlin cleats, the Contractor shall ensure that purlin cleat spacing is satisfactory for the available stock lengths of roof sheeting. However, the Engineer's approval must first be obtained before any alteration is made in purlin spacing or sheeting sizes.

Splices in portal and other frames shall be made where shown on the details or where directed by the Engineer.

(b) Boxed Members

Abutting edges of boxed members shall be connected and sealed with a continuous weld to exclude the entrance of moisture. Where specified such welds shall be ground flush to approval.

(c) Shop Assembly

Assembly of units in the shop prior to transporting to the site must be inspected by the Engineer before painting. The assembled work shall be laid out in the shop or yard such that all parts are accessible for inspection and testing.

The Contractor shall furnish all facilities for inspection and testing of the works and must notify the Engineer on every occasion materials are ready for inspection.

(d) Marking

All members of the structures to be site assembled shall be marked in accordance with the shop details and marking plans submitted to the Engineer for approval.

ERECTION

(a) Site Dimensions

Erection shall not commence unless and until accurate site dimensions have been taken by the Contractor. No claims will be considered should site dimensions differ from those on the drawings. Any modifications to the structural steel required in order to comply with site dimensions shall be made on the ground to the Engineer's approval before erection is commenced.

(b) Safety

All erection shall be carried out by competent and experienced personnel and the Contractor shall take every care to safeguard members of the public, workmen, and adjoining property against injury and/or damage. The Contractor shall be held responsible for all damage caused to the structure, workmen, or other property during erection.

All gear used shall be of adequate strength and shall comply with all current Regulations.

During erection the work shall at all times be adequately bolted, guyed and/or braced to make the structure secure.

(c) Storage and handling

Steel members shall be stored, handled and erected in such a manner that no member shall be subjected to excessive stresses which could have adverse effect on the properties of the steel. If, in the opinion of the Engineer, the steelwork has been subjected to such treatment, the Contractor shall remove the member from the site and replace it at his own expense.

(d) Erection Notes

No member or part of a member which has been bent or distorted shall be erected in that condition. All straightening shall be done on the ground.

Stanchions shall be wedged to line and level on steel or cast iron wedges and checked by the Engineer. After acceptance, stanchion bases shall be grouted to approval before wedges are removed. Unless otherwise shown on the drawings, all stanchions shall be left truly vertical and correct to line and level. Beams, girders, etc., shall be erected level unless otherwise shown, and correctly positioned.

Trusses and open web joists shall be carefully handled at all times and during erection shall be lifted at such points and in such a manner as will preclude any possibility of damage from excessive stresses.

Packing plates, shims, washers or similar adjusting pieces found necessary to accommodate tolerances in structural site dimensions shall be provided and fixed to the approval of the Engineer.

Immediately after erection, each truss shall be made secure by purlins, bracing or guys to approval of the Engineer.

Bracing shall be fixed in position as soon as dependent portion of the work is completed.

(e) <u>Tightening and Testing High Tensile Friction Grip Bolts</u>

Before assembly, the contact surfaces, including those adjacent to the washers, shall be descaled, and be free from dirt, oil, loose scale, burrs, paint (except priming paint), pits and other defects that would prevent proper seating of the parts.

Bolts shall be fixed with approved hardened flat or tapered washers as required between the bolt and nut and the softer mild steel.

When bearing faces of the bolted parts have a slope of more than 1 in 20 with respect to a plane normal to the bolt axis, square smooth bevelled washers shall be used to compensate for the lack of parallelism.

All bolts shall be tightened by the 'Turn of Nut' method and as approved by the Engineer to achieve in all bolts a minimum tension equal to the proof load.

(f) <u>Grouting</u>

Unless otherwise detailed on the drawings, a space of not less than 40mm shall be provided between undersides of column base plates and footings, and between all beams and roof truss bearings and concrete pads.

After each column, beam or roof truss has been wedged up to a line and level and fixed in position to approval, the space between footing or pad and the underside of the column base plate or steel member shall be grouted with a mixture of one part of Portland cement and one part of approved washed sand (1:1).

The Portland cement and sand shall be thoroughly mixed together with sufficient water to produce a mixture of 'damp earth' consistency and shall be used within twenty minutes of mixing. The caulking mixture shall be packed tight into the space between baseplate and foundation and protected from damage until it sets.

<u>PAINTING</u>

(a) <u>Paints</u>

All paints are to be obtained from suppliers approved in writing by the Engineer.

Paints are to be delivered to the site or to the Contractor's fabrication site in the original containers as supplied by the manufacturer with seals unbroken and are to be used in strict accordance with the manufacturer's instructions. Manufacturer's representatives are to be free to visit the site and inspect materials for laboratory analysis.

Paints are not be thinned unless instructed by the Engineer. No external painting is to be carried out during rain or when rain is likely to occur before the paint has had time to dry. All surfaces are to be dry and free from moisture during painting.

(b) Preparation for Painting

All structural steel shall be thoroughly scraped and wire brushed to remove mill scale and rust. Dirt, grease and oil shall be washed off with white spirit and the steel allowed to dry.

(c) Application

A first coat of Red Lead Graphite Primer or other approved primer shall be applied after fabrication of the works has been completed. A minimum of 24 hours shall elapse before the steel is moved from its position after painting has been completed.
After delivery to site, the steel shall be carefully examined and all areas where the priming coat has been damaged and/or where rust has developed shall be washed with white spirit and wire brushed as necessary and a further priming coat as for the first coat applied to completely cover the damaged areas.

During erection, surfaces of steel which are to be in contact shall be painted with one further coat of primer as previously described and the surfaces brought together whilst the paint is still wet.

After erection, paint a second and finishing coat of 'Oil Company Aluminium Paint 368/36' or other finishing paint of standard as for steelwork. Welds shall not be painted over until they have been deslagged, inspected and approved.

Steel purlins and side rails shall generally be painted as for steelwork when the following specification shall be used.

1st Coat - Red Oxide Zinc Chromate Primer or other approved primer
2nd Coat - Robbialac 'Oil Company Aluminium Paint 368/36' or other equal and approved Aluminium Paint

The interior of mild steel gutters shall be prepared as previously described and painted with 2 coats of Robbialac Epilac Coal Tar Epoxy Paint or other approved paint.

PRICES, MEASUREMENTS AND PAYMENT

Prices quoted by the Contractor shall be based on the calculated weights of steel, and shall include for manufacture, painting, and supply, all as described in the Bills of Quantities, specified, and shown on the drawings, including the cost of delivery to the site or other agreed place or places and the supply of all bolts, rivets, plugs, gussets, cleats, to complete the erection of the works.

Prices shall include for erection, (all labour, scaffolding, and other erection equipment necessary) and cover the cost of additional prime coat painting as previously specified. The prices shall also include for lining up, levelling and plumbing but not for grouting up of the bases.

The basis for payment for steelwork shall be the calculated steel weights of the structure. Any variation from the original design on which the tender was based, which results in either an increase or decrease in calculated weight of the structure as completed, shall result in the appropriate additions or deductions to the submitted tender totals.

Any written instruction from the Engineer which may result in additional work over and above that for which the Contractor quoted will be considered as extras and shall be paid for on the basis of calculated additional steel weights.

SECTION D

EXTERNAL WORKS SPECIFICATION

ARCHITECT OF ENGINEER

Whenever the word 'Engineer' is used in these descriptions of materials and workmanship, it shall, where appropriate, be read and construed as the 'Architect', Landscape Architect or, as the 'Civil Engineer' in which instance the Landscape Architect or Engineer shall be deemed vested with the duties of and be the representative of the Architect.

DISCREPANCIES IN DESCRIPTIONS

Descriptions of materials and workmanship contained in the Bills of Quantities measured items shall take precedence over descriptions contained in appendices in the event of discrepancies between the two, unless the Engineer shall otherwise direct.

TESTS AND SAMPLES

Unless otherwise described in the Bills of Quantities, the Contractor will be responsible for the costs involved in testing materials as described hereinafter. He will also be responsible for all the costs involved in supplying samples of materials or workmanship as required hereinafter to the satisfaction of the Engineer. The cost of replacing materials fixed or placed in position which do not comply with the required test results or approved samples shall be borne solely by the Contractor.

KENYA STANDARDS

All materials and goods supplied for incorporation in the works must comply with any relevant current standards issued by the Kenya Bureau of Standards.

GENERAL

The provisions of other sections of this Specification shall, where appropriate, apply to this section. The works shall be executed in accordance with consultant drawings and designs.

CONCRETE PIPES

Concrete pipes and fittings shall conform to B.S. 556 and shall have ogee or spigot and socket joints as specified in the drawings or as directed by the Engineer.

PVC SOIL SYSTEM

The Contractor shall supply and fix PVC soil pipes and fittings as indicated in the drawings. Pipes and fittings shall be in accordance with the relevant BS including BS 4514 and fixed to the manufacturer's specifications and any other particular specifications that may be issued by the Engineer during the construction period.

EXCAVATION

The excavation shall be made true and even to falls, the bottom being trimmed to the correct levels and well rammed. The minimum width of the trench at the bottom shall be the external width of the pipe plus 300mm. Wherever soft places in excavated areas are encountered, the Contractor shall excavate such soil to a hard foundation and replace with hard filling before any drains are laid. Any trenches excavated in error to a greater depth than required shall be backfilled to the required level with hard filling at the Contractor's own expense.

DRAIN RUNS

Surface water drains are to be to the diameters and of the materials as shown on the drawings, laid in straight lines and with uniform falls to the levels indicated. No alterations to the sizes, falls and runs shown on the drawings are to be made without previous consent.

JOINTING CONCRETE PIPES

Joints are to be made with best quality gaskin dipped in cement grout immediately prior to use, caulked in, and finished off to not more than one third the depth of the socket.

Pipe runs are to be laid dry and jointed in one operation with cement and sand (1:2) trowelled to a smooth face at an angle of 45 degrees to the pipes, and properly cored as the work proceeds.

Where an approved proprietory spigot and socket pipe is used, joints shall be made in accordance with the manufacturer's instructions.

BACKFILLING

No backfilling shall be carried out until drains, manholes and chambers etc., have been tested and approved. The whole of the backfilling shall be properly consolidated and shall be put back in 250mm layers. No mechanical rammers may be used until at least 600mm of consolidated material has been returned over the pipes. Only approved material may be used for backfilling. Where pipes are unprotected by concrete haunching, the first operation in filling shall be to handpack and tamp selected fine material around the lower half of the pipes to buttress them to the sides of the trench.

In the case of pitch fibre and plastic pipes, the first filling shall completely cover the pipe and shall be of material free from stones or hard material which would be retained on a 25mm sieve.

TESTING NEW DRAINS

All surface water drains will be tested to 1500mm head of water. No drains are to be covered in or further proceeded with until such test has bee made, repeated as necessary, and passed by the Architect and Local Authority.

After passing the test the head of water is to be maintained until the concrete bed, haunching or covering is complete. Immediately prior to completion of the Contract the main and branch drains shall be tested by passing through them a ball or disc 6mm less in diameter than the bore of the pipe, and the water test repeated, as required by the Architect and Local Authority.

PROTECTION OF WORK

The drains are to be laid to suit the general progress of the building work and at such times and in such a manner as to be adequately protected against damage and deterioration. The whole of the work is to be maintained and handed over in a sound and clean condition on completion of the Contract.

INVERT BLOCK DRAINS

Precast concrete invert blocks and side slabs shall be formed of concrete (Grade 20) to the dimensions shown on the drawings. Each course of side slabs required in the Bills of Quantities shall be interpreted as one complete row of side slabs to one side of the channel concerned. Drains should not normally be laid to a radius of less than 10 times the actual width of the drain.

Invert block drains shall be constructed in the positions and to the levels and dimensions shown on the drawings and laid to true line and even fall. Where underfilling is required it shall be in 100mm maximum thickness layers of compacted gravel. The earth sides to such channels shall be neatly finished to a slope of 1 to 1 or such other slope as the Architect may direct.

Invert blocks and side slabs shall be laid on a 75mm minimum thickness of compacted gravel and be neatly jointed with cement mortar (1:3) as the work proceeds. The rates included in the Bills of Quantities shall include for excavation, gravel bedding, providing, laying and jointing invert blocks, refilling and disposal of surplus all as specified and all in-situ connections in concrete of the appropriate Grade specified.

On completion, all drains, manholes, etc. shall be flushed from end to end with water and left clean and free from obstructions and deleterious matter.

ROAD GULLIES

Gullies shall be masonry gullies constructed from 225mm building stone and rendered internally. The rates included in the Bills of Quantities shall include for excavation, provision of all materials, making junctions with connections to main drains, accurate setting of frames to line and level, refilling and disposal of surplus materials.

Concrete filled gulley grating of size shown on the drawings shall be used as the cover.

KERBS, CHANNELS AND QUADRANTS

Precast concrete kerbs channels and quadrants shall be bedded and jointed in 12mm thick cement mortar (1:3) on concrete (1:3:6 - 40mm) foundation of dimensions shown on the drawings.

Immediately after being laid, the kerbs and quadrants shall be haunched on back face to half their height in concrete (1:3:6 - 40mm) to the dimensions shown on the drawings.

The exposed face of kerbs and quadrants shall be not less than 100mm nor more than 105mm above the channel of the road except where it is necessary to provide an artificial fall in the channel. The exposed surfaces of the kerbs, channels and quadrants shall conform to the required gradients and curves in vertical plane and to the required plan.

Kerbs, channels and quadrants shall conform to the requirements of B.S. 340. No joint shall exceed 12mm in width. All units shall be laid true to line and level and any unit found to be more than 3mm out of line or level at either end shall be lifted and relaid.

PRECAST CONCRETE PAVING SLABS

Unless otherwise shown on the drawings or directed, precast concrete paving slabs shall comply with B.S. 368 with minimum strength.

WEED KILLER

The finished formation of the footways and roads shall, where directed by the Architect, be sprayed with a persistent total herbicide 'Telvar' W or other equal and approved, at the rate of 4 Kg per hectare. The application shall be evenly sprayed in a high volume of water at about 100 to 200 litres per hectare.

PRECAST CONCRETE BLOCKS PAVING

Precast Concrete block paving shall be laid in sand on properly prepared and compacted sub-base as for in-situ concrete or asphalt concrete.

Blocks shall be fitted close together in a pattern approved by the Architect and boundaries shall be restrained by edge channels or kerbs before vibrating begins.

Blocks thickness and characteristic strengths shall be as measured in the Bills of Quantities.

Blocks shall be laid by hand 20 to 30mm above finished level on levelled, unconsolidated sand 50mm thick before compaction and the paving shall be compacted using a plate vibrator. Fine sand shall be brushed into the joints before and after compacting.

After compacting the surface level shall be within 5mm of the specified level and the level of any two adjacent blocks shall not differ by more than 2mm.

SECTION E

PRIME COST AND PROVISIONAL SUMS PREAMBLES

The Contractor shall include the Prime Cost and Provisional Sums for each Bill in his tender. These sums shall be expended as directed by the Architect or deducted in whole or in part if not required. Work executed in respect of Provisional Sums shall be measured and valued by the Quantity Surveyor in accordance with the Conditions of Contract.

The Contractor will be responsible for the administration of all Nominated Suppliers in accordance with the Conditions of Contract and will be required to arrange an approved programme for delivery of materials with each firm.

The Contractor will be responsible for the supervision and administration of all Nominated Sub-Contractors in accordance with the Conditions of Contract and will be required to arrange an approved programme with each firm.

The Contractor shall allow for general attendance upon Nominated Sub-Contractors and for affording them all reasonable specific attendance and facilities for carrying out their works simultaneously with his own and shall add to prime cost sums for each or all of the following items or any other item which he considers necessary :-

(a) Profit and overhead cost

(b) Supplying all necessary full size setting out templates

(c) Giving all necessary dimensions and taking responsibility for their accuracy.

(d) Unloading or assistance in unloading of materials, getting in and hoisting in position

(e) Providing all necessary working space and providing space for storage accommodation which the Nominated Sub-Contractors will erect for themselves.

(f) Allowing the free and full use of all scaffolding, ladders, hoists, trestles, scaffold boards and all plant of a similar nature belonging to or provided by the Contractor while it remains erected on the site. Any further scaffolding required shall be the Nominated Sub-Contractor's responsibility and he shall pay the cost thereof unless otherwise stated.

g) Supply of water and supply of temporary lighting and of electric power, as more specifically described in Bill No. 1 under 'Water for the Works' and 'Lighting and Power for the Works' respectively.

(h) Providing all necessary latrine accommodation as more specifically described in Bill No. 1 under 'Sanitation of the Works'.

(i) Removing ad replacing duct covers, pipe casings etc., as necessary for the execution and testing of Nominated Sub-Contractor's work.

Provision is made after each Prime Sum Cost for the pricing of the foregoing under two headings:-

'Add for Profit' should include (a)

'Allow for Attendance' should include (b) to (i) and any other expenses involved in compliance with the preambles of this Appendix.

Builder's work in connection has been measured separately unless otherwise described or unless any particular Sub-Contractor has been instructed to execute his own builder's work. Where work in connection is required from the Contractor, he must obtain particulars of positions in which chases, holes, mortices, etc., will be required so as to avoid unnecessary cutting away. No claim will be considered for the extra cost of cutting away work already built as a result of the Contractor's failure to obtain sufficient particulars beforehand.

Any percentage addition made by the Contractor against an item of 'Add for Profit' beneath a Prime Cost Sum will be deducted from the Contract Sum and in lieu thereof he will be paid the said percentage of the actual amount directed to be expended in respect of that particular Prime Cost Sum.

SECTION F

PLUMBING, DRAINAGE AND FIRE FIGHTING INSTALLATIONS SPECIFICATION

1 PART B

1.1 GENERAL MECHANICAL SPECIFICATION

1.1.1 GENERAL

This section specifies the general requirements for plant, equipment and material forming part of the Sub-Contract Works and shall apply except where specifically stated elsewhere in the specification or on the contract Drawings.

1.1.2 QUALITY OF MATERIALS

All plant, equipment and materials supplied as part of the Sub-contract works shall be new and of first-class commercial quality, shall be free from defects and imperfections and where indicated shall be of grades and classifications designated herein.

All products or materials not manufactured by the Sub-contractor shall be products of reputable manufacturers and so far as the provisions of the Specification is concerned shall be as if they had been manufactured by the Sub-contractor.

The Sub-Contractor as called for by the Specification and Contract Drawings shall supply materials and apparatus required for the complete installation unless mention is made otherwise.

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

Defective equipment or that damaged in the course of installation or tests shall be replaced as required to the approval of the Engineer.

1.1.3 REGULATIONS AND STANDARDS

The Sub-Contract Works shall comply with the current edition of the following:-

i) The Kenya Government Regulations
ii) The United Kingdom Institution of Electrical Engineering (*IEE*) Regulations for the electrical equipment of buildings.
iii) The United Kingdom Chartered Institute of Building Services Engineers (*CIBSE*) Guides.
iv) British Standards and Codes of Practice as published by the British Standards Institution (*BSI*).
v) The Local Council By-laws.
vi) The Electricity supply Authority By-Laws.
vii) Local Water Authority By-Laws.
viii) The Kenya Building Code of Regulations.

1.1.4 ELECTRICAL REQUIREMENTS

Plant and equipment supplied under this Sub-Contract shall be complete with all necessary motor starters, control boards, and other control apparatus. Where Control Panels incorporating several starters are supplied, they shall be complete with a main isolator.

The supply power up to and including local isolators shall be provided and installed by the Electrical Sub-Contractor. All other wiring shall be as described in the "Particular Specification".

The Sub-Contractor shall supply three copies of all schematic, cabling and wiring diagrams for the Engineer's approval.

The starting current of all electric motors and equipment shall not exceed the maximum permissible starting currents described in Kenya's power utility Company's By-Laws.

All electrical plant and equipment supplied by the Sub-Contractor shall be rated for the supply voltage and frequency obtained in Kenya that is 415 volts, 50Hz, 3-phase or 240 volts, 50Hz 1-phase as specified in the "Particular Specification".

The Consultant may reject any equipment that is not rated for the above voltages and frequencies

1.1.5 TRANSPORT AND STORAGE

All plant and equipment shall, during transportation be suitably packed, crated and protected to minimise the possibility of damage and to prevent corrosion or other deterioration.

On arrival at site, all plant and equipment shall be examined and any damage to parts and protective priming coats made good before storage or installation.

Adequate measures shall be taken by the Sub-Contractor to ensure that plant and equipment do not suffer any deterioration during storage.

Prior to installation all piping and equipment shall be thoroughly cleaned.

If, in the opinion of the Consultant any equipment has deteriorated or been damaged to such an extent that it is not suitable for installation, the Sub-Contractor shall replace this equipment at his own cost.

1.1.6 SITE SUPERVISION

The Sub-Contractor shall ensure that there is an English-speaking supervisor on the site at all times during normal working hours.

1.1.7 INSTALLATION

Installation of all special plant equipment shall be carried out by the Sub-Contractor under adequate supervision from skilled staff provided by the plant and equipment manufacturer or his appointed agent in accordance with the best standards of modern practice and to the relevant regulations and standards described under Clause 3 of this section.

1.1.8 TESTING

3.1.8.1 GENERAL

The Sub-Contractor's attention is drawn to Part "A", Sub-Clauses 2.1.44 and 2.1.45 on Pages 2.11 and 2-12 respectively of the "Preliminaries and General Conditions".

The following sub-clauses are intended to define the Sub-Contractor's responsibilities with respect to testing and inspection.

3.1.8.2 MATERIAL TESTS

All material for plant and equipment to be installed under this Sub-Contract shall be tested, unless otherwise directed, in accordance with the relevant B.S. specification concerned.

For materials where no B.S. specification exists, tests are to be made in accordance with the best modern commercial methods to the approval of the Engineer, having regard to the particular type and application of the materials concerned.

The Sub-Contractor shall prepare specimens and performance tests and analyses to demonstrate conformance of the various materials with the applicable standards.

If stock material, which has not been specifically manufactured for the plant and equipment specified is used, then the Sub-Contractor shall submit satisfactory evidence to the Consultant that such materials conform to the requirements stated herein in which case tests of material may be partially or completely waived.

Certified mill test reports of plates, piping and other materials shall be deemed acceptable.

3.1.8.3 MANUFACTURED PLANT AND EQUIPMENT - WORKS TESTS

The rights of the Consultant relating to the inspection, examination and testing of plant and equipment during manufacture shall be applicable to the Insurance Companies or Inspection Authorities so nominated by the Engineer

The Sub-Contractor shall give two weeks' notice to the Consultant of the manufacturer's intention to carry out work tests and inspections.

The Consultant or his representative shall be entitled to witness such tests and inspections. The costs of such tests and inspections shall be borne by the Sub-Contractor.

Six copies of all test and inspection certificates and performance graphs shall be submitted to the Consultant for his approval as soon as possible after the completion of such tests and inspections.

Plant and equipment which is shipped before the relevant test certificate has been approved by the Consultant shall be shipped at the Sub-Contractor's own risk and should the test and inspection certificates not be approved, new tests may be ordered by the Consultant at the Sub-Contractor's expense.

3.1.8.4 PRESSURE TESTING

All pipe work installations shall be pressure tested in accordance with the requirements of the various section of this specification. The installations may be tested in section to suit the progress of the works but all tests must be carried out before the work is buried or concealed behind building finishes. The Consultant or his representative must witness all tests and the Sub-Contractor shall give 48 hours' notice to the Consultant of his intention to carry out such tests.

Any pipe work that is buried or concealed before witnessed tests have been carried out shall be exposed at the expense of the sub-contractor and the specified tests shall then be applied.

The Sub-Contractor shall prepare test certificates for signature by the Consultant and shall keep a progressive and up-to-date record of the Sections of the work that have been tested.

1.1.9 COLOUR CODING

Unless stated otherwise in the Particular Specification all pipe work shall be colour coded in accordance with the latest edition of B.S. 1710.

1.1.10 WELDING

3.1.10.1 PREPARATION

Joints to be made by welding shall be accurately cut to size with edges sheared, flame cut or machined to suit the required type of joint. The prepared surface shall be free from all visible defects such as lamination, surface imperfections due to shearing or flame cutting operation, etc., and shall be free from rust, scale, grease and other foreign matter.

3.1.10.2 METHOD

All welding shall be carried out by the electric arc process using covered electrodes in accordance with B.S. 639.

Gas welding may be employed in certain circumstances provided that prior approval is obtained from the Engineer

3.1.10.3 WELDING CODES AND CONSTRUCTION

All welded joints shall be carried out in accordance with the following specification:-

a) Pipe Welding
All pipe welds shall be carried out in accordance with the requirements of B.S.806.
b) General welding
All welding mild steel components other than pipe work shall comply with the general requirements of B.S. 1856.

3.1.10.4 WELDERS QUALIFICATIONS

Any welder employed on this Sub-contract shall have passed the trade tests as laid down by the Government of Kenya.

The Consultant may require seeing the appropriated certificate obtained by any welder and should it be proved that the welder does not have the necessary qualifications the Consultant may instruct the Sub-Contractor to replace him by a qualified welder.

2 PART C

2.1 GENERAL PLUMBING AND DRAINAGE SPECIFICATIONS

2.1.1 MATERIALS AND STANDARDS

4.1.1.1 GENERAL

This section specifies the general requirements for plant, equipment and materials forming part of the Plumbing and Drainage Installations.

4.1.1.2 PIPE WORK AND FITTINGS

Pipe materials are to be used as follows:-

4.1.1.2.1 PLUMBING

The pipe materials for Hot and Cold Water Mains shall be Chlorinated polyvinyl chloride (CPVC) or Polyvinyl chloride (PVC) or Un-plasticised Polyvinyl chloride (u-PVC) or Polypropylene random copolymer (PPR-C) or Galvanised mid steel (GMS) medium or heavy grade or Galvanised Cast Iron (GI) or any other, as can be specified in the Bills of Quantities and on the drawings.

a) Chlorinated polyvinyl chloride (CPVC)

The Chlorinated polyvinyl chloride (CPVC) pipes to conform to ISO 4422, ASTM D. or the relevant Kenya Standard.

Fittings shall comply in all respects with ASTM F or the relevant Kenya Standard. Pipes shall be supplied in plain-ended lengths.

1. Thickness

The Minimum acceptable wall thickness of pipe and fittings shall be as follows:-

Nom. Dia. (*mm*)	15	20	25	32	40	50	63	75
Thickness (*mm*)	1.7	1.9	2.5	3.1	3.7	4.9	7.0	7.6

2. Jointing

The method of jointing to be employed shall be that of Solvent welding, using the pipe and manufacturers approved cement. Seal rings joints shall be introduced where it is necessary to accommodate thermal expansion.

3. Anchoring

All bends, valves and hydrant tees etc., in the line of the water main shall be adequately anchored to resist thrust due to internal water pressure. A concrete block shall be cast under and around the pipe and between it and sides of the trench. Well-rammed material shall be used to support the pipe and either side of the concrete.

4. Workmanship

The installation method of jointing shall be done by applying correct adhesive solution at cleaned surfaces to be joined; and both jointing and fixing shall comply in all respects to the manufacturer' site-work instructions. The maximum intervals between pipe supports shall be as follows:-

i) at 21ºC

Pipe Diameter (mm)	15	20	25	32	40	50	63	75	100
Horizontal & Vertical (m)	1.68	1.68	1.83	1.89	2.13	2.13	2.44	2.44	2.74

ii) at 49ºC

Pipe Diameter (mm)	15	20	25	32	40	50	63	75	100
Horizontal & Vertical (m)	1.37	1.52	1.68	1.83	1.83	2.98	2.29	2.28	2.59

iii) at 71ºC

Pipe Diameter (mm)	15	20	25	32	40	50	63	75	100
Horizontal & Vertical (m)	0.91	0.91	1.07	1.07	1.07	1.22	1.37	1.37	1.52

iv) at 82ºC

Pipe Diameter (mm)	15	20	25	32	40	50	63	75	100
Horizontal & Vertical (m)	0.76	0.76	0.91	1.07	1.07	1.07	1.22	1.22	1.37

Pipes passing through walls or floors shall be sleeved to allow unrestricted movements.

The works shall be inspected and tested during installation and all work, which will be concealed, shall be tested before it is finally enclosed and verified by the Clerk of Works.

Any other test may be demanded upon completion for soundness and performance to the satisfaction of the Local Water Authority.

5. Pipe Bed

Pipes shall be uniformly laid on a 75mm thick bed, (Sand or red soil) and must not be allowed to rest on the joint or on stones etc.

6. Supports to Fittings

In underground installations care shall be taken to ensure that heavy components such as valves are fully supported so that the pipeline carries no weight.

7. Backfilling

For the protection of the pipe initial backfilling shall be carried out as soon as possible after laying. The initial backfill shall be fine grained material thoroughly compacted around the pipe and consolidated to depth of 6" above the crown of the pipe at no time shall heavy rocks, stones or other objects be included in the balance of the backfill that might protrude the initial backfill layer and come into contact with the pipe.

8. Testing

Pipelines shall be tested in sections under an internal water pressure normally one and a half times the maximum allowable working pressure of the class of pipe used. Testing shall be carried out as soon as practicable after laying and when the pipeline is anchored. Precautions shall be taken to eliminate all air from the test section and to fill the pipe slowly to avoid risk of

b) Polypropylene random copolymer (PPR-C)

The Polypropylene random copolymer (PPR-C) pipes to conform to ISO /R1133, DIN. or the relevant Kenya Standard.

Fittings shall comply in all respects with DIN or the relevant Kenya Standard. Pipes shall be supplied in plain-ended lengths.

1. Thickness

The Minimum acceptable wall thickness of pipe and fittings shall be as follows:-

i) PN20

Out. Dia. (*mm*)	20	25	32	40	50	63	75	90
Thickness (*mm*)	3.4	4.2	5.8	6.7	8.4	10.5	12.5	15.0

ii) PN16

Out. Dia. (*mm*)	20	25	32	40	50	63	75	90
Thickness (*mm*)	2.8	3.5	4.5	5.6	6.9	8.7	10.4	12.5

iii) PN25

Inner pipe	**Out. Dia. (*mm*)**	20	25	32	40	50	63
	Thickness (*mm*)	3.4	4.2	5.8	6.7	8.4	10.5
Aluminium	**Thickness (*micron*)**	200	200	200	200	200	200
Outer coat	**Out. Dia. (*mm*)**	21.8	26.8	33.8	41.8	51.8	64.8
	Thickness (*mm*)	0.5	0.5	0.5	0.5	0.5	0.5

2. Jointing

The method of jointing to be employed shall be that of fusion welding, using the correct welding machine or an electric welder and suitable electric couplings. Seal rings joints shall be introduced where it is necessary to accommodate thermal expansion.

3. Anchoring

All bends, valves and hydrant tees etc, in the line of the water main shall be adequately anchored to resist thrust due to internal water pressure. A concrete block shall be cast under and around the pipe and between it and sides of the trench. Well-rammed material shall be used to support the pipe and either side of the concrete.

4. Workmanship

The installation method of jointing shall be fusion welding; and both jointing and fixing shall comply in all respects to the manufacturer' site-work instructions. The maximum intervals between pipe supports at 100^{o}C shall be as follows:-

Pipe Diameter (mm)	10	15	20	25	32	40	50	75	100
Horizontal (m)	0.75	0.90	1.05	1.20	1.35	1.65	1.80	DO	DO
Vertical (m)	1.50	1.80	2.10	2.40	2.70	3.30	3.60	DO	DO

Pipes passing through walls or floors shall be sleeved to allow unrestricted movements.

The works shall be inspected and tested during installation and all work, which will be concealed, shall be tested before it is finally enclosed and verified by the Clerk of Works.

Any other test may be demanded upon completion for soundness and performance to the satisfaction of the Local Water Authority.

5. Pipe Bed

Pipes shall be uniformly laid on a 75mm thick bed, (Sand or red soil) and must not be allowed to rest on the joint or on stones etc.

6. Supports to Fittings

In underground installations care shall be taken to ensure that heavy components such as valves are fully supported so that the pipeline carries no weight.

7. Backfilling

For the protection of the pipe initial backfilling shall be carried out as soon as possible after laying. The initial backfill shall be fine grained material thoroughly compacted around the pipe and consolidated to depth of 6" above the crown of the pipe at no time shall heavy rocks, stones or other objects be included in the balance of the backfill that might protrude the initial backfill layer and come into contact with the pipe.

8. Testing

Pipelines shall be tested in sections under an internal water pressure normally one and a half times the maximum allowable working pressure of the class of pipe used. Testing shall be carried out as soon as practicable after laying and when the pipeline is anchored. Precautions shall be taken to eliminate all air from the test section and to fill the pipe slowly to avoid risk of

c) P.V.C. (Hard) Pressure Pipe and Fittings

All P.V.C. pipes and fittings shall be manufactured in accordance with B.S. 3505:1968 or the relevant Kenya Standard.

Fittings shall comply in all respects with British Standard 4346 Part 1: 1969 or the relevant Kenya Standard. Pipes shall be supplied in plain-ended lengths.

1. Thickness

The Minimum acceptable wall thickness of pipe and fittings shall be as follows:-

Nom. Dia. (*mm*)	10	12	20	25	32	40	50	75	100
Thickness (*mm*)	1.5	1.7	1.9	2.2	2.7	3.1	3.9	5.7	7.3

2. Jointing

The method of jointing to be employed shall be that of Solvent welding, using the pipe and manufacturers approved cement. Seal rings joints shall be introduced where it is necessary to accommodate thermal expansion.

3. Anchoring

All bends, valves and hydrant tees etc., in the line of the water main shall be adequately anchored to resist thrust due to internal water pressure. A concrete block shall be cast under and around the pipe and between it and sides of the trench. Well-rammed material shall be used to support the pipe and either side of the concrete.

4. Workmanship

The installation method of jointing shall be solvent welding; and both jointing and fixing shall comply in all respects to the manufacturer' site-work instructions. The maximum intervals between pipe supports at 200C shall be as follows:-

Pipe Diameter (mm)	10	15	20	25	32	40	50	75	100
Horizontal (m)	0.75	0.90	1.05	1.20	1.35	1.65	1.80	DO	DO
Vertical (m)	1.50	1.80	2.10	2.40	2.70	3.30	3.60	DO	DO

Pipes passing through walls or floors shall be sleeved to allow unrestricted movements.

The works shall be inspected and tested during installation.

All work, which will be concealed, shall be tested before it is finally enclosed and verified by the Clerk of Works.

Any other test may be demanded upon completion for soundness and performance to the satisfaction of the Local Water Authority.

5. Pipe Bed

Pipes shall be uniformly laid on a 75mm thick bed, (Sand or red soil) and must not be allowed to rest on the joint or on stones etc.

6. Supports to Fittings

In underground installations care shall be taken to ensure that heavy components such as valves are fully supported so that the pipeline carries no weight.

7. Backfilling

For the protection of the pipe initial backfilling shall be carried out as soon as possible after laying. The initial backfill shall be fine grained material thoroughly compacted around the pipe and consolidated to depth of 6" above the crown of the pipe at no time shall heavy rocks, stones or other objects be included in the balance of the backfill that might protrude the initial backfill layer and come into contact with the pipe.

8. Testing

Pipelines shall be tested in sections under an internal water pressure normally one and a half times the maximum allowable working pressure of the class of pipe used. Testing shall be carried out as soon as practicable after laying and when the pipeline is anchored. Precautions shall be taken to eliminate all air from the test section and to fill the pipe slowly to avoid risk of damage due to surge.

d) Galvanised Mild Steel Pipe work

Galvanised mild steel pipe work shall be manufactured to comply in all respects with the standards described for black steel pipe work in paragraph 2.1.3 above.

Galvanised shall be carried out in accordance with the requirements of BS 1387 and BS 143 respectively.

e) Black steel Pipe work

All black steel pipe work up to 65 mm nominal bore shall be manufactured in accordance with B.S. 1387 Medium Grade, with tapered place threads in accordance with BS 21. All fittings shall be of malleable iron and manufactured in accordance with BS 143.

Pipe joints shall be screwed and socketed and sufficient couplings union shall be allowed so that fittings can be disconnected without cutting the pipe. Running nipples and long screws shall not be permitted unless exceptionally approved by the Consultant.

All black steel pipe work, 80mm nominal bore up to 150mm nominal bore, shall be manufactured to comply in all respects with the specification for 65mm pipe, except that screwed and bolted flanges shall replace unions and couplings for the joining of pipes to valves and other items of plant.

All flanges shall comply with the requirements of BS 10 to the relevant classification contained hereinafter under section C of the Specification

f) Copper Tubing

All copper tubing shall be manufactured in accordance with BS 2871 from C.160 “Phosphorus De-oxidized Non-Arsenical Copper" in accordance with BS 1172.

Pipe joints shall be made with soldered X] fittings and connections to equipment shall be with compression fitting manufactured in accordance with B.S. 864.

Short copper connections tubes between galvanised pipe work and sanitary fitments shall not be used because of the risk of galvanic action.

If, as may occur in certain circumstances, it is not possible to make the connection in any other way than by the use of copper tubing, then a brass straight connector shall be positioned between the galvanised pipe and the copper tube in order to prevent direct contact.

4.1.1.2.2 DRAINAGE

a) Mu-PVC Waste Systems

All pipes and fittings shall be manufactured in accordance with B.S. 5255:1968 or the relevant Kenya Standard.

Pipes shall be supplied in plain-ended lengths.

1. Thickness

The Minimum acceptable wall thickness of pipe and fittings shall be as follows: -

Size (*in*)	Size (*mm*)	Pipe and Fittings Wall Thickness (*m*m)
1¼	32	1.8
1½	40	1.9
2	50	2.0

2. Jointing

The method of jointing to be employed shall be that of Solvent welding, using the pipe and manufacturers approved cement. Seal rings joints shall be introduced where it is necessary to accommodate thermal expansion.

3. Anchoring

All bends, valves and hydrant tees etc., in the line of the water main shall be adequately anchored to resist thrust due to internal water pressure. A concrete block shall be cast under and around the pipe and between it and sides of the trench. Well-rammed material shall be used to support the pipe and either side of the concrete.

4. Workmanship

The installation method of jointing shall be solvent welding; and both jointing and fixing shall comply in all respects to the manufacturer' site-work instructions. The maximum intervals between pipe supports at 200C shall be as follows:-

Nominal Size (*in*)	Nominal Size (*mm*)	Horizontal (*mm*)	Vertical (*mm*)
1¼	32	500	1,200
1½	40	500	1,200

2	50	900	1,200
3	80	900	2,000
4	100	1,000	2,000
6	150	1,000	2,000

Pipes shall be fixed in straight runs and horizontal runs shall be laid to gradients in conformity with BS 5572 Code of Practise for Sanitary Pipe work and in any event not less than 18mm/m unless otherwise specified.

Pipes passing through walls or floors shall be sleeved to allow unrestricted movements.

The works shall be inspected and tested during installation at any stage in accordance with BS 5572. All work, which will be concealed, shall be tested before it is finally enclosed and verified by the Clerk of Works.

Any other test may be demanded upon completion for soundness and performance to the satisfaction of the Local Water Authority.

5. Pipe Bed

Pipes shall be uniformly laid on a 75mm thick bed, (*Sand or red soil*) and must not be allowed to rest on the joint or on stones etc.

6. Supports to Fittings

In underground installations care shall be taken to ensure that heavy components such as valves are fully supported so that the pipeline carries no weight.

7. Backfilling

For the protection of the pipe initial backfilling shall be carried out as soon as possible after laying. The initial backfill shall be fine grained material thoroughly compacted around the pipe and consolidated to depth of 6" above the crown of the pipe at no time shall heavy rocks, stones or other objects be included in the balance of the backfill that might protrude the initial backfill layer and come into contact with the pipe.

8. Testing

Pipelines shall be tested in sections under an internal water pressure normally one and a half times the maximum allowable working pressure of the class of pipe used. Testing shall be carried out as soon as practicable after laying and when the pipeline is anchored. Precautions shall be taken to eliminate all air from the test section and to fill the pipe slowly to avoid risk of damage due to surge.

b) A.B.S. Waste System

Where indicated on the drawings and schedules, the Sub-contractor shall supply and fix A.B.S. Waste pipes and fittings.

The pipes, traps and fittings shall be in accordance with the relevant British Standards, including B.S. 3943, and fixed generally in accordance with manufacturer's instructions, and B.S. 5572: 1978.

Jointing of pipe shall be carried out by means of solvent welding in accordance with the manufacturer's instructions and B.S. 5572: 1978.

Jointing of pipe shall be carried out by means of solvent welding. The manufacturer's recommended method of joint preparation and fixing shall be followed.

Standard brackets, as supplied for use with this system, shall be used wherever possible. Where the building structure renders this impracticable the Sub-contractor shall provide purpose made supports,

Expansion joints shall be provided as indicated. Supporting brackets and pipe clips shall be fixed on each side of these joints.

c) P.V.C. Soil System

The Sub-contractor shall supply and fix P.V.C soil pipe and fittings as indicated on the drawings and schedules.

Pipes and fittings shall be in accordance with relevant British Standards, including B.S. 45l4 and fixed to the manufacturer's instructions, and B.S. 5572.

The soil system shall incorporate synthetic rubber gaskets as provided by the manufacturer whose fixing instructions shall be strictly adhered to.

Connections to W.C. and pass shall be effected by the use of a W.C. connector gasket and cover, fixed to suit pan outlet.

Suitable supporting brackets and pipe clips shall be provided at maximum of metre centres.

The Sub-contractor shall be responsible for the joint into the Gully Trap on Drain Trap as indicated on the drawings.

d) u-PVC Square Rainwater System Pipe and Gutter

Gutters shall be a rectilinear section 116mm or 137mm wide and shall be supplied in plain-ended lengths with the minimum acceptable wall thickness of gutter shall be 2.20mm.

Rainwater pipes shall be square in section 58mm or 75 mm internal diameter and shall be supplied in plain-ended lengths with the minimum acceptable wall thickness or rainwater pipes shall be 1.80mm.

Pipe support brackets must be adequate to screen expansion gaps.

The grade of u-PVC used for gutter and pipe shall have a minimum softening point of 75°C when tested by the Vicat method as described in B.S, 2782.

The pipe and gutter shall be colour grey, to BS 5252, 10.A.07, black, white or rustic.

e) u-PVC Rainwater Fittings

All fittings shall be injection moulded and shall be compatible with pipe and gutters and shall conform to BS 4576 or the appropriate Kenya Standard.

All gutters, pipe and fittings shall be colour grey to British Standard 5252, 10.A.07, or black, white or rustic.

Gutter connecting fittings shall have integrally moulded seal retaining cavities housing a rubber seal of hollow section.

The fitting shall incorporate a gutter-retaining clip.

Gutter shall be supplied in plain-ended lengths.

The minimum acceptable wall thickness of gutter shall be 2.20mm.

Rainwater pipes shall be circular in section, 65mm nominal diameter complying in all respects to British Standard 4576 or the relevant Kenya Standard.

Rainwater pipes shall be supplied in plain-ended lengths. The minimum acceptable wall thickness of rainwater pipes shall be 1.80mm

Pipe support brackets must be adequate to screen expansion gaps.

The grade of u-PVC used for gutter and pipe shall have a minimum softening point of 75oC when tested by the Vicat method as described in B.S. 2782.

The pipe and gutter shall be colour grey, to BS 5252, 10.A.07, black, white or rustic.

f) u-PVC Underground Drainage System

1) Pipes and fittings

The pipes and fittings shall comply in all respects to British Standard 4660 & 5481 or the relevant Kenya Standards.

Pipes shall be supplied in plain-ended lengths.

The minimum acceptable wall thickness of pipe and fittings will be as follows:-

Item	Description	Minimum Acceptable Wall Thickness	
1	110mm pipe	3.0mm	
2	160mm pipe	3.9mm	
3	110mm junction only	3.50mm socket	3.80mm body
4	All other fittings	3.20mm socket	3.40mm body
5	160mm all fittings	4.30mm socket	4.70mm body

The method of jointing to be employed shall be by lip seal socketted fittings. Jointing to other materials shall be made in the manner specified by the manufacturer.

The grade of u-PVC used for the pipe shall have a minimum softening point of 82°C when tested by the `Vicat` method 102D as described in British Standard 2782, and for fittings 79°C.

The pipe and fittings shall be of colour golden brown approximating to British Standard 381C:No.414. The seal retaining caps shall be black polypropylene.

The natural rubber for lip seal joints shall be to British Standard 2494:1976.

Holder bats shall be made of mild steel protected from corrosion by galvanising or search coating for optimum fit to pipe supports a special purpose made P.V.C. packing pieces may be used.

The base of soil and vent stack connection to the below ground drain shall be made with a bend of minimum centre line radius of 250mm.

Minor changes of direction where permitted shall be made with a variable bend that has a constant effective length

2) Excavation of Trenches

The installation, method of jointing shall conform in all respects to the manufacturer's site work instruction.

Trenches shall be excavated to a sufficient depth to allow a 50mm minimum bed below the underside of the pipe. Trench width shall be not less than the outlet diameter of the pipe plus 300mm and not wider than necessary.

3) Trench Invert

The base of the trench shall be such that even support is given to the pipe for its full length. Soft spots shall be removed and replaced with compacted granular material as described below. High spots and rock shall be removed to allow full 50mm bed depth.

4) Pipe bed

The bed shall be composed of granular material to the specification called for below and shall for below and shall cover the full trench width and length and boned to gradient

5) Laying and jointing

Pipes and fittings shall be laid true to gradient in straight lines and jointed in accordance with manufacturer's instructions. All pegs used for alignment and other purposes must be removed after use and before side filling. All joints shall be watertight complying with CP.301, Clauses 5:3.

Pipe barrels shall be in continuous contact with the trench bed when laid.

6) Side Filling

The side filling of pipes shall be composed of hard granular material, which shall be to the requirements below.

Side fillings must be placed equally on both sides of the pipe and compacted, so as to buttress the pipes against the trench walls. Side filling shall continue up to pipe crown level as a minimum and above this level if required by the Engineer.

7) Back Filling

The first 300mm of backfill above crown level shall be taken from selected trench spoil all passing 25mm sieve. It shall be placed in two 150mm layers each firmly tramped. Above the 300mm level mechanical filling and compaction may be used.

Where cover is less than 450mm the pipe shall be covered with 75mm of selected material laid to support a concrete tile or slab indicating the presence of a service.

8) Granular Material for Bed and Side Fill

All material for bed and side fill shall be hard and granular passing 20mm sieve and shall contain no more than 5 per cent fines passing 3mm sieve.

The material may be composed of crushed stone, clinker, quarry scalping, ballast, gravel, shingle or all-in aggregate to British Standard 882.

The material shall have a compaction factor of 0.3 or less.

g) Concrete Pipe

Where concrete pipe and fittings are used in connection with the conveyance surface water of sewage under atmospheric pressure, they shall be manufactured in accordance with the requirement of B.S. 556, Class l, except where

The joints of concrete pipe and fittings may be one of the following depending application and conditions:

1) Flexible spigot and socket type.
2) Flexible rebated type (Storm water drainage only)
3) Ordinary spigot and socket type.
4) Ordinary rebated type (*Storm water drainage only*)

Joints (*1*) and (*2*) shall be sealed with suitable rubber gaskets manufactured in accordance with B.S. 2494 except where they are likely to be contaminated by oil products, in which case the gaskets shall be manufactured in accordance with B.S. 3514.

Joints (*3*) and (*4*) shall be made with approved cement mortar mix.

h) Pitch Fibre Pipe work

Pitch Fibre Pipe work and fittings for use in connection with external drainage services shall be manufactured in accordance with the requirements of B.S. 2760. Pipes shall be connected by means of purpose tapered joints manufactured in accordance with B.S. 2760.

Until such time as the use of pitch impregnated fibre is covered by a code of practice, the jointing laying and cutting of these pipes shall be carried out in accordance with the requirements of the notes contained under Appendix C of B.S. 2760.

4.1.1.3 VALVES

a) Draw-off Taps and Stop Valves (Up to 50mm Nominal Bore)

Draw off taps and valves up to 50mm nominal bore, unless otherwise stated or specified for attachment or connection to sanitary fitment shall be manufactured in accordance with requirement of B.S. 1010.

b) Gate Valves

All gates valves 80mm nominal bore and above, other than those required for fitting to the buried water mains shall be of cast iron construction, in accordance with the requirement of B.S. 3464. All gate valves required for fitting to the buried water mains shall be of cast iron construction in accordance with the requirements of B.S. 1218.

All gate valves up to and including 65mm nominal bore shall be of bronze construction in accordance with the requirements of B.S. 1952.

The pressure classification of all valves shall depend upon the pressure conditions pertaining to the Site of Works.

c) Globe Valves

All globe valves up to and including 65 mm nominal bore shall be of bronze construction in accordance with the requirements of B.S. 3061.

The pressure classification of all globe valves shall depend upon the pressure conditions pertaining to the Site of Works.

d) Check or Non-Return Valves

All check or non-return valves 80mm nominal bore and above shall be of the swing check type of cast iron construction in accordance with the requirement of B.S. 4090.

The pressure classification of all check or non-return valves shall depend upon the pressure conditions pertaining to site of the Works.

e) Ball Valves

All ball valves for use in connection with hot and cold water services shall be of the Portsmouth type in accordance with the requirements of B.S. 1212, constructed from bronze or other corrosion resistant materials. These valves fall into three pressure classifications as follow:-

Item	Description	Maximum (Bar)
1	Low Pressure	3.52
2	Medium Pressure	7.72
3	High Pressure	12.62

The pressure classification required for each ball valve will be designated in the description of its associated equipment contained in section C of the specification

f) Manually Operated Mixing Valves

Mixing valves for shower fittings and other appliances being provided under the Sub-contractor Works shall be manufactured in accordance with the requirements of B.S. l4l5 from bronze or other corrosion resistant materials.

4.1.1.4 WASTE FITMENT TRAPS

a) Standard and Deep Seal P & s Traps

Where standard or deep seal traps are specified they shall be manufactured in suitable non-ferrous materials in accordance with the full requirements of B.S. 1184.

In certain circumstances, cast iron traps may be required for cast iron baths and in these instances bath traps shall be provided which are manufactured in accordance with the full requirements of B.S. 1291.

b) Anti-Siphonic Traps

Where anti-siphon traps are specified, these shall be similar or equal to the range of traps manufactured by Greenwood and Hughes Ltd., Deacon Works Littlehampton, Sussex, England.

The trade name for traps manufactured by this company is "Grevak".

4.1.1.5 PIPE SUPPORTS

a) General

This Sub-clause deals with pipe support securing pipes to the structure of buildings for above ground application.

The variety and type of support shall be kept to a minimum and their design shall be such as to facilitate quick and secure fixings to metal, concrete, masonry or wood.

Consideration shall be given, when designing supports, to the maintenance of desired pipe falls and the restraining of pipe movements to a longitudinal axial direction only.

The Sub-contractor shall supply and install all steelwork forming part of the pipe support assemblies and shall be responsible for making good any damage to builders work associated with the pipe support installation.

The Sub-contractor shall submit all his proposals for pipe supports to the Consultant for approval before any erection work commences.

The Sub-Contractor shall submit all his proposals for pipe supports to the Consultant for approval before any erection work commences.

b) Steel and Copper Pipes and Tubes

Pipe runs shall be secured by pipe clips connected to pipe hangers, wall brackets, or trapeze type supports. 'U-bolts shall not be used as a substitute for pipe clips without the prior approval of the Engineer.

An approximate guide to the maximum permissible support spacing in meters for steel and copper pipe and tube is given in the following table for horizontal runs.

Size Nominal Bore (mm)	Copper Tube To BS 659 (m)	Steel Tube To BS 1387 (m)
15	1.25	2.0
20	2.0	2.5
25	2.0	2.5
32	2.5	3.0
40	2.5	3.0
50	2.5	3.0
65	3.0	3.5
80	3.0	3.5
100	3.0	4.0
125	3.5	4.5
150	4.5	5.5

The support spacing for vertical runs shall not exceed one and a half times the distances given for horizontal runs.

c) Cast Iron and Asbestos Cement Spigot and Socket Jointed Pipes

Cast iron and asbestos cement socketed pipes shall generally be supported at every socket joint by means of either holder bats secured rigidly to the structure, or purpose made straps for attachment to rigid steel support brackets.

When holder bats are used, they shall conform to the requirements of B.S. 4l6.

Suitable anchors shall be provided at all changes of pipe directions, junctions and tees, to counterpart the effect of end thrust loads.

d) Asbestos Cement Pressure Pipes

Asbestos Cement pressure pipes with either cast iron detachable joints or asbestos cement screw joints shall be supported and anchored on either side of the joint. The joint shall remain free.

Pipe hangers and trapeze type supports shall not be suitable for the suspension of asbestos pressure pipes unless they are designated with suitable restrictions to prevent swinging while at the same time providing the necessary support requirements.

Within building, asbestos pressure pipes shall be carried either on concrete support on rigidly fixed Steel wall brackets.

Suitable anchors shall be provided at all changes of pipe directions, junctions and tees to counterpart the effect of end thrust loads.

e) Concrete and Pitch Pipes

These pipes shall not be used for above ground application.

f) Expansion Joints and Anchors

Where practicable, cold pipe work systems shall be arranged with sufficient bends and changes of direction to absorb pipe expansion providing that the pipe stresses are contained within the working limits prescribed in the relevant B.S. specification.

The Sub-contractor shall pay particular care when supporting cast iron and asbestos cement pipes in order to ensure that the settlement and building movement do not break the pipe joints.

Where piping anchors are supplied, they shall be fixed to the main structure only. Details of all anchor design proposals shall be submitted to the Consultant for approval before erection commences.

The Sub-contractor when arranging his piping shall ensure that no expansion movements are transmitted directly to connections and flanges on pumps or other items of plant.

The Sub-Contractor shall supply flexible joints to prevent vibrations and other movements being transmitted from pumps to piping systems or vice versa.

4.1.1.6 SANITARY APPLIANCES

All Sanitary appliances supplied and installed as part of the Sub-Contract works shall comply with the general requirements of B.S. Specification.

4.1.1.7 PIPE SLEEVES

Main runs of pipe work are to be fitted with sleeves where they pass through walls and floors. Generally the sleeve shall be of P.V.C. except where they pass through the structure, where they shall be mild steel. The sleeves shall have 6mm - 12mm clearance all around the pipe or for insulated pipe work all around the installation. The sleeve will then be packed with slag wool or similar.

2.1.2 **INSTALLATION**

4.1.2.1 GENERAL

Installation of all pipe work, valves, fittings and equipment shall be carried out under adequate supervision from skilled staff to the relevant codes and standards as specified herein. The Sub-contractor shall be responsible to the Main contractor for ensuring that all builders work associated with his piping installation is carried out in a satisfactory manner to the approval of the Engineer.

4.1.2.2 ABOVE GROUND INSTALLATION

a) Water Services

Before any joint is made, the pipes shall be hung in their supports and adjusted ensure that the joining faces are parallel and any fails which all be required are achieved without springing the pipe.

Where falls are not shown on the contract Drawings or stated elsewhere in the Specification, pipe work shall be installed parallel to the line of the buildings and as close to the walls, ceilings, columns etc., as is practicable.

All water systems shall be provided with sufficient drain points and automatic air vents to enable them to function correctly. Valves and other use equipment shall be installed with adequate access for operation and maintenance. Where valves and other operational equipment are unavoidably installed beyond normal reach or in such position as to be difficult to each from a short stepladder, extension spindles with floor or wall pedestals shall be provided.

Screwed piping shall be installed with sufficient number of unions of facilitate easy removal of valves and fittings, and to enable alterations of pipe work to be carried out without the need to cut the pipe.

Full allowance shall be made for the expansion and contraction of pipe work, precautions being taken to ensure that any force produced by the pipe movement are not transmitted to valves, equipment or plant.

All screwed joints to piping and fitting shall be made with P.T.F.E. Tape.

The pump shall maintain the test pressure for about one hour and if there is any leakage, it shall be measured by the quantity of water pumped into the main in that time. A general leakage of one gallon per 25mm of diameter, per 1.6 kilometres per 24 hours per 30 meters head, may be considered reasonable but any visible individual leak shall be repaired.

b) Sanitary Services

Soil, waste and vent pipe systems shall be installed in accordance with the best standard of modern practice as described in B.S. 5572 to the approval of the Consultant.

The Sub-contractor shall be responsible for ensuring that all ground floor waster fittings are discharged to a gully trap before passing to the sewer via manhole.

The Sub-contractor shall provide all necessary rodding and inspection facilities within the draining system in position where easy accessibility is available.

Where a branch requires rodding facilities in a position to which normal access in unobtainable, then that branch shall be extended so as to provide a suitable purpose made rodding eye in the nearest adjacent wall or floor to which easy access is available.

The vent stacks shall terminate above roof level and where stack passes through roof, a weather skirt shall be provided. The Sub-contractor shall be responsible for sealing the roof after installation of the stacks.

The open end of each stack shall be fitted with a plastic coated, or galvanised steel, wire guard.

Access for rodding and testing shall be provided at the foot of each stack.

c) Sanitary Appliances

All Sanitary appliances associated with the Sub-contract works shall be installed in accordance with the best standard of modern practice as described in B.S. 5572 to the approval of the Engineer.

4.1.2.3 UNDERGROUND INSTALLATION

a) General

All underground water and drainage service installations shall be carried out in accordance with the best Standard of modern practice as described in C.P. 301 AND C.P. 310 respectively and the following clause.

b) Sequence of Operation for Underground Service Installation

1) Setting out

As described in B.S. Code of Practice 301 Cause 502.

2) Breaking Up Surface (If in Roads)

As described in B.S. code of practice 301 Clause 503.

3) Excavation and Timbering

As described in B.S. code or practice 301 Clause 503 and the following:-

Excavation shall be made to such depths and dimensions as may be required by the Consultant to obtain prior fall and firm foundations. No permanent construction shall be commenced on any bottom until the excavation to the correct level with concrete I: 4: 8 to 38 mm maximum aggregate sizes.

The Sub-contractor's price shall have included for excavating in all materials met with, for trimming bottoms to the necessary falls and for any extra excavation required for planking, strutting and working space.

The Sub-contractor shall keep the whole of the trenches or other excavation free from water and shall execute such works and install such pumps as may be necessary to keep the excavation dry at all times.

No sub-soil water shall be discharged into the sewage system without written permission of the Engineer.

4) Laying of Concrete Beds or Other Support for Pipes (*if required*)

As described in B.S. code or practice 301 clauses 504 and the following:-

All drains below buildings and roads shall be encased in concrete 150mm thick.

Concrete beds and supports shall be concrete 1:3:6 to 25mm maximum aggregate size.

5) Pipe Laying and Jointing

Drainpipe shall be laid and jointed as described under B.S. code of practice 301 Clause 505.

Pitch fibre drainpipe shall be laid, jointed and cut in accordance with the requirement or the Note contained under Appendix C of B.S. 2760.

Water pipes shall be laid and jointed as described under B.S. code of practice 310, clause 401, 402, 403 and 404.

6) Manholes

i) General

All manholes provided under the Sub-contract works shall be constructed or approved materials and in an approved manner.

All manholes shall be watertight and if constructed of brickwork, solid block work or stonework, they shall be rendered internally with a cement mortar of at least l2mm thickness and finished with a smooth surface.

The sides of all channels in every manhole shall be brought up vertically to a height of not less than the diameter of the drain and shall be benched in good concrete from the top of the channels at an angle of 30 degree to the horizontal and floated to a smooth hard surface with a coat of cement mortar.

In all other respects, manholes shall be constructed in accordance with B.S. code of practice 301.

ii) Rectangular and Square Manholes

Rectangular and square straight through manholes shall be constructed from brickwork, solid blockwork, stonework and concrete to comply with the following minimum internal dimensions (*millimeters*).

Depth below Ground of Outgoing Invert	Internal Access Shaft Dimensions L X W	Size of Main Shaft Diameter	Internal Chamber Dimensions L X W	Height of Chamber above Benching	Wall Thickness
Up to 740	-	100 to 150	610x460	-	150
Up to 740		230 to 460	760x760		150
Up to 1200		100 to 150	760x760		150
160 to 1200	-	230 to 460	910x910	-	150
1220 to1800	-	100 to 150	910x910	-	150
1220 to 1800	-	230 to 460	1070x910	-	150
1830 to 4550	760x760	100 to 150	1370x910	1370	230
1830 to 4550	760x760	230 to 460	1370x1070	1370	230
4570 & Over	760x760	100 to 150	1370x1140	1680	230
4570 & Over	760x760	230 to 460	1370x1140	1680	230

When branches are connected into the manhole, the length and width dimensions of the chamber shall be increased as follow: -

Length

Branch Diameter

l00mm 300mm/branch on the side with most branches.

150mm 380mm/branch on the side with most branches.
230 and 300mm 460mm/branch on the side with most branches.
460mm 610mm/branch on the side with most branches.

Width

Branch Diameter

100mm to 300mm for each side with branches plug
160mm 460mm or the diameter of the main drain whichever is the greater.

iii) Precast Concrete Circular Manholes

Where specified straight through precast concrete manholes shall be manufactured and constructed to comply with B.S. 556 and the following dimensional requirements (Dimensions in Millimetres).

Depth Ground Of Outgoing Invert	Internal Access Shaft Diameter	Size Main Channel Diameter	Chamber Diameter	Height Chamber Above Benching
Up to 740	-	100 to 460	910	-
760 to 2410	-	100 to 460	1070	-
2440 to 4550	760	100 to 460	1220	1370
4570 & over	760	100 to 460	1370	2680

When branches are connected into manholes the internal diameter of the chamber shall be increased, as necessary, up to a maximum chamber diameter 1830mm.

iv) Step Irons and Covers

Access shaft to manhole of depths greater than 760mm shall be provided with approved step irons as suitable intervals.

Every manhole or manhole access shaft shall be fitted with a removable airtight cast iron cover to adequate size and strength, fixed in a manner that prevents surface water gaining access into the drainage system.

Cast manhole covers and frames shall be manufactured in accordance with the requirements of B.S. 497 and shall generally fall into the following categories:-

Heavy Duty	:	For Carriageways
Medium Duty	:	For Footpaths
Light Duty	:	For domestic premises or other places where they do not have to carry wheeled traffic.

v) Back Drop Connections

Where the level of the branch drain entering the manhole is higher than can be suitably accommodated by the normal type benching, then the branch drain shall be connected to the manhole by means of a back drop or practice 301.

vi) Channels

Where the branch channel connects to the main channel in the manhole, the invert of the branch channel shall be a minimum of 38mm higher than the main channel.

7) Testing of Pipelines

After pipelines are connected up and joints have been sealed, the pipeline shall be tested before pipes are, if required, hunched or surrounded in concrete.

Methods of testing and inspection shall be in accordance with Clause 4 of the Specification.

8) Concrete Bedding, Hunching and Surround

Concrete bedding, hunching and surround shall be provided as necessary or where called for by the Consultant in accordance with the requirements laid down in B.S. code of Practice 301, Clause 310.

9) Backfilling

Backfilling of trenches, heading and around manholes shall be carried out in accordance with the methods described in B.S. code of practice 301, clause 508.

10) Reinstatement of Surface

Following the final backfilling of all trenches, headings, and manhole surrounds, the surface of the excavated areas shall be fully reinstated to the approval of the Engineer.

Where excavation have been carried out in public highways or other areas are not forming part of the site, the Sub-Contractor shall be deemed to have allowed in his price for all charges associated with the temporary and final reinstatement requirements of the local of highway Authority, whether this is carried out by the Sub-contractor or by the Authority concerned.

No Claims for extra in this respect will be accepted.

11) Sewer Connection

The Sub-contractor shall pay all charges associated with the connection by the local Authority of the drainage to the Main sewer, including necessary reinstatement.

2.1.3 TESTING AND INSPECTION

4.1.3.1 SITE TESTS - PIPE WORK SYSTEMS

a) Underground Water Mains

After laying, jointly and anchoring, the main shall be slowly and carefully charged with water, so that all air is expelled and allowed to stand full for three days before testing under pressure.

A long main shall be tested in section as the work of laying proceeds and all joints shall be exposed for inspection during the testing.

The open end of the main may be temporarily closed for testing under moderate pressure by fitting a water pipe expanding plug, of which several types are available. The end of the main and the plug should be secured by struts or otherwise, to resist the end thrust of the water pressure in the main.

If the section of main terminates with a sluice valve, the wedge of the valve shall not be used to retain the water, instead the valve shall be fitted temporarily with a blank flange, or if a socket valve with a plug and the wedge shall be placed in the open position while testing. The Sub-contractor shall provide suitable end support to withstand the end thrust of the water pressure in the main.

b) Above Ground Internal Water Services Installation

All water service pipe system installed above ground shall be tested hydraulically for a period of one hour to not less than one and half (1½) times the design working pressure.

If preferred, the Sub-contractor may test the pipelines in section. Any such section found to be satisfactory need not be the subject of a further test when system has been completed, unless specifically requested by the Consultant.

During the test, each branch and joint shall be examined carefully for leaks and any defects revealed shall be made good by the Sub-contractor and the section re-tested.

The Sub-contractor shall take all necessary precautions to prevent damage occurring to special valves and fittings during the tests. Any item damaged shall be repaired or replaced at the Sub-contractor's expenses.

c) Underground Drainage System

A site test shall be carried out on all drainage pipes before concrete hunching or surrounds are applied. These tests shall be carried out preferably from manhole to manhole.

Short branch drains connected to a main drain between manholes shall be tested as one system with the main drain. In long branches a testing junction shall be inserted next to the junction with the main drain and the branch tested separately. After the test has been passed, the testing junction shall be effectively sealed.

All tests on underground drains shall be permitted on cast iron drains at the discretion and to the approval of the Engineer.

Water tests shall be carried out in accordance with the methods described under B.S. code of Practice 301, Clause 601, (b) and (c) and the test pressure shall not be less than 1,520mm head at the highest point in the pipe section and not more than 10,360mm head at any point in the section.

The test pressure shall be maintained for a period of one hour during which time the pipe and joints shall be inspected for sweating and leakage. Any leak discovered during the tests shall be made good by the Sub-contractor and the section re-tested.

In addition to pressure tests, drainpipe runs shall also be tested for straightness where applicable. This test shall be carried out in accordance with one of the two methods described in B.S. Code of Practice 301, clause 601 (e).

Testing of manholes shall be carried out in accordance with the methods described under B.S. code of Practise 301, clause 601 (f).

d) Above Ground Soil Waste and Ventilation System

All soil, waste and ventilating pipe system forming part of the above ground installation, shall be given appropriate test procedures as described in B.S. 5572 1972.

Smoke tests on above ground soil, waste and ventilating pipe system shall not be permitted.

Pressure tests shall be carried out before any work, which is to be concealed, is finally enclosed.

In all other respects, tests shall comply with the requirements of B.S. 5572.

4.1.3.2 SITE TEST - PERFORMANCE

Following satisfactory pressure test on the pipe work system, operational tests shall be carried out in accordance with the relevant B.S. code of practice on the systems as a whole to establish that special valves, gauges, control, fittings, equipment and plant are functioning correctly to the satisfaction of the Engineer.

All hot water pipe work shall be installed with preformed fibreglass lagging to a thickness of 25mm where the pipe runs above a false ceiling or in areas where the ambient temperature is higher than normal with the result that pipe "seating", due to condensation will cause nuisance.

All lagged pipes which run in a visible position after erection shall be given a canvas cover and prepared for a painting as follows: -

i) Apply a coating of suitable filler until the canvas weave disappears and allow drying.
ii) Apply two undercoats of an approved paint and finish in suitable gloss enamel to colours approved by the Consultant.

All lagging for cold and hot water pipes erected in crawl ways ducts, and above false ceiling which, after erection are not visible from the corridors of rooms, shall be covered with a reinforced aluminium foil finish and banded in colours to be approved the Consultant.

In all respects, unless otherwise stated, the hot and cold-water installation shall be carried out in accordance with the best standard of modern practice and described in C.P. 342 and C.P. 310 respectively to the approval of the Engineer.

The test pressure shall be applied by means of a manually operated test pump or, in the case of long main or mains or large diameter, by a power driven test pump or, in the case of long main or mains or large diameter, by a power driven test pump which shall not be left unattended. In either case precautions shall be taken to ensure that the required pressure is not exceeded.

Pressure gauges should be recalibrated before the tests.

The Sub-contractor shall be deemed to have included in his price for all test pumps, and other equipment required under this clause of the specification.

The test pressure shall be one and a half times the maximum working pressure except where a pipe is manufactured from a material for which the relevant B.S. specification designates a maximum test pressure as in the case of cast or spun iron pipes, where the test pressure should not exceed 120, 180 and 240 meter/head of clause B, C or D pipes, respectively.

2.1.4 STERILIZATION OF HOT AND COLD WATER SYSTEMS

All underground water mains and above ground water distribution system, cisterns, tanks, calorifiers, pumps, etc. shall be thoroughly sterilized and flushed out after the completion of all tests of all tests and before being fully commissioned for handover.

The sterilization procedures shall be carried out by the Sub-Contractor in accordance with the requirements of B.S. code of practice 310, clause 409, to the approval of the Engineer.

2.1.5 WATER MAINS

4.1.5.1 PIPING

All piping shall be plain ended and suitable for use with flexible mechanical couplings (e.g. Viking Johnson, Dresser or Gibault). Steel pipes shall comply with B.S. 534 - Galvanized Steel Pipes for distribution system shall comply with B.S. 1387 - 1967 medium tubes and be supplied with flanges on pipes 75mm diameter and over.

On pipes less than 75mm diameter pipes shall be screwed and socketed, unless otherwise stated.

The maximum sustained working pressure to which the pipes and fittings will be subjected is based on water at a temperature of 20°C.

The Contractor shall submit full details of the colour of the pipe he intends to supply. The colour of the pipe shall be such as to meet the requirements of Clause 2 ‘Material’ and Clause 8.5 ‘Opacity’ of B.S. 3505.

The pipes up to and including 50mm diameter shall be of solvent weld type. The pipe shall be supplied with interchangeable sockets pre-formed at the factory and of such internal diameter that it takes the plain and of the pipe with same nominal diameter.

The joint shall sustain the end thrust to which the pipe shall be submitted. The Contractor shall supply sufficient quantity of the cleaner and adhesive which shall be required to make the joints with the pipes.

The pipes of 75mm diameter and over shall consider of a grooved socket at one end of the pipe. The socket shall be designed to give a clearance fit on the outside diameter of the parent pipe. The sealing medium that shall seat in the groove shall be a rubber ring.

If the formation of the socket and groove results in the thinning of the original wall thickness of the pipe, it shall be compensated for by shrinking on to the outside of the socket area as reinforcing sleeve of the same material as the pipe.

The socket and groove shall incorporate no sharp angles where the stress points are created.

The joint shall take 10% deformation of the spigot at the point where it enters the socket without leakage from the pipe when subjected to the test pressure specified for the pipe. Thermal expansion of the pipe shall be accommodated in the joint. The joint shall be capable of lineal deflection up to 30o

The sealing ring shall be of first grade natural rubber and the physical properties of the mix shall meet the requirements of B.S. 2494.

The Contractor shall supply sufficient quantity of any lubricant or other material that shall be needed to make the joint, which shall be assembled by hand.

The fittings shall have the same type of joint as for the pipes to be used. The Contractor shall submit full details of the materials, dimensions and test pressures of the fittings offered.

Precautions shall be taken to avoid damage of the pipes and fittings.

In handling and storing the pipes and fittings, every care shall be taken to avoid distortion, flattening, scoring or other damage. The pipes and fittings shall not be allowed to drop or strike objects. Pipe lifting and lowering shall be carried out by approved equipment only.

Special care shall be taken in transit, handling and storage to avoid any damage to the ends.

All jointing of pipes and fittings shall be carried out strictly in accordance with the manufacturer's instructions.

4.1.5.2 MANUFACTURER'S INSTRUCTIONS

The Contractor shall be responsible for obtaining copies of any manufacturer's instructions for pipe jointing and shall familiarize himself and his employees with these instructions.

All necessary tools and equipment required for the laying, jointing and testing of pipes and joints shall be provided by the contractor at no extra cost.

4.1.5.3 FITTINGS AND SPECIALS FOR GALVANIZED STEEL PIPES.

All specials shall be of such dimensions will mate with piping supplied. Screw down stop valves shall comply with B.S. 1010. Specials shall comply with B.S. 1740.

4.1.5.4 FLANGED ADAPTORS AND FLANGES

Flanged adaptors shall be piece suitable for connecting a flanged sluice valve to the type of piping supplied. All flanges or special shall conform to B.S. 10 part 1 and shall be drilled to Table `C` and machined across the faces. The flanged adaptors shall comply with B.S. 78 and B.S. 3961:1965. All P.V.C. flanges shall be supplied with metal backing rings, jointing of flanges shall be carried out using the joint rings, bolts and washers as necessary.

4.1.5.5 TEES

The spigot ends of all tees shall be suitable for connection to the pipe work supplied using the aforementioned flexible mechanical joints and branches shall be flanges drilled to B.S. 10 Table `C`.

4.1.5.6 HYDRANTS

The hydrants shall comprise a 75mm sluice valve and 75mm Duck feet bend with gunmetal screw connection to details shown on the detailed drawings. These specials shall comply with the requirements of B.S. 750: 1964.

4.1.5.7 GATE VALVES

All gate valves 80mm nominal bore above, other than those required for fitting to buried water mains shall be of cast iron construction in accordance with the requirements of B.S. 3463. All gate valves required for fitting to the buried water mains shall be of cast iron construction in accordance with the requirements of B.S. 1218.

All gate valves up to and including 65mm nominal bore shall be of bronze construction in accordance with the requirements of B.S. 1952.

The pressure classification of all gate valves shall depend upon the pressure conditions pertaining to the Site of Works.

4.1.5.8 AIR VALVES

Air valves shall be of cast iron conforming to B.S. 1452 Grade 14. They shall be suitable for working pressures not less than that specified for the class of pipe to which they are connected.

4.1.5.9 BALL FLOAT VALVES

Ball float valves shall be to B.S. 1212 Parts 1 and 2 shall be suitable for a working pressure not than the working pressure for the class of pipe specified for connection to the ball float valve.

4.1.5.10NON-RETURN VALVES

Non-return valves shall be of cast iron with flanges and shall conform to B.S. 4090:1966.

4.1.5.11STOP COCKS

Stopcocks up to 50mm diameter shall be brass and shall conform to B.S. 1010 Part 1: 1959 Part 2: 1973.

4.1.5.12RUBBER AND INSERTION JOINTING

Rubber and Insertion Jointing for flange joints shall comply with B.S. 2494 Part 1 and no jointing rings shall be used in the Contract, which have not been supplied by manufacturers approved by the Engineer.

4.1.5.13BITUMINOUS PAINTS

All bituminous or tar paints for protection of buried steel bolts, pipes, specials etc. shall be the best of their respective kinds manufactured by approved makers.

4.1.5.14STEEL PIPE AND FITTINGS FOR RISING MAIN

All piping shall be plain ended and suitable for used with flexible mechanical couplings (e.g. Viking Johnson, Dresser). The grade of steal used shall comply with the requirements of B.S. 3601: 1964. Pipes shall be welded or seamless and shall conform to B.S. 534: 1966 or an equivalent acceptable standard.

All pipes shall be externally and internally protected with bitumen in accordance with clauses 5.4 and 5.5 of B.S. 534:1966.

The external protection shall be reinforced with oven glass cloth glass tissue wrapping or by other approved material. All sheathed or wrapped pipes, fittings and specials shall be protected during transit by straw, wood wool or by other approved material.

The ends of all bitumen lined pipes, fittings and specials shall be closed by means of discs or other suitable covers firmly held in place.

4.1.5.15 DRAIN-OFF TAPS, STOP VALVES FOR WATER SERVICES

Fittings for mains of size 50mm or under shall comply with B.S. 1010. Samples must be submitted to the Consultant for approval prior to installation of fittings.

4.1.5.16 STORAGE OF PLANTS AND MATERIALS

The Contractor shall, at his own expense, make arrangements for dumps along the route of the pipe line for storage of pipes, his plant and materials, to suit his own convenience, but such arrangements shall be subject to the Engineer's approval.

4.1.5.17 LOADING, HANDLING AND CONVEYING OF PIPES

The Contractor shall before commencing to lay the pipes, valves or other materials examine them and ascertain that they are in perfectly sound condition and he shall be responsible for any pipes, valves and other materials, which may be found damaged after lying. The stocking of pipes and specials on site, loading and unloading etc. shall be carried out to the satisfaction of the Engineer.

4.1.5.18 INTERFERENCE WITH FENCES, DRAINS, PIPES, PROPERTY ETC

The Contractor shall ensure the proper reinstatement of fences, drains, telephone lines, K P & L. cables etc. where affected by his work. All services shall be adequately protected and propped to the satisfaction of the Engineer. The Contractor shall be liable for any damage caused to the services due to his failure to provide adequate protection.

4.1.5.19 METHOD OF EXCAVATION

a) The Contractor shall excavate the pipe trenches in the line and to the depths indicated by the Engineer. Except where otherwise indicated on the Drawings or directed by the Engineer, it is intended that the trench shall be excavated to such a depth as will allow of a minimum cover of 500mm over top of the barrel of the pipe when laid plus or minus a tolerance of 75mm either way. All trenches shall be excavated in open cuttings.

b) Where the trench passes through grassland, arable land or garden, whether enclosed or otherwise, the turf, if any, shall be pared off and stacked, and the productive soil shall be carefully removed for a width of 600mm greater than the nominated trench width or equal to the overall width of track of the excavating machine, whichever is greater, and laid aside to be subsequently used in reinstating the surface of the ground after the trench has been refilled.

c) The bottom of the trench shall be properly trimmed off, and all low places or irregularities shall be levelled up with fine material. Where rock or large stones are encountered, they shall be cut down to a depth of at least 75mm below the level at which the bottoms of the barrel of the pipes are to be laid, and covered to a like depth with materials, so as to form a fine and even bed for the pipe.

d) Joints holes shall be excavated to suit minimum dimensions as ill allow the joints to be well and properly jointed.

e) The pipe trench shall be kept clear of water at all times.

f) The Contractor shall, wherever necessary by means of timbering, or otherwise support the sides of the trench so as to make them thoroughly secure, and afford adequate support to adjoining roads, lands, buildings and property, during the whole time the trench remains open and shall remove such timbering or other work shall be deemed to be included in the rates for excavation. In case the Contractor is instructed by the Consultant to leave any portion of such timber in position, he will be paid for if accordingly.

g) The clear width inside the timbering in the case of single pipes shall be at least 320mm in excess of the external diameter of the pipe being laid, in order to allow it to be freely lowered into position, in the trench without damage to the external protection.

h) Where more than one pipe is to be laid parallel, then the clear width inside the timbering shall be at least 520mm in excess of the combined external diameters of the pipes.

i) Should the excavation be taken out to a greater depth than is specified the bottom shall be made good to the correct level with Mix 1:3:6 concrete or other materials approved by the Engineer. No payment shall be made for any other excavation carried out by the Contractor and the coat of filling up to required levels.

j) If a mechanical excavator is used by the Contractor, he shall indemnify the Employer against all claims for damage that in the opinion of the Consultant may be caused by the used of this plant. When a mechanical excavator is used the bottom 230mm of excavation shall be got out by hand to ensure an even bed for the pipes.

4.1.5.20MAIN LAYING

Mains shall be laid in straight lines and/or smooth curves as indicated on the Drawings. The vertical profile of the pipes shall be to even gradients. Any pipes not so laid shall be removed if so directed by the Engineer, and re-laid in proper manner at the Contractor's expense.

In laying the pipes and specials care shall be taken not to damage the protective linings and the pipes shall be handled with tackle as directed by the Engineer.

The pipes and specials shall be slung and sounded with hand hammer for flaws before they are lowered into the trench. After the pipes or specials have been checked they shall be cleaned internally and carefully lowered into trench and set to proper gradient and line so that there is a continuous rise from each washout to air valve.

4.1.5.21 TEMPORARY BENCH MARKS AND SIGHT RAILS.

The Contractor shall fix Sight Rails for use with boning rods at intervals of not more than 65 meters and temporary Bench Marks related to the Survey of Kenya. Datum shall be provided at intervals as directed by the Consultant.

4.1.5.22CURVES AND BENDS

Large diameter curves of main shall wherever possible be formed by giving a set not exceeding 3o to each joint, bends being used only where large diameter curves are not possible.

4.1.5.23CUTTING OF PIPES

The Contractor shall, subject to approval of the Engineer, cut pipes to such lengths as directed. Pipes should be cut off clean and square with the axis. Cuts should be made with an approved from the rotary cutting machine, but the Consultant may approve cutting by oxyacetylene cutters.

4.1.5.24FLANGED JOINTS

In laying pipes and specials with flanged joints, flanges shall be brought together and bolted with the faces absolutely parallel. A rubber jointing ring 3mm thick shall be used in each flange joint and one washer with each bolt. The ring shall be a strip ring lying within the bolt circle and a full flange width ring.

The bolts shall be tightened up gradually and equally in the customary manner in order to distribute the stress evenly over the flange. If it is found necessary to slightly from the normal run of the flange piping, the deflection shall be obtained by means of beveled gunmetal ring washer between the flanges.

4.1.5.25SURFACE BOXES

Sluice valves, air valves and fire hydrants shall be covered with Surface Boxes in accordance with details as shown on the Drawings. In roads and footpaths the boxes shall be laid flush with the surface.

4.1.5.26FIXING OF VALVES, AIR VALVES AND WASHOUT PIPES.

The Contractor shall fix the sluice valves, air valves, washout pipes complete with iron casing for spindles and surface boxes in accordance with and in position shown on the Drawings. As far as possible the cutting of pipes for this should be avoided.

4.1.5.27SUPPORT AND ANCHOR BLOCKS

Concrete mix 1:3:6 shall be placed around and against bends and other specials in trenches.

4.1.5.28COLOUR CODING

All underground pipes are to be wrapped with adhesive plastic tape at each meter in colours blue for drinking water and green for untreated water. All pipe work above ground and valves in valve chambers and pits are to be painted in similar colours.

4.1.5.29LETTERING

a) The lettering for sluice valves, fire hydrants, air valves and washout abbreviated SV, FH, Av and WO respectively shall be in accordance with the detail shown on the Drawings and colour coded as detailed hereafter:-

Untreated water:	White lettering on green background
Drinking water:	White on blue background
Fire Hydrant:	White lettering on yellow background

4.1.5.30TESTING

a) The test pressure shall be one and a half the maximum working pressure except where a pipe is manufactured from a material for which the relevant B.S. Specification designates a maximum test pressure should not exceed 120, 180 and 240 metre/head for Clause B, C or D pipes, respectively.

The pump shall maintain the test pressure for about one hour and if there is any leakage, it shall be measured by the quantity of water pumped into the main that time.

b) When a section of the main has been jointed, the ends shall be closed with caps, plugs, or flanges, which must be strongly strutted against a solid surface to the satisfaction of the Engineer. The trench shall be properly backfilled and rammed as hereinafter specified and as shown on the Drawings, for its whole length so as to cover the main to a depth of not less than 500mm, except at the joint holes which shall be kept clear of all backfilling, if necessary by the use of timbering, so that each joint is left fully exposed for inspection. No backfilling will be permitted before testing of each section.

As long a section of main as possible shall be tested at one time subject to the maximum length of open trench approved by the Consultant or permitted by the Highway Authority, and the test shall be carried out within 12 working days of the completion of such sections of mains.

Where a main is laid across a road or in such a position as to interfere seriously with the normal use of the road, the Contractor may, with the consent of the Consultant and at his own risk, fill in such joint holes as may be necessary.

He shall, at his own expense, re-excavate any or all joint holes necessary to locate a leak and carry out repair work should the results of his hydraulic test prove unsatisfactory.

The section shall then be filled with mains water, great care being taken to drive out all air through air valves, ferrules or otherwise to the approval of the Consultant.

c) After the section to be tested has been charged and all air liberated it shall standing under moderate pressure for several days' final airing.

The leakage from the mains and connections from each section tested shall not exceed 4 litres of water per 25mm diameter of main, per 2 km. length each 24 hours, every 30 metres head of pressure, and any visible individual lea shall be repaired.

To determine the rate if leakage, the Contractor shall furnish a suitable hydraulic test pump, pressure gauge, connections and water meter or other appliance, for measuring the amount of water pumped.

If the leakage were at a greater rate than that specified, the Contractor should re-excavate the trench where necessary and shall remake the joints and replace defective work until the leakage shall be reduced to the allowable amount.

d) The Employer shall charge the Contractor the cost of any couplings required to join up tested lengths of main if, in the Engineer's opinion, greater lengths could reasonably have been tested or if failure under test requires the pipe to be cut, or other methods of laying should have been adopted.

The Contractor shall supply water used by the Contractor in testing the main. The Contractor shall carry out all work, which may be necessary for making temporary connections to the existing mains to obtain water for testing at his own expense.

e) In carrying out the test for water tightness the Consultant only shall authorise the operation of all valves, but the Contractor shall provide all the necessary labour to assist in the opening and

closing of the valves to the Engineer's instructions, and he shall allow in his prices for all his expenses in connection with testing on completion.
The Consultant shall be the sole judge of water tightness.

4.1.5.31 CLEANSING AND STERILIZING THE MAIN

When a pipeline is complete and where applicable, has successfully passed the test, it shall be thoroughly washed out using, if possible, an open end. Thereafter it shall be sterilized by being filled with a suitable solution containing not less than 20 p.p.m. of free available Chorine or such other sterilizing agent as the Consultant shall approve. After standing for 24 hours the main shall again be washed out and refilled with mains water prior to the taking of Bacteriological samples.

The Contractor shall provide all necessary stop-ends fittings and chemicals for this work.

Emptying and washing out of the pipes shall be done in such a manner as not damage the trench or cause undue flooding of the vicinity, and the Contractor shall supply and use such piping, specials and/or hose as may be necessary to facilitate the flow of water to the nearest drain or watercourse. Water used for washing out and sterilizing will be supplied by the Employer.

Before any section of the main is put into use a bacteriological sample or samples will be taken by the Engineer`s Representative and only on receipt of a satisfactory Certificate from the Medical Research Laboratory of the Employer will the main or section of main be permitted to be put into supply and be considered as having been substantially completed.

Any expenditure involved in providing facilities or materials for the taking of samples shall be included in the Contractor's tendered rates and the Consultant will specify and shall be the sole judge as to the number of samples required and the points at which they are to be taken.

The cost of the Bacteriological Examination will be borne by the Employer but if the sample and samples are not satisfactory the cost of any subsequent analyses will be borne by the Contractor.

4.1.5.32 CLEARANCE OF SITE

The Contractor shall remove all surplus pipes, specials and other fittings from the side as directed by the Engineer. The site of works shall be levelled and all surplus excavation, debris, cut trees or bushes shall be carted to the approved tip sites.

4.1.5.33 EXISTING INSTALLATIONS

a) **Cold Water**
Where pipes for cold water are to be connected up to existing installations, the condition of the existing installation is to be reported to the Consultant in order to establish if part of the existing installation is to be replaced.

b) **Sanitary Fittings**
Where existing sanitary fittings are to be removed or replaced, the fitting is to remove with outmost care and fittings and taps to be handed over to the client.

c) **Sealing off Existing Drains and Manholes**

Existing foul, surface water and subsoil drains exposed during progress of work are to be recorded and reported for investigation by the Architect. Where not required to be removed, seal off with concrete or grout solid as directed. Seal off connection to manholes, demolish walls to 500mm below surrounding ground level and fill remainder of manhole with consolidated approved rubber and cover to level of surrounding ground as directed.

2.1.6 COLD WATER STORAGE TANKS

Cold-water storage tanks shall include the ball valves and connectors for inlet, supply, washout, and overflow and may also include fire reel system supply pipe. The Sub-Contractor shall also include in his pricing the price of the overflow and amount pipes to a place to be indicated by the Engineer. He shall also include the washout valve.

Where paint is required tithe Sub-Contractor shall use the paint, which will not be toxic.

The tanks shall be manufactured to the following British Standards:-

a) Galvanised Mild Steel tanks to BS 417
b) Sectional Steel tanks to BS 1564

Where non-standard sizes shall be used, they shall be manufactured to the relevant standard but with the approval of the Engineer.

2.1.7 WATER HEATERS

4.1.7.1 ELECTRICALLY HEATED

Non-pressure and low-pressure type domestic electric water heaters shall comply with B.S. 843: 1964, high-pressure types shall be of a Standard not less than the appropriate B.S.

Domestic heaters shall, if nothing else is pacified, be supplied with 25mm thick fibreglass lagging and enclosed in the corrosion-proofed steel, finished in white stove enamel and be similar to manufactured `HEATRAE`.

Electric thermostatically controlled immersion heaters shall comply with B.S. 3456: Section A8:1963 and C.P. 324. 202: 1948.

Purpose made storage water heaters of the specified sizes shall comply with B.S. 853 and shall be to the specified working and test pressure. The heaters shall be provided with all necessary bosses, coils etc., and shall be hot dip galvanized after manufacture. Insulation shall, if nothing else is specified, be fibreglass to the specified thickness with finish suitable for painting.

Domestic heaters for floor mounting shall, if not provided with legs, be mounted on a minimum 100mm high concrete plinth.

Floor mounted purpose made heaters shall be provided with minimum 225mm high legs of sufficient strength welded to the heaters and to suitable floor plates before galvanising. Wall mounted heaters shall be supplied with all necessary brackets.

2.1.8 SOLAR WATER HEATERS

4.1.8.1 GENERAL

All materials, equipment and accessories are to be new and in accordance with the requirements of the current rules and regulations where such exist, or in their absence with the relevant British/European standard.

Uniformity of type and manufacture of equipment or accessories is to be preserved as far as practicable throughout the whole work.

If in this specification, the practice is adopted of specifying a particular item as “similar” to that of a particular firm’s product, it is to be clearly understood that this is to indicate the type and quality of the equipment required. No attempt is being made to give preference to the equipment supplied by a firm whose name or products is being quoted.

Where particular manufacturers are specified herein, no alternatives makes will be considered, and the Engineer shall be allowed to reject any other makes.

The tenderer will be entirely responsible for all the materials, apparatus, equipment, etc in connection to his work, and shall take special care to protect all parts of finished work from damage until handed over to the Employer.

The work shall be carried out by competent workmen under skilled supervision. The Engineer shall have authority to have any of the work taken down or changed, which is executed in any unsatisfactory manner.

The works shall be carried out strictly in accordance with:-

a) British Standard B.S. 5918, Domestic hot water supply and solar water heating System
b) “British code of Practice” C.P. 310: Water Supply
c) British Standard code of Practice” C.P. 342: Centralized Hot water supply
d) All other relevant British standard Specifications and Codes of Practice (herein after referred to as B.S and C.P respectively.)
e) By-Laws of the Local Authority
f) The “Specification” and the “Particular Specification”
g) The tender/working drawings
h) The engineer’s Instructions.

The drawings and specifications are to be read as a whole and are to explain each other. Work shown on the drawings and not described in the specifications or vice versa shall be duly executed under the contract.

4.1.8.2 SOLAR PANEL – CONSTRUCTION

Solar panels shall be flat plate solar collectors. The structure of the collector and its components must withstand local extreme environmental conditions including winds, storm etc.

4.1.8.2.1 SOLAR PANEL - INTERNAL CONSTRUCTION

a) **Absorber -** Shall be located directly beneath the glass sheet and fully cover the internal area of the panel.

Absorber shall be made of copper sheet or aluminium with a selective surface chemically treated similar to the black chrome finish or similar. The selective surface shall achieve 95% absorptivity of solar radiation and 15 to 20% emissivity of infra-red radiation. The absorber and the selective surface shall not be affected during life span of the absorber.

b) Heat Exchanger - Copper tubes and fittings shall be utilized for internal panel pipe work and in accordance with B.S. 2871 or similar. All joints and connections between the riser and header tubings shall be leak proof and stand to hydraulic pressure tests.

The collector to be pressure tested to withstand a pressure of 8 kg/cm^2 whichever is greater. In general, collectors shall be pressure tested at 15 times the rated operating gauge pressure of 8kg/cm^2, whichever is greater.

A certificate of pressure testing to be issued when required and requested by the Engineers.

c) Insulation - The underside of the absorber, inclusive headers and the outer casing internal sides shall be insulated with 50 mm fiberglass insulation, minimum density 64 kg/m^3. The insulation shall be non-combustible and shall withstand maximum continuous operating temperature of 200^{o}C (and minimum operating temperature of –50^{o}C).

4.1.8.3 HOT WATER SOLAR CYLINDER

a) The hot water solar cylinder shall have a nominal capacity as specified on the contract drawing and particular specification to the designed highest water level. The hot water cylinder shall have a separate feed tank attached to it.

b) The cylinders and the feed tanks shall comply with B.S. 417, 699, 2777, 4214, 1565, 1566 and 3198. Refer also Water Storage tanks as specified elsewhere. The Cylinder and tanks shall be supplied complete with screwed BSPF parallel thread flanged connections for flow, return, vent, overflow and drain pipes.

c) Cylinder shall be provided with a magnesium electrode as corrosion protection, weight: minimum 1.5 kg and have an inspection cover to facilitate renewal of the electrode.

d) The cylinder shall be galvanized, after manufacture in accordance with the requirements of BS. 729 Part 1 and pressure tested in accordance with the above B.S.

A certificate of pressure testing to be issued when required and requested by the Engineers / Project Manager’s Representative. Refer also to “Protection of Metal surface” as specified elsewhere in the specification.

e) **Insulation -** The cylinder shall be insulated on all the sides with 100 mm fiberglass, or 100 mm thick foam injected polyurethane. At the inspection cover, the insulation shall be easily removable.

f) **Cladding -** The insulation shall be with full 24 gauge galvanized M.S. Sheet cladding.

3 PART D

3.1 PARTICULAR SPECIFICATIONS FOR PLUMBING AND DRAINAGE INSTALLATIONS

3.1.1 INTRODUCTION

The specifications cover the execution of Plumbing and Drainage installations and should be read in conjunction with other relevant specifications, drawings and contract documents issued to the sub-contract.

3.1.2 INCLUDED IN THE SUB-CONTRACT

The works include, unless otherwise specified, supply delivery, installation, testing and commissioning, cleaning-up and setting to work all the installations described in the specifications and as shown on the contract drawings.

The provisions of all labour, materials, tools instruments testing apparatus and scaffolding necessary to execute the work in a first class manner, even such labour materials instruments or apparatus which are not specifically mentioned in the contract but are necessary for the satisfactory completion of the work, including such elements as:-

a) Cold water supply pipe work and fittings to the water storage tanks from the existing water mains.
b) Water storage tanks complete with all necessary covers, fittings, washout and overflow pipes and supports. The subcontractor is expected to take the overflow and washout pipes to a reasonable discharge point.
c) The water supply pipe work to the functional and sanitary as shown on the drawing plus the necessary fixing support and jointing materials from the water storage tanks.
d) The sanitary and operational fittings together with the fixing supports and jointing of the supply and discharge pipes.
e) The waste and soil pipe work from the sanitary and operational fittings to the first manhole including all fixing, supports and jointing materials.
f) All cutting away and all making good will if nothing else is specified, be carried out by the main contractor but it will be the responsibility of the sub-contractor to ensure that this work is kept to a minimum, be responsible for the correct marking out of all chasers and holes; and will provide also necessary details to the main contractor.
g) The sub-contractor shall also be responsible for ensuring that runs for floor or wall chases, holes to be cut or left will be marked out at the appropriate stage of structural work.
h) The sub-contractor shall undertake all notifications demanded by the Authorities in order to comply with current regulations and produce all certificates, if any, the authorities without extra charge.
i) The sub-contractor shall as part of his tender supply all necessary information such as manufacture, catalogue or type numbers, brochures or copies of catalogue pages, weight and all other relevant information which are necessary to classify the equipment tendered for.

j) All other material labour, tools instruments, scaffolding, etc, which are necessary for completion in a first class manner of the plants to the Engineer's satisfaction. Excluded
k) are only materials and workmanship especially mentioned herein as excluded from this Sub-contractor"
l) The sub-contractor shall include for cables, pipes etc from central facilities to working area.
m) Provide the Engineer for his approval complete working and manufacturing drawing as specified.
n) Commissioning and testing of the plants as specified.
o) Supply of complete operation and maintenance manuals as specified as well as adequate instruction of the client's maintenance personnel as specified.
p) The sub-contractor shall include for full maintenance during initial maintenance period as specified.

3.1.3 EXCLUDED FROM THE SUB-CONTRACT

a) All concrete works, inclusive of necessary holes, plinths etc.
b) All block work inclusive of necessary holes (to be marked by the Sub-contractor) etc.
c) All electrical wiring up to and inclusive of isolators and switchboards.
d) The main contractor will provide central located facilities for supply of water and power during the construction period.

3.1.4 EXTENT OF THE SUB-CONTRACTOR'S DUTIES

At the commencement of the work, the sub-contractor shall investigate and report to the Engineer if all materials and equipment to be used in the work, and not specified as supplied by others, are available locally. If not available, the subcontractor shall at this stage place orders for the materials in question and copy the orders to Consultant. Failure to do so shall in no way relieve the sub-contractor from supplying the specified materials and equipment in time.

Any item or material found to be defective shall be replaced by the sub-contractor within seven days of his being notified and any result of defective workmanship shall be repaired including supply of new parts if necessary, immediately upon being notified.

The sub-contractor shall furnish at his own cost any samples of material or workmanship required for the sub-contract works, that may be called for by the Engineer for his approval and the Engineer may reject materials or workmanship not in his opinion up to the approved standard. The sub-contractor shall allow in his prices such samples.

The sub-contractor shall when authorized in writing by the Consultant, make variations from the specifications and drawing. No profit will be allowed on omitted items or works.

The sub-contractor shall submit to the Architect or to the Engineer claims for any work for which he considers demanding extra payments before the beginning of such work.

The sub-contractor shall be responsible for verifying all dimensions relative to his work by actual measurements taken in the site.

The sub-contractor shall request any alteration to the building structures within 30days of the awarding of the sub-contractor. Only such alteration as deemed unavoidable by the Engineer will be considered.

The sub-contractor shall collaborate with the Engineer and the main contractor in planning the installation before work is commenced. Particular care shall be taken to ensure that there is close collaboration with the other sub-contractors when installing services.

The Engineer shall have full rights to inspect the work in progress and all materials equipment for use in the installation prior to its erection whether these are on site or the sub-contractor's workshop.

The sub-contractor shall allow for all reasonable access to the works for this purpose.

Where large items of equipment are to be installed, the sub-contractor shall advise the main contractor in good time so that access is provided for installation before work is commenced on site.

The sub-contractor or his responsible representative shall be in all site meetings as and when required in order to discuss the works, make necessary decisions, receiving relevant instructions and to confirm fulfilment of time schedules.

3.1.5 FINISH PAINTING

When all the installations have been set to work, tested and commissioned, the sub-contractor shall prime the pipe work with an undercoat and paint 2 No. coats of paints in accordance to BS 1710 Colour coding and to the satisfaction of the Consultant.

4 PART E

4.1 PARTICULAR SPECIFICATIONS FOR FIRE FIGHTING SYSTEMS INSTALLATIONS

4.1.1 HOSE REEL SYSTEM

6.1.1.1 GENERAL

The particular specification details the requirements for the supply, installation and commissioning of the hose reel installation. The hose reel installation shall comply in all respects to the requirements set out in C.O.P. 5306 Part 1: Lower Floors.

The Sub-Contractor shall include for all appurtenances and appliances not necessarily called for in this specification or shown on the Contract Drawings but which are necessary for the completion and satisfactory functioning of the Works.

No claims for extra payment shall be accepted from the Sub-Contractor because of his non-compliance with the above requirements.

If in the opinion of the Sub-Contractor there is a difference between the requirements of the specifications and the Contract Drawings, he shall clarify these differences with the Engineer before tendering.

6.1.1.2 COMMENCEMENT OF WORKS

The sub-contractor in submitting his tender shall be deemed to have included for commencing any necessary work on site at such a time as will comply with the main contractor's programme, or shall be directed by the Engineer.

6.1.1.3 ORDERING

The sub-contractor shall order materials from the quantities taken from his own approved working drawings and not the quantities shown in the specifications.

6.1.1.4 SPARES

Spares shall be presented to the client at hand over.

6.1.1.5 SCOPE OF WORKS

The Sub-Contractor shall supply, deliver, erect, test and commission all the automatic fire fighting hose reel installation which is called for in this specification and shown on the Contract Drawings.

In connection with the above works the Sub-Contractor shall liaise fully with the plumbing Sub-Contractor who will be responsible for making a new connection to the existing water mains, supplying and laying a metered service pipe, up to the connections to the water tank.

The Sub-Contract shall handover to the Electrical Sub-Contractor all the electrical control gear for the installation. The Electrical Sub-Contractor shall supply electrical power, interconnecting cabling and wiring to the hose reel installation.

The Sub-Contractor shall supply and handover all the wiring and control diagrams necessary for the Works when required to do so.

Though the Electrical Sub-Contractor shall install the isolator and be responsible for the electrical connections in compliance with electrical regulations, the Sub-Contractor for the Works contained in this document shall supply and install the starting and stopping gears, indication equipment and retain full responsibility for the correct functioning of the installation.

6.1.1.6 FIRE HOSE REEL PUMPS

The fire hose reels pumps shall consist of a duplicate set of multi-line centrifugal pumps as Lowara Sphere Unit Model CEM 80/5 or similar approved. The pumps shall be capable of delivering 2.3 l/s (8.3 m^3/hr) against a head of 25 m (2.5 bars). The complete specification of the packaged pump set to be as follows: -

a) **Pumps**
High Efficiency single impeller pump, enclosed type motor, enclosed in a stainless steel shell.

b) **Pump Materials**
Suction and Discharge Casing made from Grey Cast Iron. Pump body, back plate, shaft, conveyor, diffuser and impeller made from Stainless Steel AISI 304.

c) **Motors**
T.E.F.C. Squirrel Cage Motors conforming to metric standards suitable for 240 volts (± 6%), single phase, 50 Hz supply. Windings insulated to Class "F", Speed 2800 RPM, permanent split capacitor, built-in thermal overload and IP 44 protection.

d) **Mechanical Seal**
Self-adjusting type with carbon/ceramic with elastomer made of NBR and other components in stainless steel.

e) **Base Frame**
Welded fabrication from Mild Steel sections with facility for lifting unit.

f) **Flexible Connections**
Flexible connections affixed to suction and discharge connections of the pump.

g) **Valves**
Pump Isolating Valves shall be Butterfly Valves to B.S. 5155 with Cast Iron nylon coated disc and black nitrile liner. Non-Return Valves shall be vertical lift type to be manufactured from Cast Iron with nitrile seal.

h) **Control Panel**
The control panel is to be located in the position indicated on the contract drawings.
The control panel shall be constructed of mild steel with auto lacquer finish, be moisture, insect and rodent proof and shall be provided complete with spare fuses and a wiring diagram enclosed in plastic laminate.
Standard panel cubicle manufactured to IP55 Standards, containing Direct-On Line Starters or Star Delta Starters above 4.0 kW.
Safety features to include 240 volts low voltage controls except for starter coils. Panel shall be mounted on vibration isolators to minimise vibration to electrical equipment.

The panel shall incorporate HRC main fuses and thermal overloads for the pump motors, time control unit for minimum run period, start relay incorporating timing element for standby pump delay, and one set of voltage free changeover contacts to give remote alarm/indication for the indicator lights mentioned.

The pump shall be controlled by a pressure switch and the control panel shall include the following facilities to IP 54 protection:-

i. "On" push button for setting control panel to live
ii. Green indicator light for indicating control panel live
iii. Duty/stand by pump auto-change over
iv. Duty pump, pump run green indicator light
v. Stand by pump, pump run green indicator light
vi. Duty pump fail red indicator light
vii. Stand by pump fail red indicator light
viii. Hand/Off/Auto Switches
ix. Line and control circuit fuses
x. Low water condition pump cut out with red indicator light

i) Pressure Switch

It shall be of Differential adjustment type switch manufactured to IP44 Standards.

Multi-pump sequencing control effected from a single pressure instrument, utilising control circuitry especially for pressure boosting applications.

j) Pressure Gauge

4" Dial Bottom Connection to B.S 1780 calibrated in Bars and kPa.

k) Membrane Tank - (24 litre Hydrosphere)

Fabricated Steel Construction housing a neutral rubber diaphragm ideally suited for drinking water applications. Pre-charged with Nitrogen to correct pressure at test stage.

l) Low Level Water Cut-out

The pumps shall be protected by a low level cut out switch to prevent dry pump run when low level water conditions occur.

6.1.1.7 PIPE WORK

The pipe work for the hose reel installation shall be galvanised wrought steel tubing "Medium" Grade Class "B" to B.S. 1387: 1967 with pipe threads to B.S.21.

6.1.1.8 PIPE FITTING

The pipefittings shall be galvanised wrought steel pipefittings welded or seamless fittings conforming to B.S.1740 Part 1971 or malleable iron fittings to B.S.143/1256.

All changes in direction shall be with standard bends or long radius fittings. No elbows will be permitted.

6.1.1.9 FLANGES

The flanges shall comply with B.S.4504:1969. All flanges shall comply to a nominal pressure rating of 16 bar (P.N.16)

6.1.1.10GASKETS

The gaskets for use with flanges to B.S. 4304:1969 shall comply with B.S. 4865 Part 1: 1072 for pressure up to and not exceeding 64 Bar.

6.1.1.11NON-RETURN VALVES

The non-return valves up to and including 80 mm diameter shall be as Pegler to B.S.5153: 1974 with flanges to B.S. 4504 P.N.16.

The valves shall be of iron construction with gunmetal seat and bronze hinge pin.

6.1.1.12GATE VALVES

The gate valves up to and including 80 mm shall be as Pegler non-rising stem and wedge disc to B.S.1952.: 1964 (B.S. 5154:1974) with screwed threads to B.S. 21 taper thread.

6.1.1.13SLEEVES

Where pipe work passes through walls, floors or ceilings, a sleeve shall be provided one diameter of the pipe, the space between to be packed with mineral wool, to the Engineer's approval.

6.1.1.14HOSE REELS

The hose reels to the installation shall consist of recessed automatic hose reels as Mather & Platt Model 1065 standard swinging hose reel (recessed).

All the above hose reels shall comply with B.S.: 1976 and B.S, 3169: 1970 and is to be installed to the requirements of C.P. 5306 Part 1 1976.

The hose reels shall be supplied and installed complete with first-aid non-kicking hose 30 metres long, with nylon spray jet/Shut-off nozzle. A screw down chrome plate globe valve to B.S. 1010 to the inlet of the reel shall be fitted. The orifice to the nozzle is to be not less than 4.8 mm to maintain a minimum flow of 0.4 l/S to the jet.

The hose reels shall be installed at 1.5 metres centre above the finished floor level in locations shown on contract Drawings.

6.1.1.15EARTHING

The hose reel installation shall be electrically earthed by a direct earth connection.

The installation of the earthing carried out by the Electrical Sub-Contractor.

6.1.1.16FINISH PAINTING

Upon completion of testing and commissioning of the hose reel installation the pipe work shall be primed and finish painted with 2 No. coats of red paint to the Architects requirements.

6.1.1.17TESTING AND COMMISSIONING

The hose reel installation is to be flushed out before testing to ensure that no builder's debris has entered the system. The installation is to be then tested to one and a half times the working pressure of the installation to the approval of the Engineer.

Simulated fault condition of the pumping equipment, is to be carried out before acceptance of the system by the Engineer and Architect.

4.1.2 PORTABLE FIRE EXTINGUISHERS

6.1.2.1 WATER/CARBON DIOXIDE EXTINGUISHERS

The portable water filled carbon dioxide cartridge operated fire extinguishers shall have 9 litres nominal capacity and shall comply with BS 5423.

The extinguishers shall be supplied complete with wall mounting brackets 370mm long neoprene hose and pressure relieve valve treated at 30 bars.

6.1.2.2 CARBON DIOXIDE EXTINGUISHERS

The portable carbon dioxide extinguisher shall have 5 kilogram nominal capacity, supplied complete with wall mounting brackets hose and horn and shall comply with BS 5423.

6.1.2.3 FIRE BLANKETS

The fire blankets shall measure 1.22 x 1.22 metres made from texture woven glass fibre and shall be completely fire resistant.

The blanket shall be housed in sturdy non-corrosive dispenser and shall be fitted with special tapes to offer instant, single action release.

6.1.2.4 FIRE HYDRANTS

The fire hydrant shall be screw down to BS 750 (*type 2*) with screwed outlet and similar or equal to Glenfield make.

4.1.3 SPRINKLER INSTALLATION

6.1.3.1 GENERAL

This section includes the supply and installation of sprinkler system in Basement complete with control valves, gauges, pumps and pipe-work.

For Preambles and Specifications applicable to this section the Contractor is hereby referred to "RULES of the FIRE OFFICES" COMMITTEE for AUTOMATIC SPRINKLER INSTALLATIONS" 29^{TH} Edition issued (revised) November 1973 and particularly to section dealing with ORDINARY HAZARD Group II.

6.1.3.2 SYSTEM COMPONENTS

6.1.3.2.1 SPRINKLERS

Sprinkler heads shall be of approved makes and types. They shall not be allowed in any respect nor have any types of ornamental or coating applied after leaving the production factory. Sprinkler heads of conventional or spray patterns are acceptable for use with orifice of 15mm diameter.

6.1.3.2.2 PIPE-WORK

6.1.32.2.1 PIPE SPECIFICATION

Sprinkler pipe-work to be "class B" black steel tubes conforming to BS 1387, steel tubes and tubulars for screwing to BS 21 pipe threads.

6.1.3.2.2.2 WELDED PIPES

Only pipes of 50mm in diameter or greater may be joined together by welding unless the joints are fabricated, welded and inspected in the workshops of installing sub-contractors whose welding procedures shall have been approved by the Fire Insurers.

6.1.3.2.2.3 CONCEALMENT OF PIPE-WORK

Sprinkler pipe-work shall not be embedded in the concrete floors of the building, nor should it be concealed in any other situation where difficulty or undue expense would be involved in making alterations or additions which may subsequently become necessary.

Where it is considered necessary to fit orifice plates in order to assist in hydraulically balancing a system or to meet pump characteristic curves, the diameter of the orifice must not be less than 50 per cent of the diameter of the pipe into which the plate is to be filled. Such orifice plates are only allowed in pipes 50mm diameter or larger. They shall be of brass with plate central holes without burrs and thickness stated in the table below. They shall be situated not less than two pipe diameters from any elbow or hand measured in the direction of flow. Orifice plates shall have a projecting identification tag which is readily visible on which is stamped the nominal pipe diameter and the "K" factor for the orifice.

6.1.3.2.3 TEMPERATURE RATINGS

Sprinkler heads shall be of nominal temperature rating of 79^{0}C.

The following colour code shall be adopted to distinguish sprinkler of different nominal temperature ratings:

Glass bulb types (^{0}C)	Colour of bulbs
57	Orange
68	Red
79	Yellow
141	Blue
182	Mauve
204 / 260	Black

6.1.3.2.4 STOCK OF REPLACING SPRINKLERS

a) A stock of spare sprinklers shall be maintained on the premises so that any sprinklers that have operated or have been damaged in any way may be promptly replaced. These sprinklers shall be kept in cabinets located in prominent and easily accessible positions where ambient temperature conditions will not exceed 38^{0}C.

b) The number of spare sprinklers to be maintained on the premises will largely depend on the size of the protected premises and the Hazard class of the system

c) As s general guide the 34 sprinklers minimum number of spares shall be maintained of standard temperature ratings.

d) Sprinkler spanners as stipulated by the manufacturers of the sprinklers shall be kept in the cabinets for use in removing and installing sprinklers.

Nominal size of pipe (mm)	Orifice plate Thickness (mm)
50	
63	3
70	
100	6
150	
200	9

6.1.3.2.5 SLOPE OF PIPES FOR DRAINAGE

Sprinkler pipes shall be so installed that the system can be thereon duly drained. As far as practicable all pipes shall be arranged to drain to the installation drain valve which shall be not less than 50mm diameter.

6.1.3.2.6 PRESSURE GAUGE

On this installation there shall be a pressure gauge (gauge "c") fitted immediately above the alarm valve and another (gauge "g") immediately below the alarm and main stop valves.

Pressure gauges shall conform to B.S.1750. The maximum scale valve of such gauges shall be of the order of 150 per cent of the known maximum pressure. Pressure gauges must have scales with divisions not exceeding 0.2b for a maximum scale valve of 10b, not exceeding 0.5b for a maximum scale on excess of 16b.

Means must be provided to enable each pressure gauge to be readily removed without interruption of installation.

6.1.3.2.7 VALVES

6.1.3.2.7.1 INSTALLATION CONTROL VALVES

The installation must be provided with a set of installation control valves comprising:-

i) A main stop valve
ii) An alarm valve (wet pipes)
Or
iii) A composite alarm valve suitable for a wet system
iv) A water motor alarm and gong.

a) Stop valves

i) General

All stop valves except these fixed by the Water Authorities on the branches from a town main shall be "right handed" i.e. they must be so constructed that in order to shut the valve the spindle shall turn clockwise. The controlling wheels of all stop valves shall be clearly marked showing in which directions the wheel is to be turned to close the valve; there shall be an indicator also which will show whether the valve is open or shut.

ii) Main Stop valves

The installation shall be provided with a main stop valve, which when closed will shut off all supply of water to the installation. All water supplies shall be connected before passing through the main stop valve.

The main stop valves shall be placed to an entrance to the premises preferably a main entrance, in such a location at to be always readily visible and accessible to authorized persons. It must be secured open by a padlocked or riveted strap.

A plan of the risk with the position of the main stop valve or valves, clearly indicated thereon shall be placed within the building where it can be readily seen by firemen or others responding to the alarm. In addition, a location plate shall be fixed on the outside of an external wall, as near to the main stop valve as possible, bearing the following words in raised letters or other approved type of letters.

iii) Sprinkler Stop Valve Inside

The words “SPRINKLER STOP VALVE” should be in letters of at least 35mm, and the word “INSIDE” of at least 35mm in height. The words shall be painted white on black ground.

iv) Stop Valves Controlling Water Supplies

All stop valves controlling water supplies shall be secured open by a padlocked chain or a padlocked or riveted strap.

b) Alarm Valves

i) Alarm (Wet Pipe) Valves

Alarm (wet pipe) valves (often referred to as “Ordinary’ Alarm Valves) shall be of an approved type. They shall be fixed on the main supply pipe immediately by above the main stop valve and before any connection is taken off to supply any part of the installation.

c) Alarm Devices

i) Water Motor Alarms

Every installation shall be fitted with an approved water motor alarm and it must be located as near the alarm valve as practicable and in any case the total length of pipe-work should not exceed 25m. The water motor must not be located higher than 6m above the valve.

The pipe-work should be galvanized and of 15mm nominal diameter where the length does not exceed 6m otherwise it must be of 33mm nominal diameter throughout. The pipe-work shall be arranged to drain through a non-ferrous fitting having an orifice not larger than 3mm diameter.

Water motor alarms must be tested at least once a week. For this purpose, there shall be a 15mm test valve on the installation side of the alarm valve.

ii) Electric Alarm Pressure Switches

Electric alarm pressure switches are permitted on this system as an auxiliary warning device. They are not accepted as a substitute for the standard water motor alarm device.

1. The apparatus, including the alarm switch and control unit, must be approved by the Fire Officers' Committee and the installation must be carried out by manufacturers of approved automatic fire alarm systems or sprinklers systems or other sub-contractors specially approved by such manufacturers for the purpose.
2. There shall be a maintenance contract which will ensure that the installing sub-contractors will make half-yearly inspections of the system and at all times maintain it on an efficient working order. Following each inspection the installing sub-contractors shall certify that that system is in satisfactory working order.
3. Alarm signal may be initiated either
   a. By a flow of water in the sprinkler system using an electric alarm pressure switch connected to the alarm valve in a similar manner to the sprinklers alarm motor using water flow alarm switches in the system pipe-work above the alarm valve. Or
   b. By fall of pressure in the pipe-work system above the alarm valve.
4. Adequate means shall be provided to avoid false alarms such as may occur with water supplies subject to fluctuations in pressure.
5. The system wiring and power supply must conform to the requirements laid down in British Standard Code of Practice for Electrical Fire Alarms.

6.1.3.2.8 GAUGES

Brass-cased pressure gauges not less than 100mm diameter shall be connected to the suction and the discharge sides of each pump. The gauges shall be graduated in kN/m^2 and meters of water; the range of the scales shall not exceed 1½ times the maximum head; the static head at rest shall be marked by an adjustable red pointer, the two gauges shall read exactly alike under these conditions. Where duplicate pumps are installed one pair of gauges shall be so a connected with isolating cocks that the head of each pump can be read.

6.1.3.2.9 DRIVES

Pumps shall be driven by electric motors and may be direct-driven or belt driven as indicated. Drives shall be properly aligned; flexible couplings are required for direct drives. For belt drives provision shall be made for the adjustment of belt tension. Floor mounted pump sets shall be positioned on an anti-vibration base and be properly levelled before the holding down bolts are grouted in.

6.1.3.2.10 AUTOMATIC SPRINKLER PUMP-SET

6.1.3.2.10.1 GENERAL

The automatic sprinkler shall consist of an automatic mounted centrifugal electrically driven pump and an automatic horizontally mounted diesel driven fire pump.

One pump shall be connected to the normal incoming Electrical grid main and if applicable to the standby Generator and the other to be coupled to a diesel engine.

6.1.3.2.10.2 PUMPS

The Pump sets shall be similar to those detailed in the bills of Quantities including all the interconnecting pipe-work in galvanized, valves, pressure switches, flow controller and panel. Pumps shall be complete with a drain plug and except where the pump is inherently self-venting an air cock.

The pumps shall be capable of providing at installation control valve a running pressure of at least 1.4 bars plus the pressure equivalent of the difference in height between the highest sprinkler and the valves at a nominal rate of 1750dm^3/min.

The pumps shall be constructed of cast iron with impeller of cast iron/ brass alloy and are to have mechanical seals.

The motor shall be three phase, totally enclosed fan, cooled squirrel cage continuously rated complying in general with BS 2613/1970.

Provisions shall be made for low level cut outs to the pumps to prevent dry pump run in the event of low level water conditions.

The pumps shall be provided with a plate giving the output pressure at the nominal flow specified. Where the performance characteristic is achieved with an orifice plate not integral with pump delivery, the pump name plate shall carry a reference to the fact that the performance given is that of pump and orifice plate combination, and reference shall be made to the orifice K factor.

6.1.3.2.10.3 THE DIESEL ENGINE

Vertical type multi-cylinder four – stroke engine, complete with all necessary ancillary equipment and drives, constructed to comply with BS 649 and suitable for running continuously on oil engine fuel to BS 2869, class A.

a) **Rating**
   The rating shall be continuous as defined in BS 649.
b) **Speed and Governing**
   The normal speed of the engine shall be 1500 revolutions per minute.
   Speed governing shall be B.S. 649 class A and over speed protection shall be provided.
c) **Time of Run – Up Speed**
   From the initial operation of the starting switch, the engine shall start, run up to normal speed and be capable of accepting full load within a minimum of 10- 15 seconds.
d) **Cooling**
   Engine cooling shall be by water jacket, with water circulating pump and heavy duty radiator with electrically or mechanically driven fan. The radiator shall be fitted with flanges or other suitable arrangement to enable ventilation ductwork to be attached with airtight joints. The fan rating shall be adequate allowing for the additional resistance to air flow of any ductwork and louvers fitted.
   The cooling equipment shall be composite with the engine.
   A thermostatically controlled valve shall be provided in the cooling system to assist rapid heating up to the water in the engine jacket when starting from cold and to control its

temperature when the engine is running. Where necessary to limit the oil temperature rise, water cooled lubricating oil stabilizer complying with B.S. 3274, shall be incorporated in the engine cooling system. Sufficient inhibitor shall be added to the cooling water to protect the cooling system from internal corrosion.

e) Engine Starting

Engine starting shall be by a battery powered electric starter motor complete with automatic starting and sequencing control equipment and starter cutout switch. The engine starting control equipment shall be arranged to disconnect the mains operated battery charger to prevent its being overloaded during starting. The starter motor shall be of adequate power for its duty and of the 'non – hold – on' type in which the pinion is moved axially to engage a gear-ring on the engine fly wheel before the starter is fully energized. The pinion shall positively disengage when the engine starts or when the motor is de – energized.

f) Fail to Start Protection

The starting equipment shall incorporate a suitable automatic process timer, so arranged that, if the engine fails to start within reasonable time (e.g. 8 seconds), the starter motor shall be disconnected. The starting attempt shall be repeated after an interval of 2 seconds and, if necessary, repeated a third time. If the Engine fails to start at the third attempt, the starter motor shall be automatically isolated from the battery.

Disconnection of the starter by the fail – to – start device shall operate the visual warning indicator(s) and audible alarm(s) specified hereafter.

g) Engine Safeguards

Safeguards shall be provided and arranged to stop the engine automatically by de – energizing a solenoid coupled to the stop lever on the fuel injection pump rack. The operation of this safeguard shall at the same time give individual warning of the failure by illuminating an appropriate visual indicator and sounding audible alarm(s) as specified hereafter.

The safeguards shall operate when any of the following conditions occur, irrespective of whether the set is on automatic or manual control:

i) Engine Over speed
ii) High cooling water temperature
iii) Low lubricating oil pressure
iv) Low cooling water level.

A key operated switch shall be fitted on the control panel and so connected as to override the engine safeguards and, in an emergency, allow the engine to be restarted under manual control, but with the visual warnings remaining operative.

h) Oil Dipstick

A lubricating oil level dipstick suitably graduated shall be provided and located in an accessible position. The engine shall be totally enclosed and the engine components shall be lubricated via pressure oil system from an integrated oil pump driven by the engine.

i) Starting Handle

Suitable means shall be provided for turning by hand the engine main shaft and the associated pump to facilitate inspection and overhaul and to allow hand starting if necessary.

j) Starting Battery

The starter battery shall be 24 Volts heavy duty high performance quality lead – acid type of adequate size, suitable for trickle charging and rapid recharging after use and shall be supplied complete with corrosion resisting outer container or box of an approved type standing direct on the floor.

The type, voltage and ampere – hour's capacity of the battery shall be stated in the appropriate schedule. The battery shall be supplied in a fully charged state ready for use and shall be complete with hydrometer for testing the electrolyte.

The tender price shall be based on the provision of a lead – acid type battery, but an alkaline battery may be offered as an alternative and, together with its charging equipment, shall then be separately described and priced in the appropriate schedule.

k) Dynamo Cut Out Etc.

An engine driven battery charging dynamo (or alternator with static rectification) of adequate capacity shall be provided complete with cut – out, automatic voltage regulator, ammeter, wiring and engine mounted control board.

l) Engine Instruments

The following dial type engine instruments shall be provided:

i) Engine shaft speed indicating tachometer reading revolutions per minute.
ii) Service hours counter
iii) Lubricating oil pressure gauge
iv) Lubricating oil thermometer
v) Cooling water thermometer

The instruments may be mounted on a suitable panel fixed to the engine or may be incorporate in the main control panel.

The exhaust system shall be manufactured in heavy quality steel tubing to BS 1387, fitted with suitable robust flexible gastight sections close to the engine to allow engine movement and to reduce the transmission of engine vibration to the remainder of the exhaust system and the surroundings. Bends shall have a minimum radius of three times the diameter of the tube. As far as possible, flexible sections shall be vertical, free from bends and have sufficient length or slack to allow free movement without damage.

Silencers shall be of heavy duty baffle and absorption type, so designed and installed as to reduce noise to the minimum practical level without appreciably impairing the working efficiency of the engine.

The silencers and exhaust pipe-work shall be properly and adequately supported clear of fuel tank and feed pipes, and shall be provided with suitable insulation to protect personnel, plant and buildings from excessive heat.

The pipe-work shall drain away from the exhaust manifold and drain cocks shall be fitted in the lower parts of the system to enable condensate to be readily removed.

The system shall be so constructed as to enable it to be readily dismantled for maintenance. Bolts, washers, and nuts shall be greased with graphite grease or other suitable heat resisting lubricant during assembly.

The exhaust system shall terminate at a safe point outside of the building to be approved by the engineer.

m) Air Intake Cleaner.

A suitable and efficient air cleaner / silencer of an approved type complying with BS 1701 Grade ‘A’ or ‘B’ for use in a medium atmosphere shall be fitted on the air intake manifold.

n) Drain Plugs and Cocks

Drain plugs and cocks, as appropriate shall be fitted adequately to drain the engine of lubricating oil, water and fuel. They shall be designed and constructed as to be free from leaks and so positioned as to be readily accessible and allow draining to be undertaken without need for special receptacles.

o) Fuel and Lubricating Oil Filters.

Suitable and efficient oil filters of an approved type and construction having replaceable elements shall be provided in the fuel oil and engine lubrication systems. The oil filters shall be readily accessible and allow the elements to be changed without difficulty. The fuel oil filter shall be located as close as possible to the fuel pump manifold.

p) Wiring on Engine Unit

The Electrical wiring on the engine unit shall be carried out with M.E.C.C. Cable having a conductor minimum cross -section of 1.5mm^2 for single core cables and for multi-core cables. All wiring shall be adequately supported and protected from accidental damage and properly installed and terminated in suitable boxes with flexible connections, all in accordance with the manufacturer’s recommendations. Special arrangements shall be made where wiring is subject to movement and vibration.

Mains Voltage circuits and extra low voltage circuits shall be segregated as far as practical.

q) Fuel Tank and Connections

A fuel oil service tank shall be provided having a capacity sufficient to give ten hours full load running of the engine and manufactured and installed generally in accordance to BS 799, part 1. The tank, complete with all necessary pipe-work, valves and connections, shall be arranged as an integral part of the set or shall be installed at high level on adequate and approved supports adjacent to the set.

The service tank shall be clearly lettered to indicate the type of oil to be used and the capacity of the tank in litres and gallons, and shall be provided with the following:

- i.) Filling orifice, oil strainer, filling pipe extension and filler cap.
- ii.) Vent pipe to atmosphere.
- iii.) Dial type contents level indicator, with adjacent size scale clearly marked in proportional part content, i.e. empty, quarter, half, three quarters and full.
- iv.) Connections for the engine leak – off return pipe (where necessary)
- v.) Drain valve and drain hose connection.

r) Fuel Tank Filling Pump.

A cast iron wall mounted hand operated semi- rotary transfer pump shall be provided of a size capable (with normal operation) of transferring fuel from the delivery drum or other vessel to the service tank at the rate of at least twenty times the maximum consumption of the engine when at full output.

The pump shall be clearly labeled to indicate the type of oil to be used and shall be provided and fitted with suitable connecting pipe-work, including a length of oil – resisting protective cap or cover with retaining chain shall be provided when the pump is not in use. A removable type filter shall be incorporated in the oil supply line.

s) Coupling to Pump

The engine shall be coupled to the pump in an approved manner in a mono-block arrangement or by a suitable shaft coupling and satisfactorily guarded to comply with BS 1649.

The Sub – contractor shall state the method of coupling proposed.

4.1.4 WORKING DRAWINGS

The sub-contractor shall submit two sets of working drawings for engineer's approval within four weeks after his appointment for the sub-contract works; and additional four sets of approved drawings for issue to contractors for works related to this sub-contract.

The working drawings shall be prepared in metric scales not smaller 1:50 and in such detail that not only the sub-contract works can be executed on site but also the sub-contractor's proposals and intentions of the installations are clearly defined and detailed.

The working drawings shall include, but shall not be restricted to the following:

a) Fully dimensioned drawings clearly showing the exact locations and physical measures of all items of equipment, pipe work and pipe fittings, electrical connections and fixing details.
b) Equipment make, model numbers, rating and net operating weights
c) Sizes and location of plinth, holes in building fabric and any other related builder's works.
d) Comprehensive details of electrical; requirements and wiring diagrams.

Upon practical completion of the sub-contract works and before handing over of the sub-contract works, the sub-contractor shall provide two sets of "as installed" drawings for the sub-contract.

The record drawings shall detail the installations "as installed" on site and shall include all information called for in working drawings.

Before handing over of the sub-contract works, the sub-contractor shall also provide two sets of water resistant, laminated operating instructions and two sets of comprehensive maintenance and troubleshooting manuals, in English, for the complete sub-contract works.

4.1.5 OPERATING AND MAINTENANCE INSTRUCTION

After completion of the testing and commissioning of the sub-contract works, the sub- contractor shall demonstrate to and instruct the client's representative/s in the proper usage, maintenance and trouble shooting of all aspects of the sub-contract works.

4.1.6 HANDING OVER

The sub-contracts works shall be considered complete and defects liability period shall commence only after:

a) The sub-contractor works and associated support services have been satisfactorily completed, tested, commissioned and operated for a period of seven days after commissioning.
b) The sub-contractor has submitted the record drawings and maintenance manuals called for in clause 2.20, test certificates and manufacturers' warranty certificates.
c) The sub-contractor has demonstrated the operation, servicing maintenance and trouble shooting of all aspects of the sub-contractor works to be relevant representative/s of the employer.

4.1.7 FIRE AUTHORITY APPROVAL

The sub-contractor shall be responsible to arrange for inspection and certification of the fire-fighting installations by the local fire authority.

4.1.8 INSTRUCTION PERIOD

The Sub-Contractor shall allow in his contract sum for instructing of the use of the equipment to the Clients maintenance staff. The period of instruction may be within the contract period but may also be required after the contract period has expired.

The period required shall be stipulated by the Client but will not exceed two days in which time, the clients staff shall be instructed in the operation and maintenance of the equipment.

SECTION G

ELECTRICAL INSTALLATION SPECIFICATIONS

PART I

GENERAL SPECIFICATION

3 PART I - GENERAL SPECIFICATION

3.1 Extent of Electrical Installations

The Tenderer shall include in his tender, prices for the design of new installations, manufacture, inspection, testing, packing, shipment, insurance, shipping, customs duties, taxes, delivery to site, unloading and all other charges. The Tenderer shall also include for complete erection, tests on completion, setting to work, finishing and painting and maintenance of all items of plant and equipment described or implied within these Technical Specifications and shown on the relevant drawings to the satisfaction of the Engineer and the Architect.

The electrical services within the buildings shall be complete in all respects as specified herein, and shall include all items of equipment, materials, accessories, fittings, supports, etc. necessary whether such items are specifically referred to in the Contract or not. The Tenderer shall be deemed to have included in his tender price all items necessary such that the installations are complete in all respects and left in good working order.

If awarded the Contract, the Contractor shall be expected to provide fully detailed drawings of the entire installation together with layouts of all civil and building works etc. required to accommodate/house the plant and equipment, these layout drawings and details being related to the existing layouts as may be necessary. The drawings shall be submitted for approval within three weeks of the award of the Contract such that the Architect and the Engineer can be made aware of all requirements. It shall be deemed to be the responsibility of the Contractor to ensure all civil and builder's works required for this Contract are prepared and/or provided to suit the programme of this Contract. No claims will be entertained.

All proposed new layouts and structures shall be subject to the full approval of the Engineer and the Employer.

3.2 Programme for Electrical Engineering Installations

The Tenderer shall provide within a stipulated period of acceptance of his tender and award of Contract, a complete programme for the electrical engineering installations to be executed indicating the anticipated commencement and completion dates of the following activities:

- (i) Submission of working drawings for approval
- (ii) Placing of orders with other specialists for plant and equipment to be incorporated in the works
- (iii) Receipt by the Contractor from other specialists of plant to be incorporated in the works.
- (iv) Manufacture by the Contractor of plant to be incorporated in the works

(v) Inspection and testing by the Engineer
(vi) Shipment of the plant from country of manufacture
(vii) Delivery of the plant and equipment to site
(viii) Erection on site, details for all activities
(ix) Telephone Data installations
(x) Kenya Power Company installations
(xi) Tests on Completion.

Operations shall be commenced when instructed and shall be carried forward to completion with the greatest possible expediency, to the satisfaction of the Architect and the Engineer, in accordance with the Programme. The Contractor’s programmes shall be agreed with the Engineer and shall adhere fully to the requirements and timing of the agreed Main Contractor’s programme.

3.3 Drawings accompanying the Tender Documents

The Electrical Drawings indicate generally the arrangement of the installations and are for assistance in tendering only. The position of equipment and apparatus shown thereon are approximate only, the exact positions, together with the actual runs of ductwork, trunking and conduit etc., will be agreed upon with the Engineer and the Employer prior to commencement of work. It shall be deemed that the prices entered by the Contractor include for the repositioning, of the various services, to meet the above requirements. No claims will be entertained.

The Contractor shall satisfy himself as to the correctness of all Drawings and measurements particularly the dimensions of the electrical installations. If the Contractor finds any discrepancy in the Drawings or between the Drawings and the Technical Specifications or between the electrical installations and the Drawings, he shall immediately refer the same to the Engineer who will make a ruling on the discrepancy. Figured dimensions shall be taken in preference to the scale mentioned on or attached to any Drawings. Details shown on Drawings shall be read in conjunction with items included in the Technical Specifications.

The Engineer will furnish the Contractor within a reasonable time after the receipt by the Engineer of a written request for the same, any details of which, in the opinion of the Engineer are necessary for the execution of any part of the works. Such a request to be made only within a reasonable time prior to the execution of such work in order to fulfil the Contract. One copy of the Drawings, details and Technical Specifications shall be kept on the site until the completion of the Contract and the Engineer shall at all reasonable times have access to the same. The Contractor shall return all copies of Drawings and other relevant details to the Engineer on the completion of the Contract.

Additional Drawings will be issued by the Contractor to the Engineer to suit the design requirements of the works. These Drawings being issued either during or after the tender period as may be required or necessary. These Drawings will supplement the details contained within the Technical Specifications and Bills of Quantities and the Tenderer shall be deemed to have taken these into account in his pricing. Where the Contractor can demonstrate that the Drawings relate to new approved or additional items these new or additional items shall be priced to approval in accordance with the Contract rates and prices.

3.4 Contract Working Drawings

The Contractor shall prepare fully detailed Working Drawings for all items of plant, equipment and accessories required for installation under this section of the Contract. Two copies of each Drawing shall be forwarded to the Engineer for approval and or comments. One copy will be returned stamped "approved" or "not-approved". Where Drawings require further information and/or modifications to meet the comments made by the Engineer they shall be re-submitted, again in duplicate, for approval.

When Drawings have been approved two further copies shall be forwarded to the Engineer, together with copies to the Architect, Site and the Employer.

Drawings, and, where relevant, calculations in respect of the following shall be prepared by the Contractor and submitted to the Engineer for his approval commencing within ten (10) days from acceptance of the tender.

(a) Cabling and external cable routes
(b) Details of all conduit and trunking runs in respect of different services
(c) Details of lighting and power circuits, routes etc
(d) Details of sub-main switchgear and distribution boards
(e) Fire alarm layouts and all circuit diagrams
(f) Lightning and surge protection details
(g) Technical literature for all the services
(h) Layouts of all ducts, chases, holes, trenches and all other services throughout the whole of the building and associated external works

All drawings shall be to scale and fully detailed with all the important dimensions shown and the construction of key components indicated.

During progress of the building works, the Contractor shall make all necessary checks on site to ascertain that the various services can be installed as specified and shown on the approved Drawings.

Where such works cannot be so installed, this must be immediately brought to the notice of the Engineer and Architect prior to the progress of such works.

The Engineer, in conjunction with the Architect and the Employer, will check and return the Drawings submitted for approval within a reasonable period, but in any case not exceeding fourteen (*14*) days from receipt of the Drawings.

The layouts of plant and equipment are for general guidance only. The Contractor shall assess the requirements and prepare a plant layout for approval within twenty one (*21*) days, the required liaison being maintained with other specialists, such that an agreed layout is submitted for approval.

3.5 Record Drawings

As soon as the works are complete and all tests satisfactorily carried out, the Contractor shall hand to the Engineer two sets of Record Drawings, together with one set of negatives of the same, showing the works as finally installed. These Drawings shall be prepared on approved transparent plastic material in black ink or as approved by the Engineer. The certificate, of making good defects, will not be issued until this condition has been complied with. Record Drawings are in addition to detailed Working Drawings and shall show all cable routes, circuits, trunking, conduits, plant, trenches, ductwork and ducts etc., together with the entire plumbing, drainage and firefighting installation, as finally installed.

The Engineer will provide the Contractor with a set of Contract Drawings (in addition to the two sets provided for the Contractor's site and office use), which shall be maintained by the Contractor's representative on site and which shall be used for recording of Contract variations as they occur. This set of Drawings shall be available for the Engineer's inspection on site, and shall be kept up to date.

The cost of the preparation and submission of the above Contract and Record Drawings shall be deemed to be included within the Contractor's prices.

3.6 Maintenance Manuals

At the start of the defects liability period, the Contractor shall hand over to the Engineer, four sets of maintenance and operations manuals for each plant and equipment installed. These manuals shall be in English and shall be fully illustrated.

3.7 Builder's Work and Civil Works

Builder's Work and Civil Works that are incidental to this section of the Contract such as cutting of holes in walls and floors, provisions of foundations for the plant and machinery, shall be the responsibility of the Main Contractor. The Contractor shall be fully responsible for the preparation of all such details that relate to such works, the details being subject to approval by the Architect and Engineer prior to submission to the Main Contractor for action. Other items such as fixing of brackets, cables and ductwork and trenching, making good etc. shall be carried out by the Contractor to suit the installation of all the services.

It is the Contractor's sole responsibility to ensure that all holes and chases are in the required position and that any additional ducts, holes and chases necessary for erection of the installations in situ concrete walls, floor slabs etc., are included in the early stages of construction as appropriate.

The Contractor shall furnish the Engineer, Architect and Main Contractor with all the necessary information including position of foundations, brackets and fixings and shall ensure that such works are performed in accordance with available information.

The Contractor shall include in his tender all supports, fixings, plugging of holes in walls, ceilings and floors to facilitate the fixing of the pipework, accessories, and all other portions of the plumbing, drainage and firefighting installations. Any purpose-made fixing brackets shall also be provided and installed by the Contractor, including escutcheon plates and the like.

The Contractor shall supply and install approved pipework support brackets and hangers. It shall be deemed that prices include for any special requirements and that the Contractor has visited the site during the tender period to ascertain all details.

The Contractor shall pay particular attention to the fixing and alignment of items. All items shall be installed square, true and perpendicular to floors i.e. as shown on Drawings and as may be required at site to the Engineers approval.

3.8 Commissioning of the Electrical Installation

The Contractor shall instruct the Employer's Maintenance Engineer or his representative on the operation and maintenance of the various components forming the electrical installation and shall provide drawings, diagrams and manuals to ensure the Maintenance Engineer or his representative is completely conversant with such installations.

The Contractor shall ensure that the services installations are left in complete safe working order and operating to the satisfaction of the Engineer.

3.9 Regulations and Standards

The Installations must be carried out strictly in accordance with the following documents: -

Electrical Services

(i) The current edition of the IET Wiring Regulations , BS 7671
(ii) Relevant International Standards
(iii) Current Regulations and by-laws of KP
(iv) Regulations and by-laws of the Ministry of Energy
(v) Nairobi City Council By-Laws
(vi) Current Regulations of Communication Authority
(vii) By-laws of the Energy Regulatory Board (ERB)
(viii) Any other duly constituted Authorities regulations having jurisdiction over the Works.
(ix) Water Supply and Sewerage Authority's Regulations.
(x) The Specification and accompanying documentation and Drawings.
(xi) The Working Drawings produced by the Contractor and approved by the Engineer.

The Contractor shall undertake all modifications demanded by the authorities in order to comply with the regulations, and produce all certificates, if any, for the authorities at no extra charge.

3.10 Quality of Materials

All materials, fittings and accessories are to be new and in accordance with the requirements of the current rules and regulations where such exist, and with the relevant international standards.

Uniformity of type and manufacture of fittings and accessories is to be as far as practicable preserved throughout the whole Works.

Wherever the term 'similar to' is used in these Technical Specifications in reference to any item, the word will be understood to mean type and quality of the equipment and not preference.
Where particular manufacturers only are specified herein no alternative makes will be considered without good reasons.

All materials shall be of good quality, suitable for the purpose specified, and to the approval of the Engineer.

3.11 Workmanship

The Tenderer shall take into consideration, when pricing his tender, that there will be other specialists working alongside him. Any disruptions to the existing services must therefore be kept to a minimum, and in this respect the Contractor shall include in his prices for carrying out Works outside normal working hours as may be directed by the Engineer. No claim will be entertained where abnormal working hours are required to meet this requirement and completion of the works within the specified Contract period.

The Contractor shall be fully responsible for co-ordination of installation of all services. For all services involving ducted wiring, such wiring shall be capable of future addition or maintenance.

The Contractor shall be deemed to have included in his tender prices for relocating switches, terminal points, ductwork, outlets and fixtures in positions and/or locations at least one metre in any direction from the positions indicated on the Drawings. Within these limits no variations in the Contract sum will be made unless the work has already been executed in accordance with previously approved Working Drawings.

Only qualified and certified persons shall be allowed to carry out installation work. The Works shall be performed in a neat and workmanlike manner.

The Contractor shall take every precaution to avoid damage to the existing property including roads, paved walkways, grassed areas, landscaping, cables, drains and other services, and he will be held responsible for and shall make good all such damage at his own expense to the satisfaction of the Engineer.

The Contractor will be responsible for the exact runs and placing of pipe work, conduit, boxes, ductwork and accessories that are to be cast in concrete, ceilings, floors, walls, columns and beams, and for the proper fixing of the pipe work and accessories to the shuttering and the steel reinforcement work.

Where ductwork is to be concealed, the pipes etc. shall be in an exact position relative to the finished plaster or such other finishes as may be applied to enable adequate cover to be applied.

Where services are run above the false ceilings the Contractor shall ensure that access to all services is readily available such that future maintenance can be carried out without difficulty. Full details shall be included on the Working Drawings such that the Engineer can give consideration to the Contractor's proposals.

3.12 Setting out of work

The Contractor will be responsible for laying out his work and shall obtain all the necessary information as may be required to carry out the work. Such information shall be obtained sufficiently in advance to avoid any possibility of delay to the Works as a whole.

The Contractor shall be fully responsible, and shall seek, the details of all work being carried out by the various trades on Site, particularly where such trades may interfere with each other, or where co-ordination is necessary. No claims for extra costs will be entertained arising from omissions, oversight, or neglect in this regard.

In advance of the delivery of the plant and equipment, the Contractor shall arrange for the supply of all-necessary foundation bolts, templates, nuts, plates, sleeves, anchorages, etc., as required and as may be directed by the Engineer.

3.13 Erection and checking of work

The Contractor shall provide, and be solely responsible for, all skilled and unskilled labour, tools, lifting tackle and other equipment required for handling of plant and equipment when transporting to Site, within the Site and during erection.

All erection works shall be subject to approval by the Engineer.

All parts shall pass such tests as required by the Engineer to prove compliance with the Contract irrespective of any tests which may already have been carried out at the Manufacturer's Works. In particular all electrical pressure tests made at the Manufacturer's Works shall be repeated at voltages approved by the Engineer.

The Contractor shall supply and install all supports, fixings, brackets and similar items as may be necessary for the completion of the installation of the services as specified and as shown on the Drawings.

3.14 Site performance and acceptance tests

The Contractor shall give notice of the date of the specified tests to be performed on completion of installation. The notice shall be made in writing to the Engineer at least five days to the date of the specified tests. Unless otherwise agreed the tests shall take place within seven days of the stated date or on such day or days as the Engineer shall in writing notify the Contractor in writing. The tests shall be carried out under normal working conditions to the satisfaction of the Engineer and shall extend over such continuous periods as he may direct.

All skilled labour, supervision, apparatus, fuel and instruments required for carrying out the tests will be the responsibility and at the expense of the Contractor. The accuracy of the instruments shall be demonstrated if required. The Contractor shall ensure that test instruments are in good working condition and have been calibrated by an authorised agent.

If any part of the plant or equipment fails to pass the specified tests, further tests of the said part shall, if required by the Engineer, be repeated. The Contractor shall, without delay, put in hand such modifications as found necessary so as to meet the requirements of the Contract and any expense which the Client may have incurred by reason of such further tests shall be deducted from the Contractor’s Contract price.

Each completed system within the installation shall be tested as a whole under operating conditions to ensure that each component functions correctly in conjunction with the rest of the system.

3.15 Test records

The Contractor shall make the necessary records of all the tests carried out, and when the tests have been successfully completed he shall provide the Engineer with test records and reports in a format to be agreed.

3.16 Dust, insect and vermin proofing

All equipment, likely to be affected by ingress of dust, shall be effectively dust proofed and vermin proofed where no protection is afforded in its normal manufactured form. All materials used shall be in general resistant to attack by insects, micro-organisms or other fauna or flora. Materials used for such protection shall be to the approval of the Architect and Engineer.

3.17 Painting and finishing

All mechanical and electrical plant and equipment installed under this Contract shall be painted or otherwise finished to approval in accordance with appropriate international code for standard colours to be furnished by the Contractor prior to the shipment or manufacture of the plant or equipment including all pipe work, ductwork, etc. Such finish shall be entirely compatible with the conditions of heat, humidity, exposure to the weather, and other relevant factors arising from the materials, location and condition of operation of the equipment.

Paintwork will be measured in the builder's work in connection with the Engineering Element. Any additional work will be measured in accordance with the conditions of the Contract.

The Engineer may request samples of paint finishes, the cost of which shall be deemed to have been included within the tendered prices for all works.

All final painting of equipment, fixtures, and accessories shall be carried out by the Contractor, except where it is the usual practice of the manufacturer of items of plant and equipment to apply a high standard of protective finishing paintwork in the shop before despatch. This will be acceptable provided the Contractor at his own costs makes good any damage to paintwork, occurring in shipment, transportation and installation.

The interiors of electrical switchboards control panels, and similar items, shall be finished in an approved enamel colour and shall comply with the appropriate international standards for enamel finish which shall be furnished by the Contractor prior to shipment or manufacture of the plant or equipment. The exteriors of such panels and enclosures shall be of international standards specification colour as specified by the Engineer.

3.18 Labels

All items of electrical plant, Sub-main distribution boards, etc. shall be neatly and clearly labelled externally with identification marks corresponding with those on Drawings or in Technical Specifications. Final details shall be agreed upon by the Contractor and the Engineer.

Identification labels shall be of laminated plastic material engraved, black on white, with no less than 6mm "Lino" style letters and shall be fixed on or adjacent to all items by means of at least two brass screws or to the approval of the Engineer. Self-adhesive labels shall not be permitted.

All main switches, circuit breakers, isolators, valves, motors, switch-fuse, consumer service units, and distribution boards etc. shall be neatly and clearly labelled externally with identification marks corresponding with those on the Drawings or Technical Specifications. Final details shall be agreed upon by the Contractor and the Engineer.

All labels/plates shall be in English.

3.19 Specialist manufacturers

Where specialists are not nominated by the Employer, the Contractor shall appoint specialist manufacturers and suitable specialists for any sections of the Works described herein in which he is not himself an experienced, recognized and approved specialist.

The Tenderer shall, on submission of his tender, indicate the names of all proposed specialist manufacturers and specialists, together with the precise sections of the Works for which each will be responsible. The Contractor may be required to seek alternative manufacturers or Contractors or to accept specialists nominated by the Employer; it shall be deemed that the prices entered in the tender include for this requirement. For plant and equipment supplied by suppliers other than the Contractor, the Contractor will be required to furnish an agreement between himself and the supplier stating that he is authorised by the supplier to deal in the plant and equipment and that he is authorised to stock the necessary spare parts or that the Employer will be authorised to revert to the supplier in the event of breakdown of the plant or equipment.

The Contractor shall allow in his prices for phasing his work to meet the requirements of the other specialists, and for varying his programme or otherwise, to comply with the erection programme of such specialist. No additional costs will be allowed to the Contractor for any disruptions to his programme, or otherwise, in his compliance with the above requirements.

3.20 Interference with the existing Works

The Contractor shall not interfere in any way with any existing works whether the property of the Employer or of a third party and whether the position of such works is indicated to the Contractor by the Engineer or not. The exception being where such interference is specifically described as part of the Works either in the Contract or in any instruction from the Engineer.

3.21 Protection of Works

The Contractor shall carefully protect from injury by weather all Work and materials which may be affected thereby and allow in his prices for all dams, pumping, shoring, temporary drains, sumps etc. necessary for the purpose. The Contractor shall clear away and make good at his own cost to the satisfaction of the Engineer all damage caused thereby.

3.22 Sundries

The necessary holding down bolts, supporting brackets and templates, guards and screens, locks, piping, conduits, lamps and other requisite sundries whether specified in detail or not shall be provided, under the Contract and it shall be deemed that the Contractor's prices, rates and the like include for all such items.

3.23 Schedules of technical data

Where included in the Tender Documents, all Tenderers shall complete Schedules of technical data; otherwise the Tender may not receive full consideration, and will be liable to rejection.

3.24 Copies of orders

Copies of all orders for major items of plant, equipment and materials places with suppliers shall be provided in triplicate to the Engineer.

3.25 Inspection and tests at Manufacturer's Works

The Engineer, and his duly authorised representative, shall have at all reasonable times access to the Contractor's premises to inspect and examine the materials and workmanship of the mechanical and electrical plant and equipment during its manufacture there. If part of the plant and equipment is being manufactured on other premises, the Contractor shall obtain for the Engineer and for his duly authorised representative permission to inspect as if the plant and equipment was manufactured on the Contractor's own premises. Such inspection, examination or testing, if made, shall not relieve the Contractor from any obligation under the Contract.

Where the plant and equipment is a composite unit of several individual pieces manufactured in different places, it shall be assembled and tested as one complete working unit, at the Maker's works, to the relevant International Standards where applicable.

PART 2 - PARTICULAR SPECIFICATIONS
ELECTRICAL INSTALLATIONS

4 PART 2 - PARTICULAR SPECIFICATION

4.1 Extent of installation

The Contractor shall carry out all the necessary works for successful installation of the electrical services as described and set out in this section of the Technical Specification, Bills of Quantities and accompanying Drawings in accordance with the General Electrical Specification herewith.

The Works, the major elements of which are scheduled below, includes the supply of all labour, material, equipment, plant and components necessary for complete installation and setting out work in respect of the entire electrical services requirements within the proposed development and rendering it in complete working condition in respect of but not limited to the following installations:

- Incoming electricity supply
- Low Voltage Switchboards;
- Electrical distribution;
- Lighting and power installations;
- Earthing
- Lightning and transient over-voltage protection; etc
- Provisions for ICT and Security Installations

In general the installations shall be concealed in conduits except in areas where surface installation is Necessary. In such cases, installation will be carried out in trunking, conduit or cable tray as indicated on the Drawings.

4.2 Incoming Electricity Supply

The incoming power supply to the Proposed Project will be from a new 315KVA transformer terminated to Client’s LV Switchgear to

The Contractor shall be responsible for liaison with KP personnel in respect of organising to carry out final connections of the supply cable (*if necessary*) to the Three phase KP Bulk Client meter indicated above.

4.3 Meter Board for the Expo Hall

New meter board, as specified, shall be supplied, installed, tested and commissioned complete with the specified MCCBs (*moulded case circuit breakers*), metering and items Necessary for the complete installation and setting to work.

The meter boards shall be of the residential cubicle type, constructed and installed as described below.

The meter boards, suitable for wall mounting, comprising of a sheet steel cubicle with front access, with space for KPLC Cut-Out, KPLC Three phase energy bulk meter and MCCBs (*where specified*) etc. The meter board shall be heavy duty, cast metal, enclosed type, with Perspex viewing glass.

The meter board shall be rigidly constructed and shall be of not less than 1.4 mm gauge.

The doors shall be of similar rigid construction free from twists and warps. The hinges shall be brass, and attached by brass screws. The meter board shall be lockable and a Viro or Yale padlock shall also be provided.

The Contractor should ensure that entry of cables, ducts, and conduits shall be neatly made.

All bolts, nuts, screws, hinges, handles, etc. shall be corrosion resistant.

The meter boards must be approved by the engineer before installation.

4.3.1 Moulded Case Circuit Breakers

(a) General

Moulded Case Circuit Breakers (*MCCBs*) shall as a minimum requirement comply with IEC-60947-2-ED. 5.0 CORRIGENDUM 1 and BS EN 60947-2:2017 or any other approved equivalent Standard.

The breaking capacities of the circuit breakers shall be at least equal to the prospective fault level at the point of the distribution system where the breakers are installed.

All MCCBs shall be designed for horizontal or upright mounting without any adverse effect on electrical performance.

The MCCB shall be provided with a cover manufactured by the MCCB manufacturer.

(b) Construction

Operating mechanism shall be of the quick make quick break type, with the speed of operation independent of the operator, and mechanically trip free from the operating handle so as to prevent the contacts from being held closed against short-circuit and overload conditions. The operating mechanisms shall be constructed to operate all poles in a multi-pole breaker simultaneously during opening, closing and tripped conditions.

The breakers shall be operated by a toggle, which shall clearly indicate the three fundamental positions ON, OFF and TRIPPED. If required, rotary handles shall be supplied.

The breaking and extinction of the electrical arc shall be achieved by means of non-welding contacts and an arc chute surrounding these contacts.

The current limiting MCCBs with very high capacity shall be made of two parts: -

- A standard circuit breaker for small and medium fault current
- A current limiter block to break and limit large short-circuit current.

The current limiter blocks shall be of fuse free type and the one opening mechanism type and factory fitted to the standard breakers.

All accessories and electrical auxiliaries such as shunt trip or under-voltage release auxiliary contact or motor mechanism shall be manufactured in such a way that they can be easily adapted on the installation premises.

(c) Operation

Each pole of the MCCB is provided with bimetallic thermal element for inverse time delay protection and magnetic element short-circuit protection. The thermal releases shall be of the adjustable type and could be equipped with sealing facility. Above 250 Amps the trip unit could be of the solid state energised by internally mounted current transformer.

It shall not require any external power supply to operate the tripping mechanism. All MCCB's shall be provided with interchangeable trip unit.

Current discrimination tables showing overload and short-circuit discrimination shall be provided for each rating.

4.3.2 Earthing

The Contractor shall provide Earthing of the meter board in accordance with the KP / IET Regulations all as per section 4.23 of these specifications.

4.4 Electrical Distribution System

4.4.0 Scope of Work

The Contractor shall supply and install test and commission new distribution cables as indicated on the drawings to complete the electrical distribution system, all in accordance with the IET Wiring Regulations BS 7671.

4.4.1 Sub-main Cables

The Contractor shall supply new PVC insulated or armoured cables with stranded copper conductors as shown on the drawings. All low and medium voltage cables shall be rated at 600/1000 Volts and shall comply with the relevant British Standard or other approved international standards. The Contractor shall supply, install, test, and commission the entire sub-main cable system.

All the sub-main cables to consumer units for lighting and power shall be drawn in conduit/ducts concealed in walls, floors and ceilings slabs of the buildings.

4.4.2 Distribution Boards

The Contractor shall supply new distribution boards of the surface/flush mounted metal enclosure type complete with MCBs. The Contractor shall ensure that each distribution board is complete with hinged lid and is so constructed that the circuit breaker toggles are concealed when the lid is closed. The distribution boards shall be controlled by an isolating switch integral with the board.

The Contractor shall ensure that all circuit breakers are provided with thermal overload and magnetic short-circuit tripping and a quick trip-free mechanism. The Contractor shall ensure that the Necessary discrimination between each main panel and final sub-circuit is provided. The Contractor shall ensure that circuit breaker and distribution boards used throughout the installation are of the same pattern, range and manufacture and all MCBs have short circuit capacity not less than 3 kA.

The final fixing and mounting height of each board and other associated switchgear shall be agreed on site to suit the plant, benches, trunking, services, cupboards etc. The rating of all distribution boards' breakers shall not be less than 100 Amp.

Where surface boards are installed sub-circuit conduits shall be suitably terminated within adaptable conduit boxes, flush mounted behind the surface mounted distribution board. The Contractor shall ensure that this is correctly done.

4.4.3 Consumer Units

The Contractor shall supply new as appropriate the consumer units of the flush mounted metal enclosure type complete with MCBs and isolating switches, similar to those described under Clause
4.4.2.

4.4.4 Contactors

The Contractor shall ensure that contactors where required are suitable for continuous heavy duty and fitted with 240 voltage coils. They shall be of robust construction to BS EN 62271-

106:2011 or approved equivalent standard where applicable, and rated at not less than the current carrying capacity of the outgoing circuits.

4.4.5 Armoured Cables

The Contractor shall ensure that underground cables (*PVC/XPLE/PVC*) are made of stranded copper conductors. The cables shall be rated at 600/1000 volts grade to BS 6724:2016 or approved equivalent international standard. The cables shall be terminated in brass compression type glands of the correct size to secure the cable inner sheath and ensure effective electrical continuity between the cable armouring wires and the metal enclosure on which the cable is terminated. A copper earth link shall be provided at the cable termination point for earthing of the cable armour and cable gland to the sub-boards earthing point.

4.4.6 Electrical Distribution System

The Contractor shall be fully responsible for the Necessary liaison and co-ordination of all works on site.

The final cable routes and layouts are to suit pipe work, drainage, cables foundations and the like. The Contractor shall produce Drawings for approval indicating the alternative proposed routes of cables. These shall in general follow an agreed service reserve decided by the Engineer, in conjunction with the Employer.

4.5 Lighting Installation

4.5.1 Scope of the Work

The Contractor shall supply, install connect, test and commission the lighting fittings as shown on site and set out in the Schedule.

4.5.2 General

All lighting fittings shown on the drawings or set out in the various schedules are to be supplied and installed complete under this quotation.

The lighting installation shall be generally concealed throughout, the conduits being run above the false ceilings, cast within the concrete slabs or chased into the walls. The various positions for all lighting fittings are as indicated on the drawings. These however, are subject to minor changes and adjustment to suit the false ceiling details and the locations of services and facilities. All supports, fixings and the like to be supplied under this contract, the Contractor being responsible for the final ceiling arrangement. Where false ceilings are provided, all openings, services access, trims, suspensions and connections to suit the fittings supplied, are to the approval of the Engineer and the Employer.

4.5.3 Method of Wiring to Fittings

The circuit wiring shall be continuous throughout on a loop-in loop-out system and there shall be no joints other than at the lighting fitting positions/boxes. The final connections to lighting fittings shall be from a conduit box complete with domed lid and cord grip. The circuit wiring terminating within the box at a suitably rated terminal block and wiring (via the cord grip) to the fitting carried out in heat resisting 3-core PVC/PVC cable.

The lighting fittings shall be wired, in general, with 2.5mm^2 single core PVC cables, the final connections to all fittings being carried out in heat resisting cable. The Contractor shall inspect to ensure that this is correctly done on site.

4.5.4 Fluorescent Fittings

Fluorescent fittings are the type as indicated on the schedules and specified herein. They are complete with tubes, wiring auxiliaries and all other items as specified or required for the complete installation and setting to work.

Each tube is provided with a low loss ballast and starting devices. Each fitting is power factor corrected to 0.90 and fused. The Contractor shall inspect and ensure that the spacing between ballasts is not less than 50mm and between condenser and other auxiliaries 75mm.

The Contractor shall ensure that internal connections are made with heat resistant wiring of ample rating, and all the wiring is bunched and neatly secured in a manner to ensure minimum heating from auxiliary components. A three ways connection unit should be properly secured and shall provide for all circuit connections.

Colour temperature of tubes shall match throughout, except where otherwise specified. In general they shall be warm white.

The Contractor shall inspect and ensure that all fluorescent fittings are approved by the Kenya Bureau of Standards (KEBS) and comply with local safety standards and if required, the Contractor shall be ready to submit a written evidence of such approval.

It shall be the responsibility of the Contractor to determine all details relating to the fixing of the fittings and auxiliaries with particular attention being paid to the false ceiling areas etc. The locations of all fittings are subject to the Engineers approval, final positioning shall therefore be agreed upon in the course of the Contract.

The recessed fittings, within any false ceilings shall be finally installed subject to the Engineers approval. The Contractor shall ensure that all fittings, trims and supports details are provided and agreed prior to the installation. The Contractor shall liaise with the Engineer to complete the works.

4.5.5 Incandescent Fittings

Incandescent fittings shall be of the types shown in the schedules. Enclosing metal-ware shall be of robust construction, complete with mounting holes, openings for cable or conduit entry, earthing terminal, and space for cable connections shall be as required. Where wiring is carried out within a stem or suspension tube, it should be of ample size to facilitate easy insertion of wires. No mountings shall be so arranged that complete rotation is possible, i.e. that wiring can be twisted. Suspension chains shall be utilised so that the wiring shall not be allowed to take the weight of the fittings.

Lamp-holders in totally enclosed fittings shall be of heat resistant type made of porcelain or brass, and connected with heat resistant cable. Generally, lamp-holders and lamps shall comply with BS EN/IEC61-1.

4.5.6 LED Light Fittings

LED fittings have been specified in the Bill of Quantities. Specifications for LED fittings must be strictly adhered to.

For LED fixtures, lamps, drivers, and components, provide a complete warranty for parts and labour for a minimum of three years from the date of Substantial Completion. LED fittings shall comply with DD IEC/PAS 62717:2011.

4.5.7 Emergency Lighting

Emergency lighting shall consist of normal LED lighting fixtures with emergency battery backup.
Battery-backed LED emergency lighting fixtures shall consist of a normal LED fixture with some or all of the LEDs connected to a battery and charger.
The battery shall be nickel cadmium and sized for a minimum of 90 minutes of fixture operation. The charger shall be solid-state and provide overload, short circuit, brownout and low battery voltage protection.
The battery and charger shall include self-diagnostic and self-exercising circuitry to exercise and test itself for 5 minutes every month and for 30 minutes every 6 months. The fixture shall include a test/monitor module with LED status indicating lights mounted so as to be visible to the public. The fixture shall not contain an audible alarm.

4.5.8 Lighting Switches

The Contractor shall inspect and ensure that light switches are rated at 20 amperes as a minimum. All switches shall generally be flush mounted and fitted with the approved flush conduit boxes. Surface switches of the metal clad type and approved range and pattern, are provided within plant rooms, service ducts and similar areas.

Circuit switches shall be one-way or two-way where more than one switch is denoted at any position; multiple gang units shall be used.

The light switches shall be assembled in single or multiple units, in boxes of galvanised steel and fixed with brass screws. Screw heads used to secure switch cover plates to be finished to match the cover plates.

The switches shall be of the same manufacture and type throughout the installation. The Contractor shall submit to the Engineer, for approval, a sample of the switches and cover plates he proposes to use. Switch plates and plug socket plates shall match in colour throughout.

The mounting heights are 1.375 m but are finally subject to adjustment to suit building details. The Contractor shall check all door swings to ensure that the switches are on the lock side. These will be entirely the responsibility of the Contractor.

4.6 Power Installation

4.6.1 Scope of the Work

The Contractor shall supply, install, test and commission the power installation as shown on the Drawings.

4.6.2 13 Ampere Switched Socket Outlets

The socket outlets shall be positioned and of the type as indicated on the site or on drawings. Every 13 Amp socket outlet shall be complete with a fused plug top.

Unless otherwise stated, 13 Amp socket outlets and spur boxes shall be wired to ring main circuits.

The socket outlets shall be assembled in single or multiple units as required. Except where mounted and fixed to trunking the sockets shall be mounted/fixed to boxes of galvanised steel and fixed with brass screws. The Contractor shall submit to the Engineer, a sample of each outlet and cover plate proposed for use in the works. This applies equally to all the power and switch plates specified throughout this document. The socket outlets shall match those of the lighting switch plates.

In the Kitchen room the socket outlets are mounted on walls at high level. The final mounting height will be to suit the levels of the equipment and shall be agreed on site. In general, all areas shall include outlets mounted at 350mm above the finished floor level. A uniform level, for all sockets and power outlets, shall be agreed to suit the requirements of the Engineer and the Employer. Locations shall be subject to change to suit the layouts within the various areas. The Contractor shall take this into consideration when pricing his tender. Where outlets are to be installed in pairs they are to be installed under the one cover plate.

Except where installed using surface wiring, all outlets shall be surface or flush mounted and fitted into approved surface conduit boxes, earthing terminals, etc. as previously described.

The circuit wiring is rated/sized to IET Regulations and shall not be less than 2.5mm^2 PVC. The wiring shall be inside conduits and/or trunkings to suit the requirements of the particular area, a concealed installation being provided throughout.

The phasing and circuit wiring for all socket outlets, power outlets and lighting circuits shall be agreed. Details shown on the Drawings are, at this stage, for information only. The Contractor shall finally provide details for approval to suit the final layout throughout the site as required by the Employer.

All socket and power outlets shall be fully earthed and bonded-up complete, especially where located and mounted close to sinks, taps, etc. All sinks, taps and water pipework and appliances shall also be fully bonded up as required by the relevant IET Wiring Regulations BS 7671 to ensure equi-potential between all items.

4.6.3 13 Ampere Switched Fused Connection Units

13 ampere switched fused connec1tion units are to be supplied installed for termination on the various circuits as indicated on the Drawings. The connection units are of the range specified on the drawings and every socket outlet shall be complete with plug top.

4.6.4 Isolators

Isolators of the indicated ampere ratings shall be supplied and installed for connection to the various items as indicated on the drawing.

4.6.5 Connections to Instantaneous Showers

Instantaneous showers are controlled from 32 Amp. DP switches with neon indicator, flush mounted in the position indicated on the drawings. Wiring from consumer unit to 32 Amp DP switch shall be 3x6mm^2 PVC single core copper cables. Connections to the instantaneous showers shall be done by means of flexible 3-core 6mm^2 PVC insulated cable.

4.6.6 Motor Control Cubicle

The motor control cubicle shall be supplied and erected as required for the installation. It shall be complete with switchgear, starters with all types of protections, facility for remote control, instruments, relays, lights for start/trip and items Necessary for the complete installation and setting to work.

The control cubicle is of the industrial enclosed cubicle type. The Contractor shall submit the details to the Engineer for discussion and approval prior to the manufacture.

4.6.7 Telephone Outlets

Flush telephone outlets shall be provided where shown on the drawings and complete with white finish plate with PVC sleeve cord with internal diameter of 5mm complete with steel clamp to retain sleeve cord on underside.

4.7 System of Wiring

Unless otherwise specified or indicated on the Drawings, all wires and cables for power and lighting enclosed in conduit and trunking shall be of single core type, PVC insulated 600-volt grade, copper to BS EN 60601 & BS 7671 61386-24:2010 The installation is or shall be carried out on the looping-in system with continuous mains throughout each circuit. All connections to fittings and the like are or shall be of a solid nature and small connectors (*other than porcelain enclosed heavy brass sleeves*) shall not be allowed. Porcelain connectors enclosing heavy brass sleeves shall be provided for heat resisting tails for enclosed fittings and for the drops for pendant type fittings.

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All connections to flexible cords or cables shall be such that any strain on the cord or cables is not transmitted to the connection.

Draw wires shall be left in all conduits provided under this contract where these conduits are for future services.

Joints in PVC cables shall not be allowed in any part of the system.

The number of cables run in conduits shall be in accordance with the IEE wiring regulations BS 7671. With the exception of 3-phase power points or sub-main supply circuits to 3-phase boards, the circuits grouped in any one conduit shall be connected to one phase of the system only. This does not apply to wiring run in trunking. All switch wires for lighting circuits shall be on the phase or "live" side.

An insulated earth wire shall be provided in all conduit and trunking systems, terminating at all outlets where an earth is required. This earth wire shall comply with BS 7430:2011+A1:2015 but in no case less than 1.5mm^2 for lighting circuits and 2.5mm^2 for power circuits and High bays light fittings' circuits.

When drawing the wires and cables into the conduits or trunking, the Contractor must ensure that proper appliances are used so that the wires and cables suffer no damage whatever in the process. All joints and kinks shall be scrupulously avoided and care must be taken to ensure that the insulation of the cables receive no damage or abrasion. Low voltage cables and medium voltage cables shall be enclosed in entirely separate conduits.

All cables shall be drawn-in after the installation of the entire conduit system and after plaster has dried out. Raw wires shall not be threaded in at the time the conduits are being installed.

4.8 Cables, Wiring and Accessories

This section of the Specification includes the inspection, delivery to site, unloading, complete installation, putting into commission and handing over in the approved working order, the whole of the main and auxiliary power cables and other cables and wiring as detailed herein and in the tender.

The work includes the supply, delivery and erection of all cable racks, cable cleats, conduits, trunking, pipes, Unistrut and fittings required for the support and accommodation of the cables and wiring, grouting of rag bolts for the fixing of cable racks, supports, and all required trenching. The work also includes the installation of cables and wiring within the trenches, conduit, trunking and the proper protection, marking and terminations of all such cables.

Jointing of cables shall not be permitted under this contract, as the distances are short and therefore continuous cable lengths can be used. However, where joints are permitted by the Engineer for any reason they shall be of an approved type and manufacture and of the cast resin type. Where joints are required for control cables they shall be housed within a purpose made concrete pit with lid and jointed/terminated such that testing can easily and readily be carried out. The cables shall be as manufactured and tested in accordance with the appropriate International Standards as applicable, and the following Standards in particular shall apply: -

Copper conductors shall be provided throughout and shall comply with BS EN 60228:2005/IEC 60228:2004 or BS EN 13602:2013 or approved equivalent.

PVC (*Polyvinyl Chloride*) insulation and PVC sheath shall comply with BS 7655-0:2006/IEC 227-4 and BS 6346 or approved equivalent.

Non-armoured PVC insulated cables shall comply with BS 6004-2012/IEC 227-4 or approved equivalent.

Armoured cables with XLPE insulated copper conductors (*25 mm^2 cross sectional area or higher*) where used shall comply with BS 5467:2016/IEC 60502-1, IEC 60811 or approved equivalent.

The tenderer should submit a fully detailed technical description and manufacturing data of the cables offered together with full test certificates of all cables and wiring provided.

All cables shall be delivered to site in the same coils as despatched from the manufacturer and the labels showing size, type and length and shall be removed only in the presence of the Engineer or his representative and handed to him.

All cables and wiring shall be of adequate rating in accordance with the relevant IET Wiring Regulations BS 7671, protected in conduits or trunkings, placed on cable trays, in underground pipe ducts or trenches, or when cleated to Unistrut inserts etc. safe-guarded so as to prevent danger.

The Contractor shall agree with the Engineer and the Employer route of all cables, conduit and cable trunking and shall not install such trunking or conduits until agreement and approval has been given.

The main supply cables shall be extended from the LV switchboard position in the service areas. It will be Necessary for the Contractor to liaise with the Engineer when finalising the cable routes.

4.9 Trenching

All underground cables where not installed within pre-formed service trenches or service duct, shall be laid in pipes, ducts or buried directly in the ground, as specified for the particular case or as indicated on the Drawings.

The Contractor shall carry out all excavation, back filling, sanding, consolidation and making good, and shall remove all spoil and waste on completion. The Contractor shall include for the re-instatement of the grass and other areas such as roads and pathways where excavation has been Necessary to accommodate the installation of the various controls, alarm, power and external lighting cables.

The depth of trenches shall be such as to provide the cover set out hereunder. Trenches shall be free of large stones and similar material likely to cause damage to cables, and the bottom shall be level and smooth, consolidated if Necessary to provide a firm bed for cables or pipes. Pipes or cables shall be bedded in 0.08 m of sand or approved equivalent material which has been sifted through a No. 36 BS sieve, care being taken to ensure than cinders, breeze, or any other chemically active material does not come in contact with the cables at any point. After the laying of the cables or pipes, back-fill material initially consisting of a further layer of sand to provide a cover of approximately 0.08 m, which shall be consolidated as Necessary before final back filling and consolidation. All cables which are laid directly in the ground shall be protected by concrete or earthenware tiles.

(I) in open ground and under pavements, the minimum cover shall be 0.6 metres.

(ii) Under roadways subject to vehicular traffic, the minimum cover shall be 0.9 metres.

(iii) Minimum horizontal spacing between LV cables laid in common trench shall be 0.03 metres, and between LV cables and other services laid in common trench or run adjacent, the minimum spacing shall be 0.3 metres.

Where cables are laid under roads, pathways exceeding 0.90m width, and paved areas, they shall be installed in continuous runs of approved asbestos cement or glazed earthenware pressure piping, the pipes extending 600 mm on either side of the roads etc.

The routes of the cables buried underground shall be clearly and permanently marked by concrete cable markers, as detailed on the Drawings. These shall be positioned 100 mm to the right of each cable and installed such that the distance between markers is approximately 20m and one at every change to direction. Details to be agreed at site to suit final external distribution.

Cables shall be snaked between all terminations and junction boxes to allow movement and settlement of soil.

4.10 Laying of Cables in the Ground

Where installation involves laying of cables directly in the ground, the cables shall be protected with pre-cast concrete cover blocks, and shall be buried at least 1.0 m below ground surface. The locations of such cables shall be made evident by means of mass concrete marker posts inscribed with cast-in lettering of the word "CABLE" which shall be of dimensions and painted in colours approved by the Engineer. The marker posts shall be installed at all changes in straight horizontal alignment or at 50 m interval, whichever is the lesser; the marker posts shall be installed 1.0 m away from the cable with the lettered face parallel to and facing away from the cable.

4.11 Other Cable Installation Methods

Where cables are not laid directly in the ground or in prepared concrete trenches or ducts they shall be supported in reinforced Industrial nylon or aluminium alloy cable cleats bolted directly on the building walls or to vertical or horizontal mild steel channel supports embedded in the floor or walls. Fixing centres for supports shall not exceed 600 mm.

Where several control cables are run in a common route, they may be supported on galvanised, perforated steel trays in preference to individual supports detailed above. Cable tray supports shall be suspended from secure overhead fixtures at intervals not greater than 1000 mm, and groups of cables fixed to the cable tray by PVC or other approved saddles at intervals not greater than 500 mm. In sections where cables are laid directly in the ground, power and control cables shall not run together but shall take different routes. Where cables are installed inside cable trenches they shall be run on separate galvanised steel hooks fixed on the sides of the cable trenches at intervals of not more than 500 mm, Power and control cables shall run on opposite walls inside the cable trenches.

4.12 Depth and Separation of Cables

Cable trenches shall be excavated or ducts laid at such a depth that the minimum distance to the top of the cable trench or duct shall comply with the following:

Minimum Clearance

Type of Service	Vehicular Roadways	Open Ground or Foot Path
LV	1000 mm	750 mm
Others	750 mm	500 mm

Where possible, electric cables and associated ducts shall be installed such that subsequent excavation to expose another service will not disturb electric cables and ducts. Where it is not possible to separate two cables by installing them along different routes, the following clearances shall be observed along parallel routes:

Type of Cable	To HV Cable	To LV Cable	To Other Cable	To Gas/water etc lower voltages
HV	150 mm	300 mm	300 mm	300 mm
LV	300 mm	150 mm	250 mm	300 mm
Others	300 mm	250 mm	150 mm	300 mm

The spacing of cables installed at the same time shall be generally in accordance with the above table, but the Engineer may specify where circumstances permit a more economical arrangement.

As far as possible electric cables shall not be installed alongside other services except where otherwise directed. Where such segregation is not possible, then 50 mm thick concrete slabs may be constructed with the Engineers approval, to separate the services. Adequate slack shall be left at each bend of the cable laid directly in the ground.

Instrument and control cables shall as far as possible be routed separately from power cables and shall not be run on long distances on parallel routes or range to cross one another. A minimum separation of 250 mm shall be maintained between them. Power cables shall not be installed in the same ducts as instrument or control cables.

Separation between the three categories of cables shall be maintained as follows

<u>Separation in mm</u>	<u>Category 1</u>	<u>Category 2</u>	<u>Category 3</u>
<u>Category 1</u>			
Instrument, Power and Control (*over 50 V under I 0 A dc or ac*)	-	200	300

Category 2

High level signals (*6 to 50 V dc*)	200	-	300

Category 3

Low level signals (*less than 5 V dc*)	300	200	-

Only conductors carrying signals of the same category shall be contained within any one multi-core cable.

4.13 Types of Cables, Conditions and Wiring

4.13.1 Power Cables

In general, these shall be multi-core cables, insulated with PVC single wire armoured and PVC outer sheath. These cables are 600/1000 volt class to BS 5467:2016/IEC 60502-1 and IEC 60811, the conductors being copper. The numbers of cores are as indicated on the Drawings and these cables shall be used for all LV distribution requirements where indicated.

PVC/XLPE/PVC cables, 600/1000-volt class to BS 5467:2012 for cable sizes of 25 mm^2 or higher shall be used where indicated.

4.13.2 Control/Alarm Cables

Multi-core control cables are PVC/XLPE and PVC sheathed overall where run in the ground with every core colour coded. Conductor sizes are to suit and details of cores and cable lengths are set out in the Drawings. Details of cable offered are forwarded with tender.

4.13.3 Domestic, Lighting and Small Power

In general, these shall be PVC insulated single core cables with stranded copper conductors, to meet the general requirements of the installation.

4.14 Terminations of Cables

The ends of each PVC/XLPE/PVC cable shall be terminated in brass compression-type cable-glands of the correct size which shall secure the cable inner sheath and ensure effective electrical continuity between the armour wires and the cubicle metal enclosure in which the cable is terminated.

Where cables are required to be terminated in terminal boxes or other items of Plant which have not been supplied by the Contractor, the Contractor shall be responsible for completing the terminations in accordance with the requirements specified above, including testing and verifying of the correct phase sequence of the cores.

Cables shall be identified inside all manholes at the cubicle terminations by tags made of brass, PVC or other types of insulating materials on 'which circuit identification marks shall be indelibly inscribed. Power cables shall have phase identification on each core done on tags made of crimped or sweated sockets of the correct size. Control and protection cables shall have each core identified by an insulated numbered ferrule.

All instrumentation cables shall have their armours or screens earthed at only one end preferably at the control cubicle end.

4.15 Cable and Wiring Test

On completion of the installation, the cables shall, in the presence of the Engineer or his representative, be subjected to the following tests as laid down in the IET Wiring Regulations BS 7671 and the Energy Act, 2006.

(a) Insulation level
(b) Polarity

4.16 Voltage Drop

The Contractor shall inspect, test and ensure that the size of every cable conductor is such that the drop in voltage drop between the origin of an installation and any load point should not be greater than the values as indicated below;

i) 3% for Lighting and 5% for other uses in Low Voltage installation supplied directly from a public low voltage distribution system

ii) 6% for Lighting and 8% for other uses in Low Voltage installation supplied from private LV supply.

The Contractor shall inspect, test and ensure that the final circuit wiring for small power and lighting circuits shall not be less than 4.0 and 2.5 mm^2 respectively as stated on the Drawings.

4.17 Conduits

Unless otherwise installed on site all concealed conduits used shall be black rigid super high impact heavy gauge Class ‘A’ PVC in accordance with BS EN 61386-1:2008. Where steel conduits are required these shall be deemed to be included in the Contractor's price.

Where surface conduits are to be installed, or conduits other than PVC specified for the various services, these shall be of the heavy gauge Class 'B' welded and screwed steel and shall comply with BS EN 61386-1:2008.

In general the installation shall be concealed throughout and shall be fixed by distance type saddles spaced at not more than 900mm apart.

Conduits installed on surface shall be supported with saddles every 60mm. Conduit runs in chases shall be firmly held in position by means of substantial pipe hooks driven into wooden plugs.

Conduit PVC connections shall either be by a demountable (screwed up) or adhesive fixed and made watertight. The tube and fittings must be clean and free of all grease before applying the adhesive. When connections are made between conduit and switch boxes, care shall be taken that no rough edges or conduit stick out into the boxes.

Conduit accessories and fittings for the heavy duty PVC conduit shall match fully the requirements of the conduit used and shall be agreed. Conduit fittings for the steel conduits shall be malleable cast iron galvanised to BS EN 60601 & BS 7671 61386-1:2008 with extended spouts, internally treated and cover fixing lugs.

The drawings with these specifications indicate the approximate positions only of points and switches, and it shall be the Contractor's responsibility to mark out and centre on site the accurate positions where Necessary in consultation with the Engineer and the Employer. The Contractor shall be responsible for the accuracy of the final positions.

Conduit outlets and junction boxes, where used in conjunction with PVC conduit, are to be PVC manufactured to BS 4607-1:1984+A2:2010.

Outlet boxes for lighting fittings are to be of the loop-in type where conduit installation is concealed and the Contractor shall allow one such box per fitting, except where fluorescent fittings are specified when two such boxes per fittings are used.

Flexible conduit are manufactured to BS EN 61386-1:2008 galvanised and with PVC outer sheath.

It shall be entirely the Contractor's responsibility to ensure that conduits and other equipment, are installed at the appropriate stage of building progress, and no extra payment shall be made for chasing, boring, cutting or any other work arising from failure to meet this requirement.

Conduits are installed in such a manner that all cables can be drawn-in after erection by means of a draw-in tape.

Where a steel conduit system is required and specified the exposed outlet boxes shall be cast metal type and flush boxes shall be cast or sheet metal. No knockouts shall be removed unless used. Where conduits enter sheet metal boxes, they shall be lock-nutted back and front. Burrs and obstructions shall be removed before installation of boxes and conduits.

No conduit shall be smaller than 20mm nor shall accommodate more than 75% of the conductors permitted under the IEE wiring regulations.

Conduits to be concealed in structures cast-insitu are or shall be secured to the steel reinforcement work with heavy binding wire, spaced not more than 900mm to prevent movement of conduit boxes during the pouring and vibrating of the concrete. Outlet boxes shall be filled with paper to prevent ingress or concrete, and all boxes shall securely fixed to the shuttering with nails or other measures, which must not be visible after removal of the shuttering unless they later can be concealed e.g. by plaster. Conduits shall be installed after the chasing work has been completed. Couplings plugged with a suitable non-metallic stopping plug shall protect all open ends of conduit.

Conduit run in chases in walls or the like shall be fixed by means of mild steel pipe hooks or saddles spaced at not more than 900 mm. Where the conduit is concealed behind the plaster it shall be sunk 20 mm below finished plaster level before application of the plaster.

Surface conduit shall also be fixed 200 mm from boxes, the boxes themselves being securely fixed. Where such an arrangement of boxes and saddles would prove to be both unsightly and unnecessary, short lengths of conduit not exceeding 900mm between boxes need not be secured further than by connection to the adjacent boxes. In such cases the Engineer reserves his right to insist upon having additional fixings provided should he for any reason whatsoever consider additional fixings Necessary.

Special care should be taken to prevent dirt and plaster to enter any section of conduit system.

All bends in conduits shall be formed without any decrease or increase of the cross section diameter of the conduits. The radius of the bend shall not to be less than indicated by British Standard. For concealed work this radius should be increased. No manufactured tees, elbows, and bends will be permitted. All conduits shall be thoroughly cleaned for sharp edges.

The conduits shall be installed avoiding unnecessary bends or changes in directions. Conduits shall be laid in straight lines. Where straight rows of conduits are installed, inspection boxes shall be placed at not more than 15 metre intervals. There shall not be more than 4 easy bends or 2 right-angle bends between boxes.

Sub-mains conductor shall not be bunched in the same conduit as other circuits.

Lighting sub-circuits shall not be enclosed in the same conduit as general-purpose power sub-circuits.

Single-phase sub-circuits shall not be enclosed in the same conduit as three-phase sub-circuit.

4.18 Cable Trunking

The Contractor shall supply new install, test all single, two and three compartments cable trunking installed on the site to ensure that they are electrically and mechanically sound. All trunking are or shall be provided with removable covers of an agreed and appropriate length for handling, removal and servicing. The colour of the trunking shall be agreed to suit the Employer, the Contractor including in his prices for factory painting in a colour agreed with the Architect.

In general all trunking shall be manufactured by a renowned company. The cable trunking shall be made from hot galvanised sheet metal and approved to CEI 23-31 standards. It shall be factory painted externally where normally visible to match the finish of the walls as approved by the Architect and to suit the requirements of the other areas as agreed. A continuous cover of the same material are provided and fitted, for all areas except as for the laboratory trunking and cover screws so arranged that no sharp protrusions occur within the wiring space.

The mounting height of the trunking shall be agreed in general and shall be skirting in all working areas.

The trunking shall be complete with all supports, tee-pieces, angles, fixings, fillets, couplings, bends etc. as required and as Necessary to complete the installation.

The trunking shall be sized in compliance with the capacity Table issued by the B.E.S.A.; the Contractor shall therefore inspect and ensure that the size all trunkings comply with this requirement.

Each conduit take-off from the cable trunk shall be lock-nutted on both sides, with no excess conduit protruding into the cable trunk unless it is properly bushed.

The Contractor shall inspect and ensure that the maximum number of cables in the trunkings shall be that in aggregate would occupy 50% of the cross sectional area of the trunking.

UPVC trunking shall, unless otherwise specified be manufactured to BS EN 60601 & BS 7671 ISO 9001:2015. All sections shall be rigidly fixed together and fixed to building structure at intervals of not more than 1200mm.

4.19 Cable Tray

The Contractor shall inspect and test to ensure that cable trays are manufactured of perforated enamelled steel plate with returned flanges and with suspensions at intervals of not more than 1000mm. The final sizes shall be determined by the Contractor to suit the requirements of the installations.

4.20 Continuity

The Contractor shall inspect, test all conduits, cable trunking and cable tray to ensure that they are mechanically and electrically continuous throughout. Where steel conduits cross expansion joints, flexible steel conduit sections, PVC sheathed are inserted, or other approved means used to provide the Necessary continuity and flexibility.

4.21 Load Balancing

The Contractor shall test and ensure that the electrical load in respect of the entire installation is balanced to the satisfaction of KPLC and the Engineer. The Contractor shall carry out such alterations to the power offtakes at the switchboard and at the distribution/control cubicle connections as may be required to balance the electrical load of the installation.

4.22 Labels

All items of equipment, apparatus and the like should be clearly labelled, labels being as previously specified. Starters controlling motors shall be labelled identically such that the motor and starting are readily identified.

4.23 Earthing

The Contractor shall install, test and commission the entire earthing installation in accordance with the 17th Edition of IET Wiring Regulations (*BS 7671*). The entire system of metallic conduits and trunking, metallic sheaths of cables, cases and enclosures of switch-gear and electrical apparatus shall be connected to the earth point, according to the current rules and regulations. The Contractor is reminded that the resistance of the earth conductor from the earth-electrode to any point in the earthing system shall not exceed 0.5 ohms.

The Contractor shall supply and install all additional conductors, cables, tapes, earthing rods, inspection pits and all associated items for the installation of the complete earthing system.

The Contractor shall carry out earth resistivity tests to determine the best location for the main earth electrode. The results of such tests shall be clearly indicated on a site plan and submitted to the Engineer for approval 21 days prior to locating of the main earth electrodes.

The earth tape or cable between the main earth terminal and the earth electrodes shall be of high conductivity copper.

The earthing shall be carried out to an externally positioned inspection/earthing rod pits by means of copper tape (*25 x 3.5mm*) or the equivalent stranded copper conductor. The pits shall be complete with an inspection lid such that access to the rods shall be readily available. The number of pits or rods will be dependent upon the values recorded during the testing and it shall be deemed that the Contractor has included in his tender for all Necessary materials to meet the requirements.

The earthing requirements, while being in accordance with the power supply authority regulations, shall also be fully in accordance with the requirements of the Institution of Engineering and Technology, Wiring Regulations BS 7671: 2008, requirements for electrical installations, together with the British Standard Code of Practice BS 7430:2011+a1:2015.

The Contractor shall include for the bonding up complete of all sinks, taps, pipework, metal branches and other similar items as required by the IET Wiring Regulations, all details shall be agreed, this being particularly important in kitchen areas, pump houses and toilets.

4.24 Lightning and Transient Over-Voltage Protection

4.24.1 Scope of the Work for Lightning and Transient Overvoltage Protection

All lightning and transient overvoltage protection system shall be in accordance with British Standard BS EN 60601 & BS 7671 62305-1:2011. The Contractor shall supply, install, inspect, test and commission the system to ensure that the lightning and overvoltage protection system is electrically and mechanically sound and shall carry out any further improvement measures deemed Necessary as directed by the Engineer.

4.24.2 Lightning Conductor

This shall consist of 25mm x 3mm (1" x $^1/_8$") bare copper tape exposed, securely fixed and extending from the air terminates at the roof structure to the earth rods at the grounding point. Several test clamp points shall be installed at intervals of 10 m and at points as instructed by the Engineer. The Contractor shall inspect, test and commission to ensure that the whole lightning system is electrically and mechanically sound and will carry out any improvement measures deemed Necessary as directed by the Engineer.

4.24.3 Air Terminals

These shall consist of copper flat saddle. The saddle shall support a rod of length 800 mm and 15 mm diameter. At the top of the rod a triple pointed discharge rod of maximum 200 mm and 15mm diameter. The Contractor shall supply, install, inspect, test and commission to ensure that they are electrically and mechanically sound and carry out any improvement measures deemed Necessary as directed by the Engineer.

4.24.4 Test Clamps

These shall be provided for each down conductor and fixed at 1800mm (6' 0") from finish ground level and at intervals of 10 m to the air terminal. No connection should be made to earth tape below the test clamps, except to the earth rod.

4.24.5 Earth Rods

These shall consist of 15mm diameter hard drawn copper rods. Approximately 1.2 m long and shall be installed or driven into the ground at the position as directed on site by the Engineer. Each earth rod shall not be installed less than 3 metres from the column of the buildings. The head of the earth rods shall be installed in a concrete inspection pit with cover.

4.24.6 Connections

Connections between the various members of the termination network and to the down conductors shall be riveted and/or soldered, welded or made with mechanical clamps specifically designed for that purpose. Clamped joints shall be first cleaned, then inhibited from oxidation with a suitable non-corrosive compound.

The resistance of the earth system shall comply with the Regulation i.e. 10.0 ohms maximum. If the earth resistance with one earth rod is not satisfactory, then additional earth rods or an earth mat shall be provided as directed by the Engineer.

4.24.7 Transient over voltage protectors

The Contractor shall supply, install, test and commission appropriate transient overvoltage protectors on all power and telephone cables entering or leaving the houses, in order to protect equipment connected to power distribution system against transient over voltages coming into the houses from outside all as per the requirements of BS EN 60601 & BS 7671 62305-1:2011.

The entire lightning system shall be tested to BS 7430:2011+A1:2015 recommendations.

4.25 Testing and Commissioning

In addition to the requirements given under previous clauses of the Specification, the requirements given in this clause shall also apply to the inspection, testing and re-commissioning of the complete electrical installation.

The Contractor shall be responsible for testing and commissioning the electrical installation to ensure that it is in proper working order to the satisfaction of the Engineer.

After inspection, testing and commissioning the installations, each part of the system shall be subjected to tests in accordance with the relevant international standards and the requirements of the power supply authority. In addition to these tests, the whole of the installation shall be subjected to complete functional tests to the satisfaction of the Engineer.

Any defects, faults or omissions made apparent by such tests shall be corrected and re-tested to the satisfaction of the Engineer.

4.26 Temporary Electricity and Telephone Supplies

During certain elements of the works it may be Necessary to use the mains supplies and therefore the Contractor will be expected to provide temporary electricity and telephone supplies which shall be metered and paid for by him.

4.27 ANNEX 01: Specifying hospital electrical distribution systems

The electrical distribution system of a hospital may look the same as that for other types of buildings—offices, hotels, etc.—but there are several important distinctions. These distinctions are not so much in the equipment used. Panel boards, switchboards, transformers, circuit breakers, and other products are all common to other types of projects. The differences lie primarily in the size and complexity of the electrical systems: the overall size of the electrical system, its need for a higher level of flexibility, enhanced needs for more emergency power that can remain operational for longer durations, and the need for enhanced safety in the hospital environment.

4.27.1 Emergency versus essential power

Often the term “emergency” power is used to refer to all power needed on a generator in a hospital. A better term for this would be “essential” power. True, emergency power comprises only those loads required to be restored within 10 seconds as required by NFPA 70: National Electrical Code for all buildings, and as defined as life safety branch and critical branch by BS EN 60601 & BS 7671 for hospitals. For a hospital, you have the essential power supply, which would include the generator(s), and this power is divided into emergency system power and equipment system power. Then the emergency system is divided into the life safety branch and critical branch.

The size, complexity, and needs for emergency power in a hospital are only a few of the ways in which its power distribution system differs from that of other building types. Following are other ways hospitals differ from other types of buildings.

It should be noted that NFPA 99: Health Care Facilities Code also has specific electrical requirements for hospitals, but as these requirements are very close to those in BS EN 60601 & BS 7671, we will focus on these BS EN 60601 & BS 7671 requirements. One other code that affects generator design and installation is NFPA 110: Standard for Emergency and Standby Power Systems. This code is more specific to generator installation requirements (and not the emergency loads that must be connected to them) for the most part, but includes many other important requirements for generators.

BS EN requires that a portion of the building’s electrical system be capable of providing emergency power in the event of normal power failure. This would include features such as exit/egress lighting, fire alarm systems, and other similar life safety functions. This can be done via a small generator (for larger buildings) or battery backup power. This amount of power is typically a very small portion of the building’s total power consumption, about 5% to 10%.

BS also requires that hospitals be provided with emergency power. Again, as hospitals must remain open throughout normal power interruption and include patients who rely on emergency power for preservation of life, this article divides the emergency branch (same terminology as NEC Article 700) into two branches: the life safety branch and the critical branch (new terminology just for hospitals).

In a hospital, the life safety branch of the emergency power system is very similar to the requirement for other building types. It includes only the small amount of power necessary to allow for the safe evacuation of the public from the building in the event of normal power failure. This includes the exit/egress lighting and fire alarm systems—similar to other buildings—as well as other loads unique to the health care environment, such as medical gas alarm systems. It also includes generator set accessories loads (such as battery chargers and block heaters) that are Necessary to ensure proper starting and operation of the generator. Again, these loads would include a very small percentage of a hospital’s total electrical system, typically 5% to 10% at most.

As we've discussed, unique to the hospital environment is the need to maintain patient safety during the loss of utility power. This is where the second branch of the emergency system, the critical branch, takes over. The hospital's critical branch is a much larger part of the electrical distribution system and handles loads such as much of the lighting and power outlets in patient rooms, intensive care rooms, operating rooms, post-anaesthesia care units (PACUs), nurse stations, pharmacies, labs, blood banks, and other similar types of spaces where patients are either directly cared for or services for these patients are arranged. Further, identifies two different types of patient care areas—general care and critical care—depending on the severity of the patient's needs. A general care area includes rooms such as a "normal" patient room or exam room where critical branch power is needed but the patient's condition is not severe. A critical care area then is exactly how it sounds: an area where the patient's care is more dependent on the hospital staff (and their need for more equipment and more emergency power). This includes operating rooms, labour/delivery rooms, intensive care units, trauma areas in emergency rooms, and so on. requires even more available power in general and also more emergency power for these types of spaces.

All these requirements for critical branch power further increase the size of a hospital emergency power system. Where life safety power would only be 5% of the building's power requirement, the critical power system of a hospital could easily account for 25% or more of a hospital's total power requirement.

In addition to "true" emergency power, other power needs in a building are also very important in the event of normal power failure but not necessarily needed for the preservation of life. This might include heating and refrigeration systems, ventilation and smoke removal systems, sewage disposal, industrial processes, and others whose interruption could create a hazardous condition or hamper rescue or fire-fighting operations. For all buildings, this is covered by BS EN Legally Required Standby Systems, and these systems must be restored to power within 60 seconds from loss of normal power. For a hospital, further defines these systems and calls them the equipment system.

BS EN doesn't specifically define which systems must be considered legally required standby but rather states that this designation should be made by the designer and/or authorities having jurisdiction (AHJ). As there are so many different types of buildings with different hazards, the designer and code reviewers must use discretion. However, for a hospital, these equipment systems are much better defined. They include large medical gas suction systems, elevators, kitchen hood supply/exhaust, ventilation systems (supply/return and exhaust) for patient care areas, heating for patient care areas, large sterilizers, and similar type loads. Again, the equipment system of a hospital can be a substantial part of the overall electrical system, especially as much of this system is the larger equipment loads such as elevators, large air handlers, and sterilizers. The equipment system can easily account for 30% or more of the overall hospital electrical system.

Even this equipment system power is further delineated based on the importance of the loads being served—into no delayed automatic, delayed automatic, and delayed automatic or manual connection. These distinctions can require a minimum of three automatic transfer switches (ATS) for the equipment system. The highest equipment system level is the no delayed automatic connection and includes only loads such as certain generator accessories. These loads (as the name suggests) must be automatically restored without delay upon loss of utility power (similar to emergency power). Note that these types of systems also may be connection to the life safety branch. (This would be a designer's choice and may depend largely on the size and complexity of these systems.) Next, equipment such as medical air vacuum pumps and compressors, smoke control systems, ventilation systems for operating and labour/delivery rooms, smoke control systems, and kitchen supply and exhaust systems must be automatically restored upon loss of utility power but are allowed to delay the emergency system restoration (typically under 1-minute delay). The final step of equipment power is allowed to have a delayed automatic connection (which would lag all other ATS) or even a manual connection to the generator system. This includes loads such as elevators, heating to patient care areas, automatic doors, sterilizing equipment, hyperbaric or hypobaric facilities, and other selected loads.

In summary, the total amount of emergency power for most buildings (and therefore the amount of emergency distribution equipment needed) is typically 10% or less and consists of only that minimal amount of power needed to help people safely exit a building within the first few minutes of normal power interruption. For hospitals, emergency power becomes the life blood of a building without utility power and must be maintained throughout a power outage, which could last for days after a storm or other catastrophic event. As a result, it's not unusual to see the emergency power of a hospital exceed 50% or 60% of the building's total power needs. Also, as separate transfer switches are need for each type of load (life safety, critical, no delayed automatic equipment, delayed automatic equipment, and delayed automatic or manual connection equipment loads), multiple ATSs are always needed for hospitals. For a 200,000-sq-ft hospital, eight or more transfer switches could be used. A similarly sized office building would typically have only two ATSs.

4.27.2 All power outlets are not created equal

Many different types of power outlets are available today. Common types are general use, residential grade, commercial grade, specification grade, and hospital grade. Many of these designations have been developed by manufacturers to define the level of quality of these power outlets. Typically, a residential grade is lower quality than a commercial grade, a commercial grade is lower quality than a specification grade, and so on. The highest level of quality for power outlets is hospital grade. Hospital grade power outlets are manufactured to the highest standards to ensure grounding reliability, assembly integrity, overall strength, and durability. All patient care areas in a hospital are required to use hospital grade power outlets per BS EN 60601 & BS 7671. Further, it requires that hospital grade power outlets shall be marked to identify them as such. U.S. manufacturers typically mark a green dot on the front of the power outlets.

However, hospital grade power outlets are not required throughout a hospital; they are required only in patient care areas (such as, patient rooms, labour/delivery rooms, etc.). They are not required in offices, nurse stations, labs, pharmacies, or other areas in the hospital, but they are commonly used in all rooms of a hospital to provide the highest quality of power outlets with the longest life and durability.

4.27.3 Grounding is twice as important

Grounding is an issue that is often misunderstood when discussing electrical distribution systems, and it's not the intent of this article to define or explain grounding in-depth. From a simplistic point of view, the grounding of an electrical system is needed for many reasons such as establishing the voltage reference point and enhancing the safety of the electrical system by providing a return path for stray voltage/current in the system (and therefore keeping it away from you). For most buildings, every branch circuit (defined as the last wiring from any panel or other source to the final point of use) must be grounded. For the purpose of illustration, think of branch circuit wiring as the wire just behind the electrical receptacle or connected to the light fixture in your house or office. It is the wiring that touches the electrical devices you touch. Poor grounding at this level can lead to the possibility of you being shocked when plugging in (or unplugging) your radio, phone, or other equipment.

Furthermore, even though all ground buses in every panel should theoretically be at the same reference point (or zero voltage point), there is always the possibility of very slight voltage differences between multiple panels grounding reference. As a result, BS EN 60601 & BS 7671 requires that any panels that serve the same patient area must have another grounding jumper (wire) connected their ground buses to eliminate the possibility of even the smallest trace of any stray voltage that could be introduced to a patient. This is another requirement distinct to the hospital environment.

There are two acceptable means for providing grounding for branch circuit wiring per BS EN 60601 & BS 7671. One is by the use of a dedicated grounding wire being run with the other wires in the circuit (the famous green or sometimes bare wire any amateur electrician knows). The second method is the use of metallic boxes and metallic conduits throughout the branch circuit that are rated to provide an effective ground path back to the electrical source.

Anyone who has ever been shocked by an electrical appliance (meaning that stray voltage used them as a grounding path instead of a grounding wire or conduit system) can tell you that it is no fun. Unfortunately, these incidents can sometimes lead to injury or even death, depending on other conditions. Obviously, these concerns are greatly magnified for someone who is already in a weakened state due to illness or injury. As a result, BS EN 60601 & BS 7671 requires that all branch circuits serving patient care areas must have both types of grounding installed (grounding wire and the use of metal raceway throughout)—often referred to as redundant grounding. This further enhances the safety of the electrical system for the patient (and the hospital staff).

4.27.4 Protection of the emergency system

Another requirement for hospitals in BS EN 60601 & BS 7671 is the need to provide mechanical protection of the emergency system (this would apply to life safety and critical branch power). This code greatly reduces the available methods for the wiring and conduit systems of emergency power branch circuits. In non-patient-care areas (where redundant grounding is not required), methods include mineral insulated cable (very expensive, fire rated cabling), PVC Schedule 80 conduit, or conduits such as PVC Schedule 40 and some flexible metal conduits where installed in 2 in. of concrete.

Typically, only nonflexible metallic conduit is allowed in patient care areas due to the need to provide redundant grounding and protection of the branch circuit. There are a few exceptions; the BS EN 60601 & BS 7671 does allow flexible conduit for specific applications where nonflexible metallic conduit is not possible due to the need for flexibility. There is even a specific flexible “health care grade” ac cable manufactured just for hospitals (where the flexible metal jacket is still rated as a grounding path and a separate grounding conductor is installed within) for these applications.

4.27.5 Breaker coordination

Another code requirement that adds significant complexity to the design of hospital electrical systems is that of overcurrent coordination of the emergency system. This requirement is actually found in BS EN 60601 & BS 7671, which applies to all building types. However, as mentioned previously, the emergency system for most buildings is a very simple one concerned primarily with small loads such as lighting, fire alarm, and other similar loads. In a hospital, the amount of emergency power and the larger size of the distribution equipment needed further complicate this issue, as close to half (or more) of the panels and breakers in a large hospital may be connected to life safety and critical branch power. The need to provide overcurrent coordination requires much more design attention to ensure that downstream breakers will open (trip) prior to larger upstream breakers so that any disruption of emergency power is minimized. Although this may seem simple enough, the tolerances of breakers is such that often larger electrical distribution equipment is needed to provide coordination than may be required based on the loads being served. This further increases the cost of the electrical system and may also affect the physical size of the equipment.

4.27.6 Ground fault protection

Ground fault protection (GFP) is the sensing of current on an electrical system to ensure that there is not a dangerous ground fault occurring downstream in the electrical system. By comparing outgoing current (on the phase conductors) with neutral currents (the "return" current), GFP devices can determine if any current is being lost in the system (i.e., a fault condition). If this is the case, the GFP protection will open a breaker (typically the main breaker) and interrupt power to the system.

The BS EN 60601 & BS 7671 requires GFP on the system's main circuit breaker for solidly grounded systems of 1,000 A or more with a line-to-ground voltage of 150 V or more. As most electrical services in US buildings of sufficient size are 480 V line-to-line (which equals 277 V line-to-ground) and 1,000 A or more, this GFP is often required.

For a hospital, however, BS EN 60601 & BS 7671 expands the GFP provisions and requires two levels of GFP protection. So in a hospital, if an electrical service needs GFP due to voltage and size of the system, the main breaker and all the feeder breakers in the electrical service must be protected by GFP. This serves to enhance reliability by removing only one feeder (through which the fault is travelling) instead of removing power from the whole service (by tripping the main breaker for the system). Similar to overcurrent coordination, this is another case where the code recognizes the need to isolate an electrical condition in a hospital electrical system in order to minimize any power disruption. Where RCDs are required, only type A (complying with BS EN 61008 or BS EN 61009) or type B (complying with IEC 62423) shall be selected, depending on the possible fault current arising.

4.27.7 Electrical systems unique to hospitals

Although most electrical equipment in hospitals is common to other building types, there are some systems unique to hospitals—notably, isolated power systems. Originally introduced in hospitals due to the use of flammable anaesthesia (commonly ether) many years ago, these systems were once mandatory in all areas where anaesthesia was used. Flammable anaesthesia hasn't been used in hospitals for many years, but isolated power systems remain for some applications. BS EN 60601 & BS 7671 requires the use of isolated power systems in "wet" locations where power disruption cannot be tolerated. The BS EN 60601 & BS 7671 code leaves the determination of wet locations to the hospital's discretion, but areas commonly considered to be wet include some general surgeries, open heart surgery, orthopaedic surgeries, and cystoscopy. Please note that the 2012 edition of NFPA 99 recently included in its requirements that all operating rooms are identified as wet locations unless a risk assessment has been provided to ensure that fluids within the space will cause no danger to patient or staff (Section 6.3.2.2.8.4). As a result of this revision, the use of these complex electrical panels will likely increase significantly in future hospital projects.

Isolated power systems serve to reduce the risks of electric shock hazards from patients' or staff members' inadvertent contact with stray voltage and allow for the safe continuation of electrical appliance use in the event of a low-level fault condition where loss of power could affect patient safety. These systems are also designed to limit the leakage of electrical current in the system (which is very small but common in any electrical system) that may cause an electrical shock. Though such a shock is normally very small and poses little risk of harm, it becomes magnified in a wet location or with a patient more susceptible to any contact to even very minor stray voltage (such as a patient in a heart surgery where any voltage introduced to the heart could have fatal consequences). Further, these systems are capable of monitoring even these smallest amounts of leakage current (under 5 mA, or five one-thousandths of an amp) and providing alarms of dangerous levels of leakage current. As you may imagine, the use of these complex electrical systems in a hospital adds significant costs and maintenance issues.

SECTION H

HEATING VENTILATION AND AIR-CONDITIONING INSTALLATIONS SPECIFICATION

1 PART B

1.1 GENERAL MECHANICAL SPECIFICATION

1.1.1 GENERAL

This section specifies the general requirements for plant, equipment and material forming part of the Sub-Contract Works and shall apply except where specifically stated elsewhere in the specification or on the contract Drawings.

1.1.2 QUALITY OF MATERIALS

All plant, equipment and materials supplied as part of the Sub-contract works shall be new and of first-class commercial quality, shall be free from defects and imperfections and where indicated shall be of grades and classifications designated herein.

All products or materials not manufactured by the Sub-contractor shall be products of reputable manufacturers and so far as the provisions of the Specification is concerned shall be as if they had been manufactured by the Sub-contractor.

The Sub-Contractor as called for by the Specification and Contract Drawings shall supply materials and apparatus required for the complete installation unless mention is made otherwise.

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

Defective equipment or that damaged in the course of installation or tests shall be replaced as required to the approval of the Engineer.

1.1.3 REGULATIONS AND STANDARDS

The Sub-Contract Works shall comply with the current edition of the following:-

i) The Kenya Government Regulations
ii) The United Kingdom Institution of Electrical Engineering (*IEE*) Regulations for the electrical equipment of buildings.
iii) The United Kingdom Chartered Institute of Building Services Engineers (*CIBSE*) Guides.
iv) British Standards and Codes of Practice as published by the British Standards Institution (*BSI*).
v) The Local Council By-laws.
vi) The Electricity supply Authority By-Laws.
vii) Local Water Authority By-Laws.
viii) The Kenya Building Code of Regulations.

1.1.4 ELECTRICAL REQUIREMENTS

Plant and equipment supplied under this Sub-Contract shall be complete with all necessary motor starters, control boards, and other control apparatus. Where Control Panels incorporating several starters are supplied, they shall be complete with a main isolator.

The supply power up to and including local isolators shall be provided and installed by the Electrical Sub-Contractor. All other wiring shall be as described in the "Particular Specification".

The Sub-Contractor shall supply three copies of all schematic, cabling and wiring diagrams for the Engineer's approval.

The starting current of all electric motors and equipment shall not exceed the maximum permissible starting currents described in Kenya's power utility Company's By-Laws.

All electrical plant and equipment supplied by the Sub-Contractor shall be rated for the supply voltage and frequency obtained in Kenya that is 415 volts, 50Hz, 3-phase or 240 volts, 50Hz 1-phase as specified in the "Particular Specification".

The Consultant may reject any equipment that is not rated for the above voltages and frequencies

1.1.5 TRANSPORT AND STORAGE

All plant and equipment shall, during transportation be suitably packed, crated and protected to minimise the possibility of damage and to prevent corrosion or other deterioration.

On arrival at site, all plant and equipment shall be examined and any damage to parts and protective priming coats made good before storage or installation.

Adequate measures shall be taken by the Sub-Contractor to ensure that plant and equipment do not suffer any deterioration during storage.

Prior to installation all piping and equipment shall be thoroughly cleaned.

If, in the opinion of the Consultant any equipment has deteriorated or been damaged to such an extent that it is not suitable for installation, the Sub-Contractor shall replace this equipment at his own cost.

1.1.6 SITE SUPERVISION

The Sub-Contractor shall ensure that there is an English-speaking supervisor on the site at all times during normal working hours.

1.1.7 INSTALLATION

Installation of all special plant equipment shall be carried out by the Sub-Contractor under adequate supervision from skilled staff provided by the plant and equipment manufacturer or his appointed agent in accordance with the best standards of modern practice and to the relevant regulations and standards described under Clause 3 of this section.

1.1.8 TESTING

3.1.8.1 GENERAL

The Sub-Contractor's attention is drawn to Part "A", Sub-Clauses 1.44 and 1.45 Page 1-11 and 1-12 respectively of the "Preliminaries and General Conditions".

The following sub-clauses are intended to define the Sub-Contractor's responsibilities with respect to testing and inspection.

3.1.8.2 MATERIAL TESTS

All material for plant and equipment to be installed under this Sub-Contract shall be tested, unless otherwise directed, in accordance with the relevant B.S. specification concerned.

For materials where no B.S. specification exists, tests are to be made in accordance with the best modern commercial methods to the approval of the Engineer, having regard to the particular type and application of the materials concerned.

The Sub-Contractor shall prepare specimens and performance tests and analyses to demonstrate conformance of the various materials with the applicable standards.

If stock material, which has not been specifically manufactured for the plant and equipment specified is used, then the Sub-Contractor shall submit satisfactory evidence to the Consultant that such materials conform to the requirements stated herein in which case tests of material may be partially or completely waived.

Certified mill test reports of plates, piping and other materials shall be deemed acceptable.

3.1.8.3 MANUFACTURED PLANT AND EQUIPMENT - WORKS TESTS

The rights of the Consultant relating to the inspection, examination and testing of plant and equipment during manufacture shall be applicable to the Insurance Companies or Inspection Authorities so nominated by the Engineer

The Sub-Contractor shall give two weeks’ notice to the Consultant of the manufacturer's intention to carry out work tests and inspections.

The Consultant or his representative shall be entitled to witness such tests and inspections. The costs of such tests and inspections shall be borne by the Sub-Contractor.

Six copies of all test and inspection certificates and performance graphs shall be submitted to the Consultant for his approval as soon as possible after the completion of such tests and inspections.

Plant and equipment which is shipped before the relevant test certificate has been approved by the Consultant shall be shipped at the Sub-Contractor's own risk and should the test and inspection certificates not be approved, new tests may be ordered by the Consultant at the Sub-Contractor’s expense.

3.1.8.4 PRESSURE TESTING

All pipe work installations shall be pressure tested in accordance with the requirements of the various section of this specification. The installations may be tested in section to suit the progress of the works but all tests must be carried out before the work is buried or concealed behind building finishes. The Consultant or his representative must witness all tests and the Sub-Contractor shall give 48 hours notice to the Consultant of his intention to carry out such tests.

Any pipe work that is buried or concealed before witnessed tests have been carried out shall be exposed at the expense of the sub-contractor and the specified tests shall then be applied.

The Sub-Contractor shall prepare test certificates for signature by the Consultant and shall keep a progressive and up-to-date record of the Sections of the work that have been tested.

1.1.9 COLOUR CODING

Unless stated otherwise in the Particular Specification all pipe work shall be colour coded in accordance with the latest edition of B.S. 1710.

1.1.10 WELDING

3.1.10.1 PREPARATION

Joints to be made by welding shall be accurately cut to size with edges sheared, flame cut or machined to suit the required type of joint. The prepared surface shall be free from all visible defects such as lamination, surface imperfections due to shearing or flame cutting operation, etc., and shall be free from rust, scale, grease and other foreign matter.

3.1.10.2 METHOD

All welding shall be carried out by the electric arc process using covered electrodes in accordance with B.S. 639.

Gas welding may be employed in certain circumstances provided that prior approval is obtained from the Engineer

3.1.10.3 WELDING CODES AND CONSTRUCTION

All welded joints shall be carried out in accordance with the following specification:-

a) Pipe Welding
   All pipe welds shall be carried out in accordance with the requirements of B.S.806.
b) General welding
   All welding mild steel components other than pipe work shall comply with the general requirements of B.S. 1856.

3.1.10.4 WELDERS QUALIFICATIONS

Any welder employed on this Sub-contract shall have passed the trade tests as laid down by the Government of Kenya.

The Consultant may require seeing the appropriated certificate obtained by any welder and should it be proved that the welder does not have the necessary qualifications the Consultant may instruct the Sub-Contractor to replace him by a qualified welder.

2 PART C

2.1 GENERAL MECHANICAL VENTILATION SPECIFICATIONS

2.1.1 GENERAL

This section specifies the general requirements for the manufacture and installation of low velocity/medium pressure air systems forming part of the Contract Works. This section shall apply except where specifically stated otherwise in the Particular Specification or on the Contract Drawings.

2.1.2 SHEET METAL DUCT WORK

4.1.2.1 MATERIAL

Ductwork within the building shall be fabricated from strip mill cold-reduced mild steel sheet continuously hot-dip galvanised in compliance with B.S. 2989: 1975.

Ductwork external to the building shall be fabricated from cold-rolled, close-annealed or cold reduced black mild steel sheet and galvanised after manufacture in compliance with B.S. 719: 1971.

4.1.2.2 CONSTRUCTION

All ductwork shall be manufactured in accordance with the Heating & Ventilating Contractors' Association, (HVCA) U.K., and Specification: DW/142: 1982, except where specifically stated otherwise in the particular Specification or on the Contract Drawings.

Ductwork material gauge and stiffening shall be in compliance with the requirements set out in Table A.

Table A

Length of Side (mm)	Nominal Sheet Thickness (mm)	Maximum Spacing Between Joints/Stiffeners		Minimum Angle section for Intermediate Stiffeners (mm)
		Without Beading Cross or Breaking or (mm)	With Beading Cross- Breaking (mm)	
Up to 400	0.6	Unlimited	Unlimited	None
400 to 600	0.6	1,500	Unlimited	25 x 25 x 3
601 to 800	0.8	1,500	Unlimited	25 x 25 x 3
801 to 1,000	0.8	1,200	1,500	25 x 25 x 3
1,001 to 1,500	1.0	800	1,200	40 x 40 x 4
1,501 to 2,250	1.0	800	800	40 x 40 x 4
2,251 to 3,000	1.2	600	600	50 x 50 x 5
For Ducts Galvanised after Manufacture				
Up to 300	1.2	As Equivalent Sizes above		
301 and over	1.6	As Equivalent Sizes above		

4.1.2.3 JOINTS

Cross joints for ducts up to 500 mm narrow side shall be `C' cleat type and sealed with liquid/mastic sealant.

Cross joints for ducts with narrow side in excess of 500 mm shall be reinforced standing seam.

Longitudinal seams shall be of the lock form type of riveted spot/plug welded lap seams.

4.1.2.4 BENDS

All bends shall have a centre line radius of one and one half times the duct width.

Where radius bends will not fit, square bends shall be provided, with air turns fitted by riveting or welding. The number of vanes shall be none in ducts up to 300mm wide, one in ducts 301mm to 500mm wide and two in ducts above 500mm to 1000mm wide and three in ducts above 1000mm. The vanes shall be positioned in accordance with fig. 1, 2, 3 and 4 of HVAC Specification DW/142: 1982.

4.1.2.5 TRANSFORMATION

Transformation and taper pieces shall, where the cross-section area is unchanged have a maximum slope of 22.5 degrees on any side. Where the Cross-sectional area is temporarily reduced up to 20 per cent, the maximum slope shall be 15 degrees.

4.1.2.6 BRANCHES

For branch ducts up to 400mm wide the take-off piece shall be tapered at 45^0 in the direction of the air flow in accordance with fig.61 of HVAC Specification DW/142.

For branch ducts over 400mm wide the take-off piece shall be of radius pattern with, where space permits, a minimum inner radius of half the branch duct width.

4.1.2.7 AIR TIGHTNESS

All ductwork shall be constructed and jointed in such a manner that air-tightness requirements are fulfilled and allowable leakage shall not exceed ten per cent of total air flow at highest fan pressure. The allowable leakage shall not be concentrated at one point of the system.

4.1.2.8 ACCESS

Sufficient number of access doors and hand-holes shall be provided in the ductwork for the purpose of maintenance, inspection, cleaning and entry of test equipment.

Access doors shall be of the hinged type and door openings in ductwork shall be adequately stiffened and made air-tight with purpose-made rubber gaskets around the door perimeter.

4.1.2.9 CONNECTIONS

Brass screwed connections shall be provided on the ductwork for thermostats, humidistats, thermometers, etc., in positions indicated on Contract Drawings. The connections shall be provided with an air-tight rubber seal.

4.1.2.10 TEST HOLES

Test holes shall be provided in all branch ducts and in the main duct on the discharge side of the fan. The holes shall be suitably spaced in accordance with B.S. 848: Part 1, on a straight length of ductwork and, where possible, not less than two metres downstream of any bends or dampers.

After completion of the testing, proprietary metal or plastic plugs shall be fixed to all test holes. The use of rubber or cork bungs shall not be permitted.

4.1.2.11 HANGERS AND SUPPORTS

Ductwork hangers and supports shall be manufactured from rolled mild steel angles or channel sections and shall be of the drop rod or cantilever type. The table below sets out construction and spacing details.

Supports for insulated ductwork shall not be connected directly to the duct stiffening or flanges. The insulation and vapour barrier should be abutted to insulator incorporation with the bearing support. The insulator shall be made from rot and vermin-proof hardwood.

Length of Longer Side (mm)	Drop Rod M.S. Rod Diameter (mm)	Hanger M.S. Flat (mm)	Minimum Bearing (mm)	Maximum Spacing (mm)
Up to 501	10	25 x 3	25 x 3 Flat or 25 x 25 x 3 Angle	3.0
501 to 800	10	25 x 3	40 x 40 x 5 Angle	3.0
801 to 1000	10	25 x 3	40 x 40 x 5 Angle	2.5
1001 to 2500	10	25 x 3	50 x 50 x 6 Angle	2.5
2,251 and Over	to suit loading			

4.1.2.12 DUCTWORK THROUGH BUILDING FABRIC

Where duct work passes through building fabric, the connections shall be by built-in galvanised sheet metal sleeves of the same thickness as the duct.

The sleeve ends shall be finished with mating flanges. Joints between mating flanges shall be fitted with sealing gasket or mastic sealant.

4.1.2.13 PROTECTIVE FINISHES

Within the building, ductwork flanges, stiffeners, hangers, supports, etc. shall be painted with two coats of red oxide or zinc chromate paint before fixing.

Outside the building, ductwork steel sections shall be painted with one coat of red oxide followed by two coats of bituminous paint.

All paints shall be used in accordance with the paint manufacturer's recommendations.

2.1.3 FLEXIBLE CONNECTIONS

Where fans or similar equipment are connected to the ductwork system, the connection shall be made with heavy-duty rot and vermin-proof neoprene or rubberised canvas.

Flexible connections shall be secured by a pre-drilled mating flange. When exposed to outside weather the flexible connection shall suitably be protected from rain.

2.1.4 AIR VOLUME DAMPERS

These shall be provided where indicated on the Contract Drawings.

Damper blades shall be of rigid construction without sharp edges and shall be substantially air-tight.

Butterfly dampers shall be used only where the longer side of the rectangular duct does not exceed 300mm. The damper spindle shall extend to the outside of the duct and shall be provided with locking device on the outside of the duct.

For rectangular ductwork having longer side in excess of 300mm, multi-leaf dampers shall be used. All multi-leaf dampers shall be constructed in demountable ductwork sections, which shall extend beyond the swing of the blades. Provisions shall be made for linkages to connect the multiple extended spindles.

The `OPEN' and `CLOSED' damper positions shall be clearly marked on all dampers.

2.1.5 FIRE DAMPERS

Automatic fire dampers shall be provided where indicated on the Contract Drawings.

These shall be of stainless steel multi-blade construction to provide positive closure and stainless steel spring operated through a fusible link rated at 72^0C.

The damper casing shall be of galvanised 16 gauge steel, with continuously welded corners and spigot connections.

The fire dampers supplied must accompany certification from a recognised fire authority.

2.1.6 DUCT THERMAL INSULATION

4.1.6.1 GENERAL

All supply air ductwork shall be insulated.

Recirculated and exhaust air ductwork within conditioned space shall not be insulated.

Outside the conditioned space both the supply and the recirculated air ductwork shall be insulated.

4.1.6.2 DUCTWORK WITHIN CONDITIONED SPACE

Insulation shall be 25 mm thick expanded polystyrene sheet or spray applied polyurethane foam to a uniform thickness of 25mm.

Polystyrene shall be fixed so that the edges butt without gap and the insulation shall overlap at corners by the thickness of the insulation. The Polystyrene sheet shall be fixed by means of a suitable adhesive and plastic impingement pins attached to the ductwork.

The insulation shall be effectively vapour-sealed by application of two coats of anti-condensation paint.

4.1.6.2 DUCTWORK IN PLANT ROOMS

The insulation shall be identical in all respects to the requirements laid down in Clause 4.06 B with the exception that the insulation shall be finished with 15mm thick layer of hard setting plastic compound trowelled to a smooth finish.

All corners shall be protected by setting in a 1mm thick aluminium angle strip into the hard setting finish.

Insulation of all connecting flanges, access hatches and all other places where operation or maintenance is likely to cause the breaking of insulation shall be levelled at an angle of 45^0.

4.1.6.3 DUCTWORK EXTERNAL TO PLANT ROOM

The insulation shall be identical in all respects to the requirements laid down in Clause 4.06 B with the exception that the insulation shall be finished with two coats of bitumastic paint and clad with 0.80mm thick polished aluminium sheeting.

The cladding shall be fixed in lengths of not less than 1.8 metres and the longitudinal seam shall have an overlap of 25mm and be screwed by self-tapping screws as described above. Joints between lengths of cladding shall be made with a 25mm overlap and sealing with bitumastic and self-tapping screws as described above. At bends the cladding shall be mitred and each section of mitre shall contain an overlap to permit sealing with bitumastic and securing with self-tapping screws as described above.

Joints between lengths of cladding shall be made with a 25mm overlap and sealing with bitumastic and self-tapping screws.

4.1.6.4 DUCT ACOUSTIC/THERMAL INSULATION

Where shown on the Contract Drawings, ductwork shall be internally insulated and insulation shall serve as both thermal insulation and sound attenuator.

Insulation shall be 25mm thick, 24 kg/m^3 density, flame-attenuated glass fibre bonded with thermal setting resin as manufactured by Newalls Insulation Co. Ltd. U.K.

The insulation shall in particular comply with Fire Classification Class 1 surface spread of flame, B.S. 476: Part 7, be hundred per cent non-hygroscopic, shall not be subject to any fibre migration for air velocities up to 25 m/s, and be suitable for temperature range of + 5^0C to + 50^0C.

The insulation shall be fixed in strict compliance with the manufacturer's installation recommendations.

2.1.7 VIBRATION ISOLATION

The Contractor shall be responsible for ensuring that sufficient provision is made to prevent the transmission of vibration from all equipment to the supporting structure and interconnected items of the complete system. It is deemed that the tenderer has included for this requirement in his pricing.

2.1.8 DUCTWORK INSPECTION AND TESTING

4.1.8.1 GENERAL

No ductwork shall be insulated or covered in any manner prior to inspection and testing.

The Contractor shall give adequate notice to the Engineer of his intention to carry out tests in order that such tests can be witnessed by the Engineer.

4.1.8.2 DUCTWORK - TESTING FOR AIR TIGHTNESS

The Contractor shall provide a suitable variable speed portable fan and effective sealing caps for this purpose.

Air leakages shall not exceed the figures stated in the table below:

Working Pressure of Fan (N/m^2)	Leakage (m^3/m^2.hr)	Test Pressure (N/m^2)
0 – 390	4	196
390 – 980	8	685

4.1.8.3 DUCTWORK - TESTING OF FLOW RATES

All fans installed under this Contract shall be charged with suitable lubricant and shall be tested upon completion of the ancillary system erection to ascertain that the performance of each fan complies with the requirements of the Specification. The complete system shall be balanced by means of dampers and other special controls so as to give the required air flows.

Test flow rates must be obtained within ± 5% of the design figures.

Flow rates delivered at air terminals may be measured by the use of a vane anemometer. Flow rates in main and branch ducts shall be measured by the use of a pilot-static tube, through holes of suitable size and spaced in accordance with B.S. 848.

SECTION I

ELECTRIC TRACTION HEALTHCARE LIFT INSTALLATION SERVICES SPECIFICATION

3 TECHNICAL SPECIFICATION FOR THE LIFT

3.1 Extent of work

This sub-contract shall include for the supply of lift equipment, transport to site, offloading, labor installation, fixing, connecting, commissioning and delivering up clean and in working order in every detail the following lift installation.

Healthcare Lift shall be provided where shown on the drawings, and shall be supplied and installed as described herein and shown on the drawings, and in accordance with BS 5655-6:2011, BS EN 81-82:2013, BS ISO 4190-2:2001, local codes & standards and other relevant standards or other equal and approved standards and in conformity with current good practice.

Installation shall include all fixings, machinery and car supports, guides and counter weights, wire ropes, motors and drives, controls and safety devices, hydraulic buffers, openings, trims, and handrails, doors, jambs and tread plates, internal shaft safety fascia plates and other items, necessary for the erection and setting to work of the equipment, all in accordance with this Specification and the Drawings herewith, and rendering the Healthcare lift fully operational to the complete satisfaction of the Engineer .

3.2 Energy Efficiency

Lift should be installed to meet industry energy efficiency standards, in this respect; the lift supplier shall install energy efficient lift.

Variable-voltage, variable-frequency, regenerative type drives shall be used.

Lift car lighting should be of a low energy type and should decrease to a lower level of energy consumption after a period of inactivity in excess of 5 min in accordance with ISO/DIS 25745-1:2008. The lighting should be restored to the normal level as the result of:

- the lift starting to move;
- the doors opening;
- a destination pushbutton being operated;
- Any other pushbutton on the car operating panel (*COP*) being operated.

Lift controllers should be placed in standby mode after 5 min of inactivity in accordance with ISO/DIS 25745-1:2008. In practice only the basic control should remain in operation.

3.3 Drawings

The work carried out under this contract shall be in accordance with all Drawings issued herewith.

The Sub-contractor shall provide two copies of his own working drawings for approval prior to commencing installation of the equipment. The drawing shall show the builders' work required.

3.4 Healthcare lift general requirements

The lift shall be electrically operated and shall serve the floors as stated below. The building shall be provided with an emergency generator. In the event of mains failure, the lift stop, cancel all calls and then using the stored battery power supply, the cars proceeds to the Ground Floor, stop and the doors remain open. Thereafter the lift would not be in service until mains power is restored.

The finished appearance of all equipment and components exposed to public view is required to be of a high architectural standard, and all panels, covers, trims, materials and finishes shall be included and provided accordingly, to the satisfaction of the Engineer. In particular, screw fixings to cover panels and the like shall be avoided unless specifically approved in each case.

The lift shall be **Class III, Healthcare lift** (*Lift designed for including Hospitals and nursing homes*) as per BS ISO 4190-1 and BS ISO 4190-2.

1 NO MACHINE ROOM-LESS (*MRL*) ELECTRIC TRACTION HEALTHCARE LIFT (TO SERVE THE MEDICAL CENTRE)

Basic Data for Healthcare Lift (TO SERVE MEDICAL CENTRE)	
No of lift	Two
Lift Type	Healthcare lift – Machine Room-Less System (*MRL*) (*to BS 5655-6:2011, BS EN 81-82:2013, BS ISO 4190-2:2001*), Class III, Category a – to fit (Bed dimensions 900 mm x 2 000 mm).
Nominal Capacity	1 275 kg
Speed (v_n)	1.0 meter per second
Number of stops	2. stops
Floors served	Ground floor and First floor.
Travel	8.785 meters (*approximately – subject to confirmation*)
Motor Room Position	Not Applicable
Power Supply	415V, 3-phase, 50Hz
Number of openings	2 openings in line
Operation	Group-collective control
Special operation	- Key operated priority - Call for emergency, use automatic re-levelling of lift car, independent service, fireman service and stand-by power operation - Automatic bypassing of landing calls, when a car is fully loaded - Touch-sensitive car operating panel (*COP*)
Control	Microprocessor with A.C. Variable Voltage, Variable Frequency drive (VVVF) system
Drive	Gearless
Car Internal size	1 200mm Width x 2 300mm Depth x 2 300mm Height
	(b_1 x d_1 x h_4)
Compensation	Rope, when travel exceeds 50 meters (*chain compensation will*

	not be acceptable)

Buffers	Hydraulic
Landing Doors	Double panel automatic side opening, 1 100mm x 2 100mm (b_2 x h_3)
Car Doors	Power operated, two panel center opening sliding doors
Door Operation	Medium speed, heavy duty, intensive traffic
Signals	Call acknowledging lights and gong, waiting hospital lanterns, at all openings
Lift Car Control	Two lift control panels

3.6 Lift well and openings

Healthcare Lift

Details of lift well, and openings are shown on the drawings.

Well Size: 2 100mm Width x 2 900mm Depth (W_w x W_d)

Height above the highest level served (*headroom*): 4 400mm (h_1)

Pit Depth: 1700mm (d_3)

Clear entrance: to be specified by lift sub-contractor.

Rough openings for the landing doors: to be specified by lift sub-contractor.

The Sub- contractor shall ensure that his equipment will fit the spaces provided, or in the event that he is unable to meet this requirement, shall clearly indicate what alterations are necessary, the cost of which is to be included in his Tender Price.

The Sub-contractor shall ensure that all rough openings in the lift wells are constructed of dimensions suitable to accept his plant and equipment, and shall provide and fit all trims, doors, jambs and other items accordingly. Additionally, he shall supply and install all guide rails, clamps, structural supports, spacers, guards, tread plates, sight guards, internal shaft safety fascia plates and other items necessary for the complete installation and setting to work of his equipment.

3.7 Machinery space

Spaces for the lift machinery are shown on the Drawings. The Sub- contractor shall layout and install his equipment in the spaces provided, having proper regard for ease of access for maintenance and inspection, and for the safety of maintenance staff. He shall ensure that adequate ventilation is provided to his plant, and shall co-ordinate with work being carried out by the electrical Sub- contractor in terms of location of lighting fittings in relation to his equipment, and any other such items.

All doors or panels provided to give access to machinery and equipment spaces for normal maintenance purposes shall be secured against unauthorized access. Opening, or removal, of such doors or panels shall expose a permanent notice reading:

DANGER, UNAUTHORISED ACCESS PROHIBITED.

The characters shall not be less than 13mm high. The notice shall not be affixed to the back of the door or panel.

The following information with respect to the machinery must accompany the tender:-

Make
KW Rating
Size
Voltage
Power consumption at full load, kW
Revolutions per minute, rpm
Full load current
Starting Current
Duration of Starting Current
Power Factor, cos -φ
Acceleration time, sec
Retardation time, sec

The motors must be provided with overload and phase failure cut-out devices. The machine shall be provided with a manually operate turning device for lowering the car to the nearest landing in case of power failure. The system must prevent engaging of the turning devices, until the power supply for the motor is switched off.

The motor, when not in operation, has to start automatically by the registration of a call. Any steel structures or supporting beams for machinery are included in this contract.

If the Sub-contractor finds it necessary to place the machinery on special concrete foundations, the Sub-contractor must do this.

The total lift motor and drive mechanism must be dimensioned for the full load in continuous operation and for a temporary overload of 10%.The Sub-contractor must provide information about the heat produced by the entire installation.

A danger notice with the words "*DANGER, LIFT MACHINERY, UNAUTHORISED ACCESS PROHIBITED*" shall be fitted on the lift motor room door by the Sub-contractor.

3.8 Ropes and sheaves

The lift shall be provided with car and counterweight ropes that shall be of traction steel of suitable size, construction and number to ensure proper operation of the lift and give satisfactory wearing qualities. Sheaves to be made of best grade steel, turned true and grooved for the ropes.

The sheaves shall be of ample diameter for the ropes used, and should have a ratio of sheave/rope diameter of not less than 40:1. Sheaves shall be fixed by means of iron beams, which are supplied and installed by the Sub-contractor.

Beams must be sound insulated from structural parts.

3.9 Shaft installations

Guide rails for car and counterweights shall be provided. The Sub-contractor shall ensure that the rails are placed accurately and fixed firmly to the shaft walls with sufficient spacing between brackets.

The fixing of rails and connection between two or more sections of rail must be in such a manner that the straight and vertical position is not influenced by changes in temperature or ordinary settlement of the structure.

The hydraulic buffers shall bring the car and counterweight to rest at the extreme limits of travel, should the car for any reason pass the limit switches.

3.10 Lift machinery and associated equipment

These shall be completely NEW and shall be of the variable frequency, variable voltage, and group-collective or full-collective control operation (*or as indicated elsewhere*).

Lift machine shall be entirely suitable for the application and designed to operate on the electricity supply provided, i.e. 415/240 Volt 50 Hz A.C.

Various parts of BS 5655-6:2011, BS EN 81-82: 2013, BS ISO 4190-2: 2001 and other relevant standards shall be strictly adhered to. In particular attention shall be applied to motors, gear reduction units (*if any*), brakes, emergency lowering, lift guides, counterweights, buffers, safety gear, lifting ropes, levelling and clearances, limit switches and all safety considerations.

The lift Sub-contractor is to supply and install all necessary safety equipment for the safe operation of the lift, including all lift shafts internal safety fascia plates, fixed so that a Healthcare cannot trap any part of his body should the lift doors be opened between floors.

3.11 Lift drive system

The lift drive system shall be of the geared type designed to operate at 1.0metres/sec with a duty load of 1 275 Kg (*for Healthcare lift*). It shall have the variable voltage, variable frequency microprocessor motor control.

The main motor shall be rated for 150 starts/hour and shall operate without vibration, overheating or noise.

Control of the motor shall be provided by a fully closed loop microprocessor system that shall include the following:-

1. A high resolution optical speed encoder, mounted directly onto the motor with a resolution of one pulse/mm of car travel.
2. An electronic load transducer located under the car capable of detecting load changes of 20 kg.
3. An optical position encoder connected directly to the car and capable of measuring 0.4mm movement.
4. A solid state car mounted transducer to verify final floor level position to within 6mm.
5. An alternating current, variable voltage, variable frequency geared drive system.

The system shall continually monitor car speed, and position and compare its results with a software based flight reference. Any error between reference and actual speed shall be corrected, within 2 milliseconds. Flight reference shall be fully programmable.

Acceleration rates shall be adjustable but when set at 1.2 m/s^2 shall provide the following minimum performance;

Jerk, to be less than 2.5 meter/sec/sec

Levelling ±3mm

3 meter flight time brake to brake 4 sec

The following features must also be provided:

1. Main motor over speed and current protection.
2. Drive over-current protection.
3. Drive over temperature protection.
4. Self-Diagnostics.
5. Ability to know car position at all times even during temporary loss of MAINS POWER

3.12 Controllers

Lift controllers shall be of the totally enclosed, heavy duty sheet steel cubicle type so mounted in the lift car to give free access to front and rear wiring connections.

An earthing terminal shall be provided on the controller, fitted with a removable link or other easy means of disconnecting. This terminal shall be clearly labelled EARTH.

Provision shall be made for operating the lift from the motor location but such provisions shall be inoperative unless all landing and car doors are closed. Push buttons shall be provided on the controller for this purpose and a changeover switch incorporated to render the car interior and landing buttons inoperative when a lift is being operated from the motor location.

An overriding SAFETY control switch shall be provided on the top of the lift cars, and with provision for operating the lift car from on top of the car.

The controller shall be fitted with a phase failure and phase reversal relay control. The controller shall be complete with all equipment and protective devices necessary for the control and operation of the lift as specified herein.

The lift shall have its Alarm System. An alarm siren will be fitted within 2 meters of the lift shaft main landing. The system shall be complete with batteries and fed by a trickle charger.

3.13 Control system

The Sub-contractor shall provide separate fully microprocessor based lift control systems each capable of operating one lift.

Each lift shall have its own controller housed within a sheet steel purpose made cabinet.

The cabinet shall be designed for front access only via lockable doors.

The cabinets shall be ventilated via louvres in the doors. These shall have dust filters provided to ensure only clean air enters. Within the cabinet a fan shall be fitted to ensure good air circulation.

Cabinets shall be spray finished in the manufacturer’s standard colours.

All fuses shall be of the cartridge type. Transformers shall be floor mounted and earthed. Relays and contactors shall be AC3 or AC4 category as applicable and adequately rated for this purpose. Wire terminations shall be of the plug in or screw type with easy access for testing.

Microprocessor and input-output cards shall be rack mounted and self-locking through insertion.

Short circuit, over temperature, phase failure and rope slippage detection shall all be included.

The controller shall have the following operation control modes in its basic form. Full operation and independent service.

The controller shall have full calculation capabilities so that operation relies upon single controller.

During operation calls placed in the system shall be allocated to the car capable of answering them in the shortest time. To do this the lift controller shall consider the following each time a call is entered. Its car position, car calls registered, car calls allocated, distance from call, drive status (*stopped or running*) coincident calls and load in the car.

The system shall be capable of learning building traffic patterns throughout the day and use this information within the call allocation program to ensure optimum service at all times.

Communications between controllers, control to car and hoist way equipment shall be by serial link, with the exception of the safety items. The control system shall be fully re- programmable via a plug in test tool. It shall be possible by use of the tool to check all lift operations including group and safety circuits.

The system shall also have a self-diagnostic facility to speed up fault location.

An RS 422A or RS 232 communications port shall be provided for future connection to a lift management system linked to a remote elevator monitoring system for remote monitoring of the operations of all the three lift by the manufacturers and automatic sending of alarm to the manufacturers in the event of a failure.

The control system shall be designed to EN81, BS 5655, and be fully tested before delivery and during commissioning and shall be **BMS (*Building Management System*) compliant.**

3.14 Lift car and landing doors

The car and landing doors shall meet the following specifications. The entrance to the lift car to be provided with power operated, two panel center opening sliding doors (*or as indicated elsewhere*) guided at the bottom by non-metallic shoes sliding in suitable grooves. Lift doors shall be installed both in the car and floor landings.

The lift car must be stopped and prevented from moving should a door be forced open. The car doors and the landing doors must open automatically when levelling; the opening to start as the car is approximately 250mm from the landing.

All doors to the Healthcare /Service lift shall be solid type of metal construction. The landing and car doors to the lift shall be similar and of approved design, and shall be hung on overhead runner bars and guided by self-cleaning tracks in cast or fabricated metal landing and car sills, all arranged to ensure easy running for automatic power operation. The design should have been fire tested in accordance with BS 476-10: 2009 and designed for a two-hour fire classification.

A safety shoe is to be fixed to each door, the operation of which will reverse the movement of the car and landing doors to the fully open position. In the event of failure of the power operating mechanism, it shall be possible to manually open the car and landing doors at any landing at which the car is standing, by the use of an emergency opening key.

Health protection shall be provided by the use of an electronic proximity detector mounted on the leading edge of the car doors. This shall provide a three-dimensional zone of detection in advance of the car doors and detection of an object within the zone shall cause the doors to immediately re-open.

Car and landing doors for Healthcare lift shall be power operated for automatic opening and closing by means of an approved motorised operating gear fixed to the top of the car. It shall provide high-speed operation of the doors and shall have variable speed control. The door operating gear should be capable of opening the lift doors in 1.20 seconds and closing the doors in 2.50 seconds, totally 3.70 seconds for both operations. Smooth operation of the doors shall be achieved.

The controls shall be so arranged that the car and landing doors work in unison, and all doors must be closed before the lift can move. The parking condition shall be with the doors closed.

Electrical and pre-Locking mechanical door locks shall be fitted to the landing doors, such that it is impossible for the lift to start until the lock lever has fallen into the mechanically locked position. The car doors, or car gate, shall be fitted with an electrical interlock such that it is impossible to operate the lift until the door or gate is closed. A bilingual notice shall be affixed to the car gates to this effect.

All electro-mechanical switches and locks shall be arranged for gravity release of switch arms in the event of breakage of any release springs.

It shall also be impossible under normal conditions to open any of the landing doors, other than that at the landing where the car is stationary .For the purposes of maintenance, however, facilities shall be provided for authorised persons to open any of the landing doors or car doors irrespective of the position of the car in the lift shaft, and such facilities shall be concealed and or locked.

An emergency release mechanism should be included with the interlock. In the event of an emergency (*or for maintenance*) the landing door should be capable of being opened from the landing with an emergency release key. The landing doors should also be capable of being opened manually from inside the lift car, when within the door zone area.

Noise levels produced by the operation of the doors when measured one meter from the landing side shall not exceed 48 dBA.

The complete entrance and operator should comply with the recommendations of BS 5655, BS EN 81-82: 2013, BS ISO 4190-2: 2001.

The Sub-contractor shall provide new car doors complete with operators, interlocks, safety devices and sight guards, and all landing doors similarly and including frames, architraves, jambs and other items complete. Door joints shall be heavy gauge pressed type of approved section and material.

Healthcare lift car should be capable of generating voice-synthesized announcements, of sufficient sound level to overcome background noise, and to announce door actions (*opening and closing*) as well as the floor level and direction of travel as the lift arrives at a landing. Emergency signals received from a fire alarm or building management system can also be announced by the voice synthesizer.

Car and door designs are described separately herein-

Landing Doors	Power operated, two panel side opening Sliding doors 1 100mm wide by 2 100mm high (*for Healthcare lift*) Mild steel with primer, undercoat and **Hairline steel top finish** to a good standard and to meet the Architect's requirements
Door Surround	Box section architraves at all levels Constructed of Mild Steel, painted to Architects color scheme
Landing Sills	Stainless Steel together with supports and Toe guards at each entrance.
Landing Indicators	Directional micro-movement touch screen buttons at each landing. The buttons when pressed will indicate by Light Emitting Diode

	(*LED*) that the call is accepted Illuminating up and down direction arrows with gong will pre-announce the arrival of the car and be fitted above each entrance at all levels. Electronic proximity card reader unit to ISO/IEC 14443, in addition to call button

3.15 Lift car

The Sub-contractor shall supply and install the lift car complete. The car frame which supports the car platform and enclosure shall be made of solid structural steel with welded, bolted or riveted joints. Bolts used must be positioned for easy adjustment. Where practicable, car dimensions should conform to the recommended standards set out in BS 5655, BS EN 81 -82: 2013, BS ISO 4190-2: 2001. The car shall be rigidly constructed and affixed to the car frame.

Car body shall be constructed of solid 25 mm seasoned timber or other approved materials, and the car body work of not less than 15mm waterproof ply. The whole car shall be sustained by a rigid metal framework. The car roof shall be provided with the necessary working platforms, complete with light and switch, isolating switch for lift power, and electrically interlocked access hatch from within the car.

Ventilation shall be provided to the car, by means of a silently operating fan in the car roof of not less than 250mm diameter, with on-off key switch control on the car panel, and arranged to operate continually except when the car is parked.

A telephone recess shall be provided, complete with fixed and trailing cabling from the telephone point to be provided and connection to the handset supplied under this contract. Recess shall be neatly trimmed and finished and fitted with a door, spring, latch, clear glass or Perspex vision panel, and instruction notice in suitable permanent material to future detail.

Car lighting shall be provided with LED lighting, with output equivalent to not less than output of 2 x 18 watts fluorescent tubes of suitable colour and temperature, key switch controlled, and in addition an emergency incandescent battery light shall be provided, and fitted to approval in a position above the car control panel

3.16 Car and door finishes

Internal Dimensions (*1 275 kg*)	Width: 1 200mm (b_1) Depth: 2 300mm (d_1) Height: 2 300mm (h_4)
Ceiling	Sheet Steel finished in high grade textured short velvet. Colour to be approved by the Architect from deluxe range
Lighting	Direct lighting shall be provided through a protruding translucent plastic diffuser.

Handrail	A handrail shall be furnished and installed on two side panels and the rear panel.

	It shall be of anodised aluminium and shall be at a height of 900mm from car floor
Rear wall	One-third wall to be full height bronze tinted mirror Remaining two thirds to be mild steel finished and to be approved by the Architect
Side walls	Gnarled wood decorative or laminated panels to be approved by the Architect.
Front return and transom	Clad in satin finished stainless steel.
Car doors, material and finish	Power operated by a quality variable speed D.C. motor and shall have positive-control over the door Doors to be two panel side opening sliding doors 1 100mm wide by 2 100mm high Hairline steel interior surface and Visible
Landing doors, material & finish	Hairline steel to match car doors, exterior surface and visible edge to meet the Architect's approval
Floor finish	3mm artificial granite tiles to approval of the Architect. The floor shall be fitted with a 150mm high skirting of stainless steel.

All details of colour and type of finishing shall be approved by the Architect before commencing manufacture.

3.17 Car operating panels

The car shall be provided with a flush control panel of approved design and construction, located adjacent to the side of the car door.

The panel shall accommodate a touch screen press -button for every floor served, a red emergency stop button, an alarm button, and key switches for car lights and fan.

A suitable matching car position and direction of travel indicator of the illuminated type shall be flush mounted at each landing above the landing door.

3.18 Car Operating Panel

The car operating panel shall be flush mounted on the both sides of the car enclosure. The individual modular units to be mounted within a satin finished stainless steel panel and suitable for ease of operation by handicapped persons.

The car operating panel shall contain the following:-

i. Full set of micro movement buttons to correspond to the number of landing levels served, with RED indication of call
ii. Emergency Stop Switch
iii. Alarm Button
iv. Door Open Button
v. Door Close Button
vi. Switch for Fan
vii. Emergency Lighting Unit
viii. Digital car position indicator
ix. Key-Operated switch for independent service
x. Car direction indicator
xi. Overload display
xii. Interphone Unit

3.19 Operation and control of lift

The lift shall be automatic push button controlled from within the car. The operation of a button shall initiate door closing, travel of the lift to the floor selected, and the automatic door opening.

Landing call panels shall be provided accordingly, with up and down buttons and out of service notice of the type which is visible when illuminated.

Panels shall be of approved layout and design.

Appropriate time delays shall be fitted to these functions as necessary, and the empty car, after standing for a selected waiting period, shall assume the parked position with the door closed.

3.20 Buttons

The car and landing call buttons shall be of the touch screen type and utilize solid state electronics with Light Emitting Diode (*LED*) illumination arranged as a halo around the button. The halo should illuminate in red/green.

Service buttons shall be of touch screen type and be identical in appearance to the car and landing call buttons.

3.21 Car button indicators

The car position indicators shall be red, 16 segment LED's 50mm high and capable of a full alphanumeric display. The LED's shall be protected by a high impact resistant polycarbonate lens.

3.22 Hall position indicator

At each landing and above the lift door a digital floor position indicator will be supplied and fixed.

Hall position indicators shall be provided at each landing and consist of 16 segment LED's protected by an impact resistant polycarbonate lens.

A "Lift Busy" indicator shall be fitted on each landing of the goods lift.

3.23 Hall lanterns

Hall lanterns shall be provided at all floors above the lobby to advise waiting Healthcare s of the travelling direction of the approaching lift.

The lanterns shall be red on all the other floors but green at the ground floor.

The light source shall be a matrix of high intensity LED's which illuminate sequentially to give the illusion of motion in the direction of travel.

The lanterns shall have a wide field of view and have an illumination test facility.

A digitally recorded chime facility shall be provided within the lantern and shall have an adjustable volume control.

The hall lantern shall be framed with a satin finish stainless steel and protected with a high impact resistant polycarbonate lens.

3.24 Lift switchboard and electrical installation

Three phase 415/240 Volt 50 Hz electricity supply is to be provided to all the lift switchboard positions by the electrical Sub- contractor. **The Lift Sub-contractor shall supply and install the lift switchboard complete with main isolators, circuit protection,** and other items as necessary, carry out all further wiring in connection with the lift installations, and set to work.

All motors and switchgear shall be rated for operation at 240V/415V 50Hz. Relays and components must be tropicalized.

(i) The installation must comply with the lEE wiring Regulations (*BS 7671*). All wiring shall be carried out in a neat and orderly manner. Cables run on walls or ceilings to be in a straight line and right angle bends enclosed in steel ducting.

Connections to equipment more than 400mm from walls shall be run from the wall in conduit cast in the floor to a connector box fixed upright adjacent to the equipment and through flexible conduit to the equipment.

All electrical switchgear must be clearly labelled.

All fixed wiring shall be installed in screwed steel conduit, and all equipment, main isolators, controls, and other items provided as specified herein. All trailing cables shall be to BS EN 50214:2006 and properly supported, fixed and terminated.

Contactors and their components shall be rated for frequent duty, and shall be amply sized in terms of current rating.

All electrical apparatus must be adequately suppressed in order to prevent interference with radio, television, radar and other similar equipment to the satisfaction of the Engineer.

The entire installation shall in each case be effectively bonded and earthed.

3.25 Silence of operation

The Sub-contractor shall guarantee the lift installation, gear and moving parts to operate in a smooth and silent manner without vibration or jerks to the satisfaction of the Engineer. All lift supports shall be of suitable dimensions to carry lift gear and shall be of sufficient strength to withstand rigidly the operational stresses. All supports and gear shall be fixed with suitable anti-vibration and sound insulation material.

The Sub-contractor shall include in his tender for the supply and installation of all necessary anti-vibration material, which shall be of an approved make.

3.26 Tests

The lift will be subject to tests during erection and on completion by the Engineer, and will not be accepted unless they comply with all the conditions and specifications.

The whole or part of the equipment may be inspected by the engineer at the maker's Works before delivery and the lift manufacturer shall provide all facilities for such inspection.

After erection the following tests shall be included in the series of tests which shall be carried out in the presence of the Engineer or his duly appointed representative:-

a) that speeds comply with the specification
b) the car to be loaded to 10% over specified full load and the lift operated for complete travel
c) both up and down directions
d) determine that all safety devices comply with conditions and specifications, and that all electrical and mechanical braking equipment compiles with the specifications
e) determine suitability of switch gear and wiring
f) determine that current consumption complies with that quoted in the Tender

The Sub -contractor will be required to provide all necessary instruments for carrying out tests including insulation resistance of the wiring.

3.27 Schedules

The Tenderer shall complete the schedules provided herewith, and shall submit such further information as is required or as may be necessary in order to fully describe his equipment and installations.

3.28 Certificates upon completion

Upon completion of the lift and after commissioning to the Engineer's satisfaction it is the responsibility of the lift Sub-contractor to provide a full set of lift tests and inspection certificates in accordance with BS 5655 (*EN 81-2*).
In addition a full set of certificates completed in full and signed and approved by the Kenya Government Factory Safety Inspector is to be provided. It will be Sub-contractor's responsibility to get the lift approved.

3.29 Spare parts

The Sub-contractor shall guarantee to hold complete stock of spare parts at all times and provide qualified staff trained in maintenance of the type of lift used, to maintain the lift equipment in good working order. Should any spare part not be available locally or local technicians not able to rectify faults, the Sub-contractor shall provide an undertaking from their principals to supply the necessary spare parts and send technicians within seven days of such occurrence, at their own cost. A written undertaking by the principals shall be included as Appendix A to this Contract, and shall form part of this Contract.

3.30 Maintenance agreement

The Sub -contractor shall submit a detailed proposal for a five-year maintenance contract after expiry of the initial 12-month maintenance period, which, after agreement with the Employer, shall constitute a part of this Contract.

3.31 Lift not in immediate use

When conditions do not permit the lift to be taken into normal service immediately following completion and acceptance, it should be immobilized. The Main Contractor should take effective precautions against damage, especially damage to equipment from dampness and builders' debris, until such time as the lift are made operational. A separate service contract shall be made with the lift Sub -contractor to make regular visits during this period, to inspect, lubricate and report on the condition of the lift. As this is a sub-contract, such necessary service contract shall be made with the Main Contractor. During the inspection it is desirable that the lift shall be moved under power. A date should be agreed with the lift Sub-contractor from which the guarantee period will commence.

3.32 Temporary use of lift

If the Sub-contractor intends to permit temporary use of a lift by some other party such as the Main Contractor, before taking it into normal service, so that it is not immobilized, then the responsibilities of those concerned should be clearly defined and agreed. In addition to the precautions noted in Clause 3.31 above, it may be necessary to arrange temporary insurance cover.

SECTION J

STAND BY GENERATOR SET WITH SOUND PROOF ATTENUATOR SPECIFICATIONS

2. **GENERAL SPECIFICATIONS OF MATERIALS AND WORKMANSHIP:**

2.1 **MATERIALS GENERALLY:**

The Generator Contractor shall include for the supply, testing, delivery and installation of all materials necessary to complete the Works, as specified and scheduled, notwithstanding that such materials may or may not be specified in detail.

Where relevant, materials shall comply with British Standard Specification. Where applicable, all materials and equipment shall be tropical finish.

2.2 **ENGINE**

The engine shall be tropical radiator, automatic mains failure plant, developing at 1500 RPM at site and in accordance with BS ISO 3046-1:2002, continuous rating.

2.3 **ENGINE TYPE**

The engine shall be turbo charged, vertical, heavy duty, four, cycle, compression ignition type to be designed for stationary duty.

2.4 **FLYWHEEL**

The flywheel shall be of the solid disc type, accurately balanced.

2.5 **LUBRICATION**

Lubrication shall be by force feed to the main and large end bearings, camshaft, valve rocker gear and timing gear. An oil temperature stabilizer shall be fitted in the system. A suction strainer shall be provided in the oil sump and a full flow fabric element type lubricating oil filter be incorporated in the system. An oil pressure gauge is to be provided. Low oil pressure shutdown device shall be incorporated in the system with visual indication.

2.6 **COOLING**

Fan assisted radiator of tropical capacity with pusher fan and high water temperature shutdown device.

2.7 **ENGINE PANEL**

Mounted on the engines incorporating the protection:

(a) One water temperature gauge. (*High water temperature*)

(b) One oil pressure gauge. (*Low oil pressure*)

(c) One over speed

2.8 **SILENCER:**

Critical Grade Exhaust Silencer of length 4 meters (*self-supporting*) measured from top of generator, complete with all installation materials

2.9 **STARTING:**

The engine shall be suitable for 24 volts starting by means of an axial type starter arranged to engage on toothed ring on flywheel in conjunction with two heavy duty, 24 volt maintenance-free batteries. Arrangements shall be made to re-charge the above batteries by means of a fully automatic, solid state battery charger which automatically adjusts the charging rate to suit the state of the battery; this shall be connected to the maintained supply of the unit.

2.10 **COUPLING**

The engine shall be coupled to the alternator by means of the flexible coupling effectively guarded against accidental handling.

2.11 **ALTERNATOR**

The alternator shall be of brush less type, screen protected, fan ventilated, drip-proof designed to develop 250kVA, 200kW. At 0.8 power factor, standby rating, 415/240 volts, three phase, four wire, 50 hertz at 1500 RPM on site.

They shall be fitted with heavy duty hall or roller bearing with suitable lubrication and packed with suitable grease and constructed in accordance with B.S.S.2613/1970, class 'E' tropically insulated.

Voltage regulation is to be maintained within limits of $\underline{+}$2.5% from no load to full load including cold to hot variations, at any power factor between 0.8 lagging and unity and inclusive of speed variation of 4.5%. Nominal voltage shall be set by means of a hand trimmuner mounted on the switchboard.

The wave form shall be in accordance with B.S.S.2613/1970, limiting total harmonic deviation to 5%. Response to transient load charges shall recover to within 3% of the steady state value in 0.3 second upon application of full load at a power factor of 0.8 lagging.

Radio and television interference suppression shall be fitted to comply with BS 3046-1:2002.

2.12 **BASE PLATE**

The unit shall be mounted on a heavy fabricated steel base plate manufactured from first quality rolled steel channel, electrically welded with machined mounting pads for engine and alternator and provided complete with holding down bolts of a suitable size and length. Anti-vibration mounting of the cushy foot type as manufactured by Metalastic Limited or equal and approved shall be provided. A fuel tank shall be incorporated in the base plate.

2.13 **SWITCHBOARD**

The changeover 450 Amps contactors together with control system remain as part of the main board. This means that they will not form part of the generator control panel (*will be done by others*).

The instruments panel shall be either separate floor mounting unit or will be mounted on the generating sets and will generally have the following:

i) 1 No. voltmeter 0-500 V – 96 mm x 96 mm with 7 position selector switch to read phase to phase and phase to neutral voltages with 2 Amps protection fuses.

ii) 1 No. Ammeter 0-1500 Amps – 96 mm x 96 mm with 4 position selector switch to read phase currents complete with 3 No. 1500/5A CTs

iii) 1 x Hourmeter

iv) 1 x Frequency meter

v) 1 x Battery charging ammeter

vi) 1 x Solid state battery charging unit

vii) 1 x Voltage trimmer

viii) 1 x Hand-Off-Auto selector switch

In hand position the generator will be started/stopped by means of start/stop push buttons.

In auto position the generator will start/stop by means of remote volt-free contact. In this position on removal of the remote signal the engine will continue to run for cooling down for a pre-determined time (*adjustable*). The system will also be provided with a 3 start attempt relay.

ix) One set of indicating lamps to show:

Low oil pressure
High water temperature
Alternator failure
Overspeed
Under speed
Failed to start

x) Push buttons for:

Reset
Lamp test
Emergency stop

xi) Volt-free contacts will be provided as follows:

Genset failure – for BMS system
Genset running – for BMS system
Genset failure – for generator selection
Control system (*by others*)
Fuel low (*in base tank*) for BMS system

xii) 1 x 450 Amps 3 pole + neutral MCCB in an enclosure with non-ferrous glanding plate and approximately 500 mm cabling space for terminating 4-core 240mm^2 XLPE/SWA/PVC copper cables.

2.14 **FINISH**

The supplier shall state the type and colour of oil proof enamel paint.

2.15 **ACCESSORIES**

The sets shall be supplied with the following per generator:

One kit of standard tools to approval
One foundation drawing
One circuit diagram
One electrical instruction book
One comprehensive instruction book
One set of necessary spares list and spares that may be required for the future maintenance.

2.16 **FINAL CONNECTION**

Connections of the generating sets at switchboard end and on generator MCCBs will be made by the electrical contractor. These connections at the generator end will be supervised and confirmed by the generator supplier.

Note: The generator sub-contractor will supply and connect the cables between the generators and switchboard. The electrical sub-contractor will provide the necessary cable ladders, trays, etc. Connection of the cables between the generator and switchboard will be done in liaison with the electrical sub-contractor.

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SECTION 3

PARTICULAR SPECIFICATIONS OF MATERIALS AND WORKS

These specifications apply for the Generator set

3.01 GENERAL:

The work covered by this Specification includes the supply, delivery, installation, setting to work, commissioning to the satisfaction of the Engineer and maintenance for a period of twelve months 1 No. 250 kVA diesel engine generating set with sound proof for standby output at 415/240V and 50 Hz.

The sets shall be supplied complete with control panels, sound attenuated enclosures (*to IP23*) (*sound proof attenuator*) designed to limit the noise level to a **maximum of 18dBA to 25dBA at full load measured at 7 metres (*Level II Sound Attenuated Enclosure*)** and all ancillary equipment necessary for its operations.

The following shall be done to electrical engineer's approval:
The sets shall be designed and supplied with heavy structural steel bases for bolting unto concrete plant plinths on robust anti-vibration and shock absorbing devices. They shall have adjusting screws for optimum setting and levelling and be so designed and installed that no appreciable engine vibration shall be transmitted to the floors or to any surroundings.

Engines and alternators shall be flanged together in true alignment so that no further alignment shall be necessary on site.

The construction of any generator room/house, the foundations and the provision of fixings for the bolting down of the set shall be carried out by the Building Contractor. The Generator Contractor shall provide early enough full details of fixing requirements.

Unless otherwise indicated, the set shall be capable of operating in a medium dust-laden atmosphere as defined in BS ISO 5011:2014 and in accordance with BS EN ISO 10581:2013.

The equipments and all components shall be suitable for operation in ambient conditions of 5^o to 40^o and up to 100% relative humidity in an unheated ventilated building at an altitude of 1750 m above sea level.

Within the operating conditions specified, the set, equipped with the standard air intake filters, shall be capable of delivering the specified output continuously at rated voltage and 0.8 lagging power factor and of delivering 10% in excess of the maximum rating for a period of one hour.

The steady state voltage shall be maintained within 2½% of the rated voltage, from no load to 10% overload and from unity to 0.8 lagging power factor. Sudden removal of the full load at rated frequency shall not cause the frequency to rise above 110% of rated frequency. If full load is then re-imposed, the frequency shall not fall below 94% of rated frequency.

All components shall be fully tropicalized and protected against mould growth.

All ferrous metal work shall be either painted or processed to give a rust-proof coating of heat and oil resisting quality.

3.02 **ENGINE**

Within the limits of the operating conditions specified, both engines, equipped with its standard air intake filter shall be capable of delivering 200 kW for a period of one hour.

The governor shall be able to maintain the frequency between 94% and 110% at any change of load.

Unless otherwise indicated, the engines shall be designed for satisfactory operation on fuel oil complying with BS 2869:2010+A1:2011.

No significant critical speed of the complete shaft system, including the generator, shall be within 15% on the rated speed.

A manually reset over speed trip shall be fitted to stop the engine if its speed exceeds the rated speed by 15%. A mechanical trip is preferred but an electrical over speed trip may be offered. Both types may be equipped with a pair of contacts which close on operation of the trip. If the device is belt driven, at least two belts shall be provided and the drive shall be capable of carrying full load with one belt removed.

3.03 **STARTING**

Starting shall be by means of electricity supplied from maintenance-free batteries. The starter motors shall be of the axial type, de-energized by a device operated from the engine.

Suitable means shall be provided for turning by hand the engine mean shaft and the associated generator to facilitate inspection and overhaul.

3.04 **MAINTENANCE**

The Contractor shall maintain the complete sets and associated control equipment forming the unit for a period of twelve calendar months from the date that the unit is put into commission and regular use.

During this maintenance period, the Contractor shall at his own expense:

(1) Make good any defects in the units and replace any parts that fail or show signs of weakness or undue wear in consequence of faulty design, workmanship or materials.

(2) Visit the site and with all diligence attend to any such defect that arises within 48 hours of receiving notification of the defect.

(3) Carry out regular examination and servicing of the unit every three months, the service and examination to include all necessary adjustments, greasing, oiling, cleaning, changing of lubricating oils (*Where necessary*) to keep the unit in sound and efficient working order.

(4) Instruct the maintenance personnel in the proper operation, care and maintenance of the set and its equipment.

If during the maintenance period the unit is, or is likely to be, out of use for a period greater than 48 hours, due to the unit or part thereof developing a defect attributable to faulty design, workmanship or materials, or neglect of maintenance by the Contractor, the Contractor shall, at his own expense, immediately provide and install on free loan a suitable temporary unit for use until the required repair or replacement has been satisfactorily undertaken and the original set (or its replacement) put into proper working order.

At the end of the twelve months period of maintenance, the Contractor shall (*in addition to the normal quarterly servicing work*) carry out a comprehensive examination and test on the set and its auxiliaries, including the checking of the operation of controls and safeguards, to ensure that the unit is in proper working order and in satisfactory condition for handing over to the client whose representative shall be present at such examination and test.

(5) Check that all radiator and engine block water drain points are free from sludge and other blockages.

(6) Check engine bolts, main drive couplings, valve clearances, fuel pump settings, governor settings, pipeline connections, water houses, exhaust couplings, flexible pipework, etc., and, where a separate cooling water tank is fitted, that the water level is satisfactory and the ball valve and overflow work.

(7) Check all outgoing connections on the generator set 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.

(8) Check access panel and doors for proper opening and closing and for the functioning of any interlocks fitted.

(9) With the set isolated from the doors for proper opening 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. Where a battery charging dynamo is fitted, check that the mains battery charger is disconnected by the operation of the auxiliary contactor during the time the engine is running.

(10) 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, where both are fitted.

(11) Stop engine by turning selector switch to 'Off' position and verify that generator contactor opens as between 95% and 85% of normal voltage. Re-check water and oil levels.

(12) Turn selector switch to 'Auto' position. Disconnect the sensing 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 and time delays on each phase in turn and also that the push buttons for mains failure simulation and engine stopping operate correctly.

NOTE:

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 possible consistent with thoroughness.

3.05 EXHAUST/SILENCER

An efficient residential exhaust/silencer with adequate draining facilities shall be mounted arranged that it may be readily re-located if required. It shall be designed to limit the noise at a maximum of 18 dB (*A*) to 25dB (A) measured at 7 meters from the generator room.

The exhaust shall be fixed 300mm below the ceiling, to discharge outside the buildings on the roof of the generator house.

The silencer and all exhaust pipes shall be fixed by the Contractor in a manner to be approved by the Engineer.

3.06 STARTING BATTERY AND CHARGER

An initially fully-charged battery shall be supplied and installed with each generator. The battery shall be supplied fixed on a suitable frame, to the approval of the Engineer.

The battery shall be either 4 No 12 or 2 No 24 volts 75AH and capable of withstanding the loads imposed upon it by its specified duties.

It shall be maintenance-free type and shall be of sufficient capacity for four starts in succession once in an eight-hour-period.

Auxiliary circuits connected to the battery shall be protected by fuses.

3.07 IMPORTANT INFORMATION TO THE TENDERER

The tenderer shall attach a properly signed letter to his tender documents, stating:

1) The country of origin of the equipment he is offering.

2) The availability of spare parts locally.

3) The cost of maintaining the whole set per annum
   (a) Excluding the cost of spare parts.
   (b) Including the cost of spare parts.

4) Mode of payment proposed.

The tenderer shall in addition attach brochures of his equipment, to the tender documents.

NB: The tenderer should note that the cost of maintaining the set mentioned in Item No.3 above, refers to the period after the first year. Maintenance for the first twelve months including all spare parts and consumables, to be carried out free of charge by the tenderer who should take this into account when tendering.

The tenderer must provide specs sheets (cut sheets) for all the items he proposes to supply

3.08 FUNCTIONAL REQUIREMENTS

As specified herein, the generator set shall be used for standby operation. It shall also be possible to start, operate and stop the generator set manually independent of any automatic features.

Within the operating conditions specified, the generator set shall be capable of starting and accepting full load within the shortest possible time and in any case in not more than 10 seconds.

The contractor shall note that the fault level of the overall system shall be limited such that the ratings of switchgear and all associated components are not exceeded.

The contractor shall ensure that the protection systems and equipment are fully integrated and graded to ensure discrimination is provided throughout the standby generation system and power distribution installation, inclusive of the main switchboard and all other sub boards and distribution boards.

Operation of the standby generator system shall be as follows:

A. Main incoming Supply Failure with Subsequent Automatic Generator Start

(i) Loss of voltage on bus bars of main incoming sections of new main switchboard detected.

(ii) Auto changeover contactors activated after nominal time delay (adjustable) and change over to generator position.

(iii) Signal given de activating power factor correction equipment (if any) within the main switchboard.

(iv) When it has attained correct voltage and speed, the set closes its respective circuit breaker onto the control panel bus bars.

B. Restoration from Incoming Supply Failure

(i) Normal healthy mains detected on main incoming sections of main switchboard.

(ii) After a suitable time delay (adjustable) auto-change over contactors operated and change over to mains supply position.

(iii) Signal given to reinstate power factor correction equipment.

(iv) Generator Output Circuit Breaker opens.

(v) Generator shall run on for a period of time (adjustable) off-loaded its respective circuit breakers opened and then shut down.

C. Test running of Generators

Facilities shall be incorporated to permit the generator to be manually started and test run both off and on load.

Reinstatement from test running shall be achieved in a similar manner as previously outlined for restoration from mains supply.

The contractor shall note that the above description as previously stated, gives a summary of the anticipated generator and control operation for automatic mains failure and test running conditions, to give an outline indication of the design intent and operation required. Full details of the total generator control system operation and the contractor shall submit functional procedures at the time of submission of detailed working drawing information.

3.10 EARTHING SYSTEMS

The contractor shall provide and install the main earthing system for the standby generation system as summarized below.

Before commencement of any work in connection with the main earthing system, the contractor shall carry out a detailed examination of the existing earthing systems and all associated connections and components, together with carrying out all necessary tests to verify the impedances of the existing earthing systems.

The results of these tests and inspection shall be fully detailed with any defects recorded in detail.

The contractor shall include within his tender for testing of the incoming supply earthing to be carried out together with any associated remedial work found to be necessary with the incoming supply earth.

Where required, the systems shall comprise earth electrodes, earth copper conductors, protective conductors comprising copper bar, tape and cables, together with bonding of equipment, ladder racking, conduit, trunking, cable tray and all exposed metal work etc.

The contractor shall carry out earth resistivity tests to determine ground conditions prior to commencement of the main earthing system.

The groups of rods shall be bonded by a solid 100mmx100mm copper PVC wrapped from a centre electrode, copper stranded PVC insulated earth conductors shall be bonded by means of purpose made lugs to the main earthing terminal, situated within the switch room and standby generator room, all to Kenya Power & Lighting Company's requirement/ approval.

The terminals shall comprise exposed hard drawn copper bar installed at low level and supported on heavy duty impact resistant insulators.

Purpose made test links shall be provided for each main earthing terminal to facilitate disconnection from the earthing for testing purposes earth electrodes and interconnections between terminals.

3.11 PERFORMANCE

The. Generator set shall be rated 250 KVA at 3 x 415Volts 3-phase 4-wire, 50 Hertz AC. It should be capable of operating at rated output in ambient conditions of 5° C to 40° C and up to 100% relative humidity in a naturally ventilated building. External noise level shall not exceed NR40 at a distance of 15 meters from the generator, with the generator running at full load.

Within the operating conditions specified, the generator sets with its standard air intake filters, should be capable of delivering its rated output continuously at rated voltage and 0.8 lagging power factor, and of delivering 10% in excess of the continuous maximum rating for a period of one hour in any 12 hour period.

The steady state voltage should be maintained within $2^{1}/2$% of rated voltage under control of the voltage regulator, between cold start ambient conditions and maximum working temperatures, at any load from no load to 10% overload and from unity to 0.8 lagging power factor. After any change in load, the voltage shall not vary by more than ±15% of the rated voltage and shall return to within ±3% within 3 seconds and to within $2^{1}/2$% of rated voltage within 15 seconds. On starting, the voltage overshoot shall not exceed 15% and shall return to within 3% in not more than 3 seconds.

The set shall be mounted on a heavy steel base suitable for anchoring onto the floor. The generator set shall be mounted on robust anti-vibration and shock absorbing devices, fitted with adjusting screws for optimum setting and levelling.

The engine shall be 6 cylinders, 4 cycles, capable of delivering the maximum horsepower required by the alternator at a governed speed of 1500 rpm.

The engine shall be designed for operation on fuel oil, complying with BS 2869:2010+A1:2011.

The engine and alternator must be torsional compatible. No significant critical speed on the complete shaft system, including the alternator, shall be within 15% of the rated speed.

The engine shall be equipped with a speed governor, which shall be self-lubricated, adjustable, hydraulic type. The speed governor shall maintain the speed within 5% from no-load to full load.

A manual reset over speed trip shall be fitted to stop the engine if its speed exceeds the rated speed by 15%. If a mechanized or belt driven trip is fitted, at least two belts shall be provided and the device shall be capable of carrying full load with one belt removed.

3.12 SET ARRANGEMENT

The set shall be mounted on a heavy steel base suitable for anchoring onto the floor. The generator set shall be mounted on robust anti-vibration and shock absorbing devices fitted with adjusting screws for optimum setting and levelling.

The set shall be enclosed in a fully weatherproof and soundproof canopy. The enclosure must reduce sound levels to comply with EU regulations 2000/14/EC. External noise shall not exceed NR40 at a distance of 15 meters from the generator, with the generator running at full load.

SECTION K 1

PART 1 – MATV PARTICULAR SPECIFICATION

SECTION 1 – TECHNICAL SPECIFICATIONS AND PRODUCTS DATA FOR MATV SYSTEM INSTALLATIONS

1. **Grid UHF Aerial ≤ 12dB, Magneto Sprayed type(As Ellies / ALCAD or equivalent to approval):**

   - **Description:**

     Double array antennas covering the complete gain range, in UHF broadband or for groups of channels. Fast and easy assembly, all the components are pre-mounted and no tools are required for their assembly.

   - **Applications:**

     Individual or MATV digital and analogue terrestrial TV installations where reception conditions are favourable.

   - **Characteristics:**

     Rejects GSM signals as well as signals coming from the lower part of the antenna.
     Robust antenna with great resistance to both sun and saltpetre.
     Made from aluminium, weather-resistant plastic and galvanised steel.
     Reduced size reflector to facilitate assembly and installation.
     Elevation angle adjustment, mounting in either horizontal or vertical polarity. Includes a balun (symmetrizer), specially designed for the antenna, with F-type connector protected inside the balun box. Packed individually, in multiple packs or unassembled.

2. **Cabling (as Astel or equivalent to approval):**

   - **RG-11 (Outdoor/Underground Cable):**

     RG11 (RG-11) is to 75 Ohm as RG213 or RG214 is to 50 Ohm cable. RG11 Cable featuring 60% Braided Shield is comprised of an Aluminium Foil bonded to the Foam Dielectric with Aluminium Braided Shield with 60% coverage.

     Quad Shield RG11 would denote alternating Aluminium Foil and Aluminium Braided Shield Layers, starting with the Bonded Foil Layer around the Foam Dielectric, with the best Quad Shield having 2 Layers of Braided Aluminium Shield, one of 60% and the 2nd at 40%. Tri-Shield RG11 will have 77% Braided Aluminium Shield Coverage between 2 Layers of Aluminium Foil Shield, the 1st Foil Layer being Bonded to the Foam Dielectric.

     RG11 is the lowest loss Flexible Braided Shield Drop cable Commercially Manufactured for Satellite TV, TV Antenna and Cable TV usage. Use for distances over 150 feet or when every dB counts. For Cable with less loss than RG11, one would then have to avail themselves to Hard-line Coaxial with a Single Solid Shield (typically Aluminium) that is pricey, but delivers commensurate Results for the Money. Most all RG11 Manufactured uses Aluminium Braided Shield, the difference of note being the amount of Aluminium Braid Coverage and the composition of the Centre Conductor; Solid Copper vs.

Copper Clad Steel will suffice in almost any utilization scenario, however most Satellite TV Operating companies will require Solid Copper Centre Conductor to be used by their respective Sub-Contractor Installers for Maintenance and Warranty issues. This is due to the DC Voltage component being fed from the Receiver back to, and Powering the LNB (f) s mounted on the Satellite Dish.

Unless the run is extremely long and the connectors applied are of dubious Quality, the DC Loop Resistance difference between Solid Bare Copper and Copper Clad Steel is negligible.

- **RG-6 (High resolution indoor copper Cable):**

RG6 (RG-6 or RG-60) is the most commonly utilized 75 Ohm flexible braided shield coaxial drop cable in use by the CATV (Cable TV), TV Antenna and Satellite TV Broadband Industries today. When used in common distribution lengths of around 150 feet, it provides the best combination of Signal loss versus size and diameter; the latter being of importance when navigating the small spaces afforded most chases and wall-plate boxes.

RG6 Cable featuring 60% Braided Shield is comprised of an Aluminium Foil bonded to the Foam Dielectric with Aluminium Braided Shield with 60% coverage. Quad Shield RG6 would denote alternating Aluminium Foil and Aluminium Braided Shield Layers, starting with the Bonded Foil Layer around the Foam Dielectric, with the best Quad Shield having 2 Layers of Braided Aluminium Shield, one of 60% and the 2nd at 40%. Tri-Shield RG6 will have 77% Braided Aluminium Shield Coverage between 2 Layers of Aluminium Foil Shield, the 1st Foil Layer being Bonded to the Foam Dielectric. RG6 is lower in loss when compared to RG59. Use for distances of around 150 feet or with appropriately placed Drop Amplifiers as necessary.

For Cable with less loss than RG6, one would then have to avail themselves to RG11 for suitable placement. Most all RG6 Manufactured uses Aluminium Braided Shield, the difference of note being the amount of Aluminium Braid Coverage and the composition of the Centre Conductor; Solid Copper vs. Copper Clad Steel.

Copper Clad Steel will suffice in almost any utilization scenario, however most Satellite TV Operating companies will require Solid Copper Centre Conductor to be used by their respective Sub-Contractor Installers for Maintenance and Warranty issues. This is due to the DC Voltage component being fed from the Receiver back to, and Powering the LNB (f) s mounted on the Satellite Dish. Unless the run is extremely long and the connectors applied are of dubious Quality, the DC Loop Resistance difference between Solid Bare Copper and Copper Clad Steel is negligible.

- **Cable runs and ducting, conduits and tray requirements**

The Digital TV Contractor will provide to the Professional Team for approval, prior to the commencement of the work, a complete plan showing clearly all intended cable and duct routes as well as any underground routes throughout the site.

The Digital TV Contractor under this contract is to supply the interfacing cableways between the Digital TV equipment.

3. **Professional TV Sockets (As ALCAD 907 Series or equivalent to approval):**

Satellite and terrestrial TV outlet. The socket shall be universal one and can be used within all kinds of satellite and combined / individual installations, and community

ones, both with multi-switches and IF/IF conversion.
The outlet shall equip with two outputs: satellite “F” socket, and TV+FM of IEC type.
To finish the item, it shall be complete with the wall plate.

Type of outlet: terminal

Input band: 5-2400MHz

TV+FM output band: 5-862 MHz

SAT output band: 930-2400MHz

FM loss: 0.2 +/- 0.1dB

Terrestrial TV loss: 1.0 +/- 0.5dB

SAT path loss: 1.2 +/-0.6dB

FM separation: >45dB

TV separation: >14dB

SAT path separation: >14dB

TV+FM selectivity: >15dB

SAT selectivity: >15dB

SAT DC transition parameters: 34V – max
500mA – max

4. 4, 6 or 8 Way Splitter (As ALCAD 906 Series or equivalent to approval):

- **Description:**

  Splitters for terrestrial and satellite TV, covering all frequencies from 5MHz to 2,300MHz.
  It shall distribute the entire input signal in equal parts among their outputs.
  It shall have a feed path through any of their outputs to the input.
  The response of the outputs is flat, with 2, 3, 4, 6 or 8 outputs.

- **Applications:**

  Individual and collective installations of terrestrial and satellite TV with a star-shaped distribution. They permit power to be fed from a preamplifier or LNB through any of the outputs. In installations with multi-switches, a control voltage can be sent through their outputs.

- **Characteristics:**

  Protection diodes in all the outputs.
  Shielded chassis and metal plate
  F-type connectors which form part of splitter chassis.

- **Accessories:**

Male F type connector for Ø6.6 mm coaxial.
Male F connector to screw onto RG-6 coaxial, Ø7.0 mm.
F load 75.
F connector tool.

5. **Mono-Chanel Amplifier (As ALCAD or equivalent to approval):**

- **Description:**

Monochannel amplifier for the UHF band designed to work with adjacent channels. It has a high gain and output level. The channel should be specified in the order.

- **Applications:**

Large, digital and analogue terrestrial MATV installations where adjacent analogue or digital channels exist. The different channels can be treated independently with this module, which results in a perfect equalization of all the received channels.

- **Characteristics:**

Each module consists of a three-stage input filter, an amplifier and an output filter which is three-stage, the filters is cavities. Filters remain highly stable with variations in temperature. Attenuator using an active MOSMIC regulator reduces the noise figure. 45dB multi turn attenuator. Switch to supply power to preamplifiers with protection against short circuits.

6. **120cm Satellite Dish, KU-Band.(to approval):**

120 cm Satellite Dish Antenna (Complete with accessories), comply with the following Specifications:-
Caliber Short axle: 120cm
Long axle: 132cm
Focus length: 720mm
KU-band Gain: 12.5GHz 43.32dB
Material: Steel
Surface spray: plastic

7. **C-Band 8ft Satellite Dish, Complete with accessories (to approval):**

Type: SW-C-240-II
Parts: 6parts
Calibre: 240cm
C band gain 4GHz, 37.2dB
F/D ratio: 0.38
Focus distance: 912MM
Material: steel board
Surface: plastic polishing
Support: many uses with
Angle of elevation: 0-900
Level: Fixed/0-3600
Wind speed: can receive, 25m/sec, can replace 40m/sec
Not damage: 60m/sec
Work surrounding temperature: ‘-40°C-—+60°C’

8. **Distribution Amplifiers, return path between 5-65mhz (as ALCAD or equivalent to approval):**

- **Description:**

Broadband distribution amplifier for terrestrial TV available in different output levels. It amplifies the return path, and is available in different frequencies according to the model. It has a gain control and slope control. Feed by a built-in switching power supply. The input and output test point permits the checking and adjustment of the installation without having to disconnect the TV signal.

- **Applications:**

Used as a distribution amplifier in large community installations or cable networks. It can be used as a line amplifier in small cable networks. These installations commonly have long runs of cable which attenuate and unbalance the signal. The channels with higher frequencies attenuate more. The distribution amplifiers compensate this loss with the equaliser and amplify the channels adding as little noise as possible.

- **Characteristics:**

Made from galvanised plate for maximum shielding. Separate housings for the power supply unit and the high frequency circuit. F type connectors, located on the lower part to help with the installation.

9. **Open Transmodulator (as ALCAD or equivalent to approval):**

- **Description:**

Modular programmable receiver of free to air digital terrestrial TV programs.
Each module selects a Standard definition TV program from the DVBT
Digital TV channel and converts it into a Terrestrial band analogue channel.
Unit can be set for Stereo or Mono audio.

- **Applications:**

Used in MATV installations where it is necessary to distribute digital channels which have been converted to analogue channels.

- **Characteristics:**

Unit has a very robust DVB-T decoder with an automatic reset system, in the event of the detection of errors, in order to reduce maintenance of the installation.
Automatic detection of the audio mode.
Decoding of mono, stereo and dual audio signals.
Modulator is VSB filtered by means of a SAW filter, designed to work with adjacent.

10. **Conditional Access Modules (as Irdeto or equivalent to approval):**

Conditional access system shall provide a stringent content security for pay-TV operations. It also enables pay-TV operators and broadcasters to offer more services, payment options and device support which equates to choice, flexibility and convenience for their customers.

Whether via cable, satellite, terrestrial, IP, mobile or hybrid networks. It shall be flexible solutions enable broadcasters to easily deploy new TV services and support new devices without interrupting existing subscriber services or compromising their digital assets.

11. Encrypted Transmodulator (as ALCAD / Televes) or equivalent to approval):

- **Description:**

Transmodulator of encrypted satellite digital television services to terrestrial digital television with DiSEqC.
Each module selects the services from a DVB-S/S2 satellite transponder and includes them in a DVB-C channel.
Equipped with a Common Interface slot for the insertion of the CAM and the subscriber’s card.
Programmable using PC software and a wireless programmer.

- **Applications:**

Collective digital cable TV installations where the aim is to distribute encrypted satellite television services while avoiding the installation of satellite receivers.
Allows channels from different satellites to be selected thanks to its DiSEqC control.
Compatible with all collective TV installations since the channels can be distributed throughout the 47-862 MHz band.

- **Characteristics:**

Automatic error-detection system which greatly reduces maintenance work on the installation. Generated output channel of outstanding quality.

12. Lightning protection:

The Digital TV System Contractor shall install devices to provide protection of the equipment from the effects of lightning discharges. This applies to all video, data and power connections.

It is the responsibility of the Digital TV System Contractor to provide a full Design Intent Methodology (DIM) detailing the specific measures to be applied, in accordance with BS EN 62305-1:2011, BS EN 62305-2:2012, BS EN 62305-3:2011, BS EN 62305-4:2011, to the equipment scheduled to be installed.

13. Earthing:

The Digital TV System Contractor shall earth all Coaxial Cables, TV Antenna and Satellite, TV Splitter Installation, and Cable TV or HDTV Antenna Coaxial Cable System Outside before bringing the TV Cable Inside the building. This way, Lightening Strikes and Power Surges have an opportunity to arrest before reaching Satellite Receiver and TV Set(s).

All coaxial cables to be spliced with a coaxial cable ground block as close to the point of entry into the building as possible. This ground block is then connected to with a #10 solid copper ground wire and a coaxial cable ground block to the building's electrical ground rod. Also, the actual mounting structure of the TV antenna also needs to be grounded to this same grounding point.

The Integral Grounding Block designed onto most Outdoor Use Compatible Satellite Signal Splitter this will effectively conveys this unwanted Electrical Energy to a Ground Rod via a Copper Ground Wire.

Proper Grounding of Masts, Antennas, Cable TV and other RF Distribution Systems can also reduce both Reception and Emination of Interfering RF Signals.
Grounding can be as simple as a 12 AWG Ground Wire connected a short distance away to 8 foot 5/8" DIA Copper Ground Rod or Bonded to the Existing Power Ground by the Power Meter.

14. Labelling

The Digital TV System Contractor shall provide labelling for all devices, panels and enclosures.
The Labelling system to be provided shall be nominated during the tender period.
A document pocket shall be provided inside each enclosure to neatly store appropriate documentation. Documentation should include at minimum all wiring diagrams, device lists of connected Digital TV System equipment.

SECTION K 2

PART 2 – ICT PARTICULAR SPECIFICATIONS

2 AN OVERVIEW OF CABLING STANDARDS

2.1 ANS/TIA/EIA-568-A and ISO/IEC 11801

The latest editions of the ANS/TIA/EIA-568-C(568-C) and ISO/IEC 11801 ('11801) cabling standards. The following overview provides some of the requirements and recommendations of each standard including differences between them.

2.2 ANS/TIA/EIA-568-C

Commercial Building Telecommunications Cabling Standard.
ANSI/TIA-568-C.0, Generic Telecommunications Cabling for Customer Premises, Ed. C, Amd. 2, 08-2012
ANSI/TIA-568-C.1, Commercial Building Telecommunications Cabling Standard, Ed. C, Amd. 2, 05-2012
ANSI/TIA-568-C.2, Balanced Twisted-Pair Telecommunication Cabling and Components Standard, Ed. C, Err. 04-2014
ANSI/TIA-568-C.3, Optical Fiber Cabling Components Standard, Ed. C, Amd. 1, 10-2011
ANSI/TIA-568-C.4, Broadband Coaxial Cabling and Components Standard, Ed. C, 07-2011

2.3 ISO/IEC 11801

Information Technology – Generic Cabling for Customer Premises.

Following are highlights of the '568-C standard and related Telecommunication Systems Bulletins (TSBs) with notes on differences in terminology and technical requirements with respect to '11801. For clarity and consistency, '568-C based terminology is used in the following overview.

2.4 Purpose

- To specify a generic voice and data telecommunications cabling system that will support a multi-product, multi-vendor environment.
- To provide direction for the design of telecommunications equipment and cabling products intended to serve commercial enterprises.
- To enable the planning and installation of a structured cabling system for commercial buildings that is capable of supporting the diverse telecommunications needs of building occupants.
- To establish performance and technical criteria for various types of cable and connecting hardware and for cabling system design and installation.

2.5 Scope

- Specifications are intended for telecommunications installations that are “office oriented”.
- Requirements are for structured cabling system with a usable life in excess of 10 years.
- Specifications addressed:
    - Recognized Media
    - Cable and connecting Hardware
    - Performance
    - Topology
    - Cabling Distance
    - Installation Practices
    - User Interfaces
    - Channel Performance

2.6 Cabling Elements

- Horizontal Cabling:
    - Horizontal Cross-connect (HC)
    - Horizontal Cable
    - Transition Point (optional)
    - Consolidation Point (optional)
    - Telecommunications-Outlet/Connector (TO)

- Backbone Cabling
    - Main Cross-connect (MC)
    - Interbuilding Backbone Cable
    - Intermediate Cross-connect (IC)
    - Intrabuilding Backbone Cable
- Work Area (WA)
- Telecommunications Closet (TC)
- Equipment Room (ER)
- Entrance Facility (EF)
- Administration

2.7 HORIZONTAL CABLING SYSTEM STRUCTURE

The horizontal cabling system extends from the telecommunications outlet in the work area to the horizontal cross-connect in the telecommunications closet. It includes the telecommunications outlet, an optional consolidation point or transition point connector, horizontal cable, and the mechanical terminations and patch cords (or jumpers) that comprise the horizontal cross-connect.

2.8 Some points specified for the horizontal cabling subsystem include:

- Recognized Horizontal Cables:
    - 6 pair 100 Ω unshielded twisted-pair.
    - 4-fiber (duplex) 62.5/125 μm or multimode optical fiber

Four-fiber multimode optical fiber either 62.5/125 µm or 50/125 µm.

- One transition point (TP) is allowed between different forms of the same cable type (i.e. where undercarpet cable connects to round cable)
- 50 Ω coax and 150 Ω STP-A cabling is not recommended for new installations.
- Additional outlets may be provided. These outlets are in addition to and may not replace the minimum requirements of the standard.
- Bridged taps and splices are not allowed for copper-based horizontal cabling. (Splices are allowed for fiber).
- Application specific components shall not be installed as part of the horizontal cross-connect (eg. Splitters, baluns).
- The proximity of horizontal cabling to sources of electromagnetic interference (EM) shall be taken into account.

2.9 BACKBONE CABLING SYSTEM STRUCTURE

The backbone cabling system provides interconnections between telecommunications closets, equipment rooms, and entrance facilities. It includes backbone cables, intermediate and main cross-connects, mechanical terminations, and patch cords or jumpers used for backbone-to-backbone cross-connections. The backbone also extends between buildings in a campus environment.

- Equipment connections to backbone cabling should be made with cable lengths of 30m (98 ft) or less.
- The backbone cabling shall be configured in a star topology. Each horizontal cross-connect is connected directly to a main cross-connect or to an intermediate cross-connect, then to a main cross-connect.
- The backbone is limited to no more than two hierarchical levels of cross-connects (main and intermediate). No more than one cross-connect may exist between a main and a horizontal cross-connects may exist between any two horizontal cross-connects.
- A total maximum backbone distance of 90m (295 ft.) is specified for high band-width capability over copper. This distance is for uninterrupted backbone runs. (No intermediate cross-connect).
- The distance between the terminations in the entrance facility and the main cross-connect shall be documented and should be made available to the service provider.
- Recognized media may be used individually or in combination, as required by the installation. Quantity of pairs and fibers needed in individual backbone runs depends on the area served. Recognized backbone cables are:

  100 Ω UTP
  150 Ω stp-a
  625/125µ Multimode Optical Fiber
  Single mode Optical Fiber

- Multipair cable is allowed, provided that it satisfies the power sum crosstalk requirements.

- The proximity of backbone cabling to sources of electromagnetic interference (EMI) shall be taken into account.
- Cross-connects for different cable types must be located in the same facilities.
- Bridged taps are not allowed.

2.10 WORK AREA

The telecommunications outlet serves as the work area interface to the cabling system. Work area equipment and cables used to connect to the telecommunications outlet are outside the scope of '568-C and '11801, but are expected to be specified in the next edition of these standards.

2.11 OPEN OFFICE CABLING

Additional specifications for horizontal cabling in areas with moveable furniture and partitions have been introduced in TIA/EIA TSB75. Horizontal cabling methodologies are specified for "open-office" environments by means of multi-user telecommunications outlet assemblies and consolidation points. These methodologies are intended to provide increased flexibility and economy for installation with open office work spaces that require frequent configuration.

2.12 HORIZONTAL DISTANCES OF COPPER LINKS (OPEN OFFICE)

Copper work area cables connected to a MuTOA, shall meet the requirements of '568-C.
The maximum length of copper work area cables shall be determined according to:

C = (102 – H)/12
W = C – 7 (<29 m)
Where:
C is the combined length of the work area cable, equipment Cable, and patch cord (m).
W is the length of the work area cable (m).
H is the length of the horizontal cable (m)

The above equations assume that there is a total of 7m (23 ft.) of patch and equipment cables in the telecommunications closet. Table 1 shows the application of these formulae. The length of work area cables shall not exceed 20m (66 ft). The MuTOA shall be marked with the maximum allowable work area cable length.

Length of Horizontal Cable	Maximum Length of Work Area Cable	Maximum Combined Length of Work Area Cables, Patch Cords, and Equipment Cable

H m (ft)	W m (ft)	C m(ft)
90 (295)	3 (10)	10 (33)
85 (279)	7 (23)	14 (46)
80 (262)	11 (36)	18 (59)
75 (246)	15 (49)	22 (72)
70 (230)	20 (66)	27 (89)

Table 1 – Maximum Length of Work Area Cables

2.13 HORIZONTAL DISTANCES OF OPTICAL FIBER LINKS

(LONG WORK AREA CABLES)

For optical fiber cables, any length combination or length of the horizontal channel does not exceed 100m (328 ft).

When deploying a centralized fiber cabling topology, the general guidelines of TSB72 shall be followed.

2.14 TELECOMMUNICATIONS CLOSET

Telecommunications closets are generally considered to be floor serving facilities for horizontal cable distribution. They may also be used for intermediate and main cross- connects.

Some specifications related to the telecommunications closet:

- Closets shall be designed and equipped in accordance with ANSI/TIA/EIA-569-C.
- Cable stress from tight bends, cable ties, staples, and tension should be avoided by well-designed cable management.
- Only standards-compliant connecting hardware shall be used.
- Cables and cords used for active equipment connections are outside the scope of the standard (10m total allowed for patch cords, equipment cables, and work area cables for each link).
- Application-specific electrical components shall not be installed as part of the horizontal cabling.
- Horizontal cable terminations shall not be used to administer cabling system changes. Instead, jumpers patch cords, or equipment cords are required for re-configuring cabling connections

The two types of schemes used to connect cabling subsystems to each other and to equipment are known as interconnections and cross-connections.

2.15 DEFINITIONS

Cross-Connection: A connection scheme using patch cords or jumpers that attach to connecting hardware on each end.

Interconnection: A connection scheme that provides for direct connections to building cabling from equipment without a patch cord.

2.16 TWISTED-PAIR (BALANCED) CABLING

The six categories of transmission performance specified for cables, connecting hardware and links are:

Designation	Transmission Characteristics	Description
3	Transmission characteristics are specified up to 16 MHz.	Meets applicable category 3 and Class C requirements of ISO/IEC 11801 (including amendments A.1 & A.2), ANSI/TIA/EIA-568-C (including addenda A-1, A-2, & A.3) and TSB67. Requirements are specified to an upper frequency limit of 16MHz.
4	Transmission characteristics are specified up to 20 MHz	Meets applicable category 4 requirements of ISO/IEC 11801 (including amendments A.1 & A.2), ANSI/TIA/EIA-568-C (including addenda A-1, A-2 & A-3) and TSB67.Requirements are specified to an upper frequency limit of 20 MHz. This classification is a superset of 3
5	Transmission characteristics are specified up to 100 MHz.	Meets applicable ca Category 5 and class D requirements of ISO/IEC 11801 (including addenda A-1, A-2 & A-3), TSB67 and draft TSB95. Requirements are specified to an upper frequency limit of 100 MHz. This classification is a superset of 4.
5e	Transmission characteristics are specified up to 100 MHz.	Performs to category 5e and additional class D requirements of draft amendment 3 of ISO/IEC 11801, and draft addendum 5 to ANSI/TIA/EIA-568-A. Requirements are specified to an upper frequency limit of 100 MHz. This classification is a superset of 5.
6	Transmission characteristics Will be specified up to 250 MHz.	Performs to category 6 and class E requirements under development by ISO/IEC and TIA.

		Requirements are expected to be specified to an upper frequency limit of at least 250 MHz. This classification is a superset of 5e
7	Transmission characteristics will Be specified up to 600 MHz.	Performs to category 7 and class F requirements under development by ISO/IEC. Requirements are expected to be specified to an upper frequency limit of at least 600 MHz. This classification is an electrical superset of 6.

2.17 UTP TELECOMMUNICATIONS OUTLET/CONNECTOR

- 8-position modular jack per IEC 60603-7 (.568-C states that all pairs must be connected).
- Pin/pair assignment: T568A Optional assignment to accommodate certain systems: T568B.
- Durability rating 750 mating cycles minimum.
- Backward compatibility and interoperability is required.

2.18 FULLY SHIELDED TELECOMMUNICATIONS OUTLET/CONNECTOR.

- Entirely new interface design to support class F cabling.
- Will require a new wiring pin/pair assignment.
- Transmission measurement methods for category 7 are under study.
- Durability rating 1000 mating cycles minimum.

2.19 UTP CONNECTING HARDWARE VS. CABLE NEXT PERFORMANCE.

- Specifications cover all types of connectors used in the cabling system including the telecommunications outlet/connector.
- Does not cover work area adapters, baluns, protection, MAUs, filters, or other application-specific devices.
- Temperature range -10°C (14°F) to 60°C (140°F).
- Outlets shall be securely mounted. Outlet boxes with unterminated cables must be covered and marked.
- Transmission requirements are much more severe than cable of a corresponding category.
- Performance markings should be provided to show the applicable transmission category and should be visible during installation (for example 6) in addition to safety markings.
- Installed connectors shall be protected from physical damage and moisture.

2.20 UTP LINK PERFORMANCE MARKING AND IDENTIFICATION

- Link category marking should be clearly visible on both ends (component markings are not sufficient).
- Labelling, markings, and color-coding shall be provided in accordance with ANSI/TIA/EIA-606.

2.21 SCREENED CABLING (ScTP)

As a result of the release of TIA/EIA/IS-729 and the maturity of the ‘568-C and ‘11801 standards, telecommunications groups recognize the presence of an overall shield over four twisted-pairs; a media hybrid termed Screened Twisted-Pair or ScTP cabling.

2.22 ScTP

Color-coding

Pair 1 = White/Blue-Blue
Pair 2 = White/Orange-Orange
Pair 3 = White/Green-Green.
Pair 4 = White/Brown-Brown

- 0.51mm (24 AWG) 100 Ω 4-pair enclosed by a foil shield.
- A copper conductor drain wire of .040mm (26 AWG) or larger shall be provided.
- Should be marked “100 Ω ScTP”, in addition to any safety markings required by local or national codes.
- Same mechanical and transmission requirements apply to backbone and horizontal cables.
- Additional performance requirements, including surface transfer impedance, is specified in the IS-729 standard entitled, “Technical Specifications for 100 Ω Screened Twisted-Pair Cabling”.

2.23 ScTP Connectors

- Interface and pair assignments same as IEC 60603-7 (‘568-C states that all 4 pairs must be connected).
- Additional transfer impedance and shield mating interface requirements specified in the IS-729 standard entitled, “Technical Specifications for 100 Ω Screened Twisted-pair Cabling”.

2.24 ScTP Patch Cords

- Specifications call for 26 AWG (7 strands @ 0.15mm) or 24 AWG (7 strands @ 0.20mm) stranded conductors.
- Allows for an overall shield.
- Less severe attenuation than horizontal cable.

2.25 ScTP Installation Practices

- Shield shall be bonded at both ends at the “Telecommunication Grounding Busbar”.
- The difference between the two grounds shall be no more than 1.0 V RMS.

2.26 FULLY SHIELDED CABLING (SSTP)

Fully shielded cabling requirements as per the ISO Standard shall be used. Cable and connector specification will extend to at least 600 MHz and intended to support class F cabling requirements.

2.27 Fully Shielded Cable

Color-coding

Pair 1 = White/Blue-Blue
Pair 2 = White/Orange-Orange
Pair 3 = White/Green-Green
Pair 4 = White/Brown-Brown

- Four 0.51mm (24 AWG) or larger 100 Ω twisted-pairs each enclosed by an individual foil shield with an overall shield provided over the four-pairs.
- Mechanical and transmission requirements as per the ISO Standards shall be employed.

2.28 Fully Shielded Connectors

- Interface and pair assignments as developed by ISO shall be used.
- Mechanical and transmission requirements as per ISO requirements shall be used.

2.29 Fully Shielded Patch Cables.

- Mechanical and transmission requirements as per ISO requirements shall be used.

2.30 Fully Shielded Installation Practices

- ISO Installation Practices shall be employed.

2.31 TSB67 and TSB95

Transmission Performance Specifications for Field Testing of UTP Cabling Systems

This bulletin provides users with the opportunity to use comprehensive test methods to validate the transmission performance characteristics of installed category 6 and lower grade UTP cabling systems. The categories of UTP cabling systems in this bulletin also correspond with the UTP cabling categories of ANSI/TIA/EIA-568-C. Additional transmission performance and applicable field test requirements are referenced in TSB95, '568-A-5 and amendment 2 to '11801 (FDAM 2)

Some points specified for TSB67 and TSB95 transmission field testing for UTP Cabling Systems

- UTP cabling systems are comprised of cables and connecting hardware specified in TIA/EIA-568-C.
- Required test parameters include wire-map, length, attenuation, and crosstalk.
- Two levels of pass or fail are indicated, depending on measured margin compared to minimum specifications. Testing of NEXT loss is required in both directions.
- Level II equipment meets the most stringent requirements for TSB67 measurement accuracy. Level IIe equipment will be required to verify category 6 and FDAM 2 performance.
- Requirements are intended for performance validation and are provided in addition to '568-C requirements on components and installation practices.

2.32 OPTICAL FIBER CABLING

Horizontal – 62.5/125 µm multimode (two fibers per outlet).
Backbone - 62.5/125 µm multimode or singlemode.

‘568-C allows the use of 50/125 µm multimode optical fiber in both the horizontal and backbone in addition to the types listed above.
All optical fiber components and installed practices shall meet applicable building and safety codes

2.33 Optical Fiber Patch Cords

- Shall be a two-fiber (duplex) indoor cable Of the same type as the cables to which they connect.
- Shall allow for easy connection and reconnection and ensure that polarity is maintained (568SC) configuration required).
- Shall perform a pair-wise cross-over of fiber positions A and B. (If provided in simplex form, one connector shall be identified as “A” and the other “B”.)

2.34 Installation of Optical Fiber Connecting Hardware

- Connectors shall be protected from physical damage and moisture.
- Capacity for 12 or more fibers per rack space [44.5mm (1.75 in.)] should be provided.
- Optical fiber connecting hardware shall be installed:
  - To provide well organized installation with cable management.
  - In accordance with manufacturer’s guidelines.

2.35 Optical Fiber Cabling Installation

- A minimum of 1m (3.28 ft.) of two-fiber cable (or two buffered fibers) shall be accessible for termination purposes.
- Testing is recommended to assure correct polarity and acceptable link performance.

2.36 Optical Fiber Work Area Connector

- A simplex or duplex SC connector shall be used at the work area.
- Recommended adapter and connector is the 586SC (a duplex SC that is capable of simplex operation).

2.37 Optical Fiber Connections

- Connector designs shall meet the requirements of the corresponding TIA FOCIS documents.
- Telecommunications outlet/connector boxes shall be securely mounted at planned locations.
- The telecommunications outlet/connector box shall have:
  - The ability to secure optical fibers.
  - Cable management means to assure a minimum bend radius of 25mm (1.00 in.) and should have slack storage capability.

  - Provisions for terminating a minimum of two optical fibers into a 568SC adapter.
- Identification of fiber types:
  - Multimode connectors and adapters shall be identified with the color beige.
  - Single mode connectors and adapters shall be identified with the color blue.
- The two positions in a duplex connector are referred to as “position A” and “position B”.
- The 568SC adapter performs a pair-wise cross-over between position A and position B of two mated connectors.
- Optical fiber runs intended for future connections shall be stored in a telecommunications outlet/connector box.

2.38 Small Form Factor (SFF) Connectors

- Qualified SFF duplex and multi-fiber connector designs may be used in the main cross connect, intermediate cross-connect, horizontal cross-connect, and consolidation points.
- A TIA Fiber Optic Connect Intermateability Standard (FOCIS) shall describe each SFF design.
- The SFF design shall satisfy the requirements specified in Annex A of ‘568-B.3 standard or later standard.
- Some advantages of SFF connectors include compact size, modular compatibility with the eight position modular copper interface, and adaptability to high-density network electronics.

2.39 TSB

Centralized Optical Fiber Cabling Guidelines

This Telecommunications Systems Bulletin (TSB) provides the user with the flexibility of designing an optical fiber cabling systems for centralized electronics typically in single tenant buildings. It contains information and guidelines for centralized optical fiber cabling.

Some points specified in TSB for a centralized optical fiber cabling system include:

- Intended for single-tenant users who desire centralized vs. distributed electronics.
- Implementation allows cables to be spliced or interconnected at the telecommunications closet such that cables can be routed to a centralized distributor for total cable lengths of 300m (984 ft.) or less, including patch cords or jumpers.
- Allows for migration from an interconnection or splice to a cross-connection scheme that can also support distributed electronics.
- Pull-through implementations are allowed when total length between the tele-communications outlet/connector and centralized cross-connect and centralized cross-connect is 90m (295 ft.) or less.
- Connecting hardware required to:
  - join fibers by re-mateable connectors or splices,
  - connectors shall be 568SC interface,
  - provide for simplex or duplex connection of optical fibers,
  - provide means of circuit identification,
  - allow for addition and removal of optical fibers.

Note: Some multi-mode fiber implementations may be limited to an operating range of 220m to support 1000BASE-SX.

2.40 CABLING SPECIFICATION CROSS-REFERENCE CHART (ANSI/TIA/EIA-568-C AND ISO/IEC 11801)

The following chart provides a side-by-side comparison that highlights many of the fundamental similarities and differences between ANSI/TIA/EIA-568-C and ISO/IEC 11801.

ANSI/TIA/EIA-568-C (and addenda) Commercial Building Telecommunications Cabling Standard	ISO/IEC 11801 (and amendments) Generic Cabling for Customer Premises

HORIZONTAL UTP CABLE

- Solid 4-pair 0.51mm (24 AWG) specified (0.64mm (22 AWG) solid also allowed). An overall shield ((ScTP) is optional.
- Performance marking should be provided to show the applicable performance category. These markings do not replace safety markings.
- Colour-coding:
  - White/blue-blue
  - White/orange-orange
  - White/green-green
  - White/brown-brown.

HYBRID AND BUNDLED CABLES

Hybrid/Bundled cables:

- Hybrid/bundled cables that contain multiple units of recognized horizontal copper cables are subject to additional NEXT loss requirements between cable units. These requirements assure a minimum of 3 dB additional power sum crosstalk isolation between applications that may operate on adjacent binder groups.
- All detailed specifications for the individual cable units used in the hybrid assembly still apply.
- Hybrid bundled cables shall meet the transmission requirements specified in TIA/EIA-568-C.

UTP PATCH CORDS AND CROSS-CONNECT JUMPERS.

- Patch cords must use stranded cable for adequate flex life
- Standard cables must meet the minimum performance requirements for horizontal cable as allowed by ‘568-C and 50 percent more attenuation allowed by ‘11801.
- Color-code for cross-connect jumpers: One conductor white, the other a visibly distinct color such as red or blue.
- Performance markings should be provided to show the applicable transmission category in addition to safety markings.

- Insulated O.D of stranded wires should be 0.8mm (0.032 in.) to 1mm (0.039 in.) to fit into a modular plug.
- Production performance specifications for plug cord assemblies are addressed in '568-C

BACKBONE UTP CABLE

- Performance markings should be provided to show the applicable performance category. These markings do not replace safety markings.
- Services with incompatible signal levels should be partitioned into separate binder groups. Guidelines for shared sheaths are provided in '568-C.
- Transmission requirements are equivalent to horizontal cables except that NEXT loss performance is based on power-sum rather than worst-pair characterization to allow for multiple disturbing signals (of the same type) in the same sheath.
- Note: Tip conductors have colored insulation that corresponds to that of the binder group. Ring conductors have colored insulation that corresponds to that of the pair.
- Backbone UTP cables consist of solid 0.51 mm (24 AWG) cables that contain more than four pairs (typically multiples of 25-pairs are used). An overall shield is optional.
- Color-coding (specified by reference to ICEA - *Insulated Cable Engineers Association*)

2.41 MODULAR WIRING REFERENCE

MODULAR JACK STYLES:

There are four basic modular jack styles. The 8-position modular outlets are commonly and incorrectly referred to as "RJ45". The 6-position modular jack is commonly referred to as RJ11. Using these terms can sometimes lead to confusion since the RJ designation actually refer to very specific wiring configurations called Universal Service Order Code (USOC). The designation 'RJ' means Registered Jack. Each of these basic jack styles can be wired for different RJ configurations. For example, the 6-position jack can be4 wired as an RJ11C (1`- pair), RJ14C (2-pair), or RJ25C (3-pair) configuration. An 8-position jack can be wired for configurations such as RJ61C (4-pair) and RJ48C. The keyed 8-position jack can be wired for RJ46S, and RJ47S. The fourth modular jack style is a modified version of the 6-position jack (modified modular jack or MMJ). It was designed to eliminate the possibility of connecting DEC data equipment to voice lines and vice versa.

MODULAR PLUG PAIR CONFIGURATIONS

It is important that the pairing of wires in the modular plug match the pairs in the modular jack as well as the horizontal and backbone wiring. If they do not, the data being transmitted may be paired with incompatible signals.

STRAIGHT THROUGH OR REVERSED

Modular cords are used for two basic applications. One application uses them for patching between modular patch panels. When used in this manner modular cords should always be wired "straight through" (pin 1 to pin 1, pin 2 to pin 2, pin 3 to pin 3, etc). The second major application uses modular cords to connect the workstation equipment (PC, phone, FAX etc) to the modular outlet. These modular cords may either be wired “straight-through” or “reversed” (pin 1 to pin 6, pin 2 to pin 5, pin 3 to pin 4, etc.) depending on the system manufacturer’s specifications. This “reversed” wiring is typically used for voice systems. The following is a guide to determine what type of modular cord you have.

HOW TO READ A MODULAR CORD

Align the plugs side-by-side with the contacts facing you and compare the wire colors from left to right. If the colors appear in the same order on both plugs, the cord is wired “straight-through”. If the colors appear reversed on the second plug (from right to left), the cord is wired “reversed”.

2.42 RECOMMENDED CABLING PRACTICES

Do’s

- Terminate each horizontal cable on a dedicated telecommunications outlet.
- Locate the main cross-connect near the center of the building to limit cable distances.
- Maintain the twist of horizontal and backbone cable pairs up to the point of termination.
- Tie and dress horizontal cables neatly and with a minimum bend radius of 4 times the cable diameter.

Dont’s:

- Do not use connecting hardware that is of a lower category than the cable being used.
- Do not create multiple appearances of the same cable at several distribution points (called bridged taps)
- Do not over-tighten cable ties, use staples, or make sharp bends with cables.
- Do not place cable near equipment that may generate high levels of electromagnetic interference.

UTP CONNECTOR TERMINATIONS

- Pair twists shall be maintained as close as possible to the point of termination.
- Untwisting shall not exceed 25mm (1.0 in) for category 4 links and 13mm (0.5 in) for category 5, category 5e, and category 6 links. Follow manufacturer guidelines for category 3 products, if no guidelines exist, then untwisting shall not exceed 75mm (3.0 in).
- Connecting hardware shall be installed to provide well-organized installation with cable management and in accordance with manufacturer’s guidelines.
- Strip back only as much jacket as is required to terminate individual pairs.

2.43 UTP CABLING INSTALLATION PRACTICES.

- To avoid stretching, pulling tension should not exceed 110N (25 lb*f*) for 4-pair cables.
- Installed bend radii shall not exceed:

  - 4 times the cable diameter for horizontal UTP cables.
  - 10 times the cable diameter for multi-pair backbone UTP cables.
- Horizontal cables should be used with connecting hardware and patch cords (or jumpers) of the same performance category or higher.
- Avoid cable stress, as caused by:
  - cable twist during pulling or installation
  - tension in suspended cable runs
  - tightly cinched cable ties or staples
  - tight bend radii.
- Important Note: Installed UTP cabling shall be classified by the least performing component in the link.

2.44 ANSI/TIA/EIA-569-A

Commercial Building Standard for Telecommunications Pathways and Spaces.

The TIA TR42.3 (formerly TR41.8.3) Working group on Telecommunications Pathways & Spaces published the ANSI/TIA/EIA-569-A ('569-A) Standard in 1998.
Following are highlights of the '569-A Standard:

(a) Purpose

- Standardize design and construction practices.
- Provides a telecommunications support system that is adaptable to change during the life of the facility.

(b) Scope

- Pathways and spaces in which telecommunications media are placed and terminated.
- Telecommunications pathways and spaces within and between buildings.
- Commercial building design for both single and multi-tenant buildings.

(c) Elements

- Horizontal
- Backbone
- Work Area
- Telecommunications Closet
- Equipment Room
- Main Terminal Space.
- Entrance Facility

HORIZONTAL

Pathways from telecommunications closet to work area.

Includes:

2.44.1 Pathway Types

- Underfloor-Network of raceways embedded in concrete consisting of distribution and header ducts, trenches, and cellular systems.

- Access Floor-Raised modular floor tile supported by pedestals, with or without lateral bracing or stringers.
- Conduit-Metallic and nonmetallic tubing of rigid or flexible construction permitted by applicable electrical code.
- Tray & Wireway-Prefabricated rigid structures for pulling or placing cable.
- Ceiling-Open environment above accessible ceiling tiles and frame work.
- Perimeter-Surface, recessed, molding, and multichannel raceway systems for wall mounting around rooms or along hallways.

2.44.2 Space Types

- Pull Boxes-Used in conjunction with conduit pathway systems to assist in the fishing and pulling of cable.
- Splice Boxes-a box, located in a pathway run, intended to hold a cable splice.
- Outlet Boxes-Device for mounting faceplates, housing terminated outlet/connectors, or transition devices.

2.44.3 Design Considerations

- Grounded per code and ANSI/TIA/EIA-607 (‘607)
- Designed to handle recognized media as specified in ANSI/TIA/EIA-568-C (‘568-C)
- Not allowed in elevator shafts.
- Accommodate seismic zone requirements
- Installed in dry locations

BACKBONE

Pathways routed from closet-to-closet.

Building Backbone Types:

- Ceiling
- Conduit
- Sleeves-An opening, usually circular, through the wall, ceiling, or floor.
- Trays

Typically the most convenient and cost effective backbone pathway design in multi-story buildings, is to have stacked closets located one above the other, connected by sleeves or slots.

Design Considerations:

- Grounded per code and ‘607
- Accommodate seismic zone requirements
- Water should not penetrate the pathway system
- Tray, conduits, sleeves, slots penetrate closets minimum 25mm (1 in.)
- Designed top handle all recognized media (as specified in ‘568-C)
- Integrity of all fire stop assemblies shall be maintained.

WORK AREA

Primary location where the building occupants interact with dedicated telecommunications equipment.

Design Considerations:

- At least one telecommunication outlet box location shall be planned for each work area.
- This location should be coordinated with the furniture plan. A power outlet should be nearby.
- Furniture System design:
    - Cable access via walls, columns, ceilings, or floors. Fittings that transition between building and furniture pathways require special planning.
    - Furniture pathway fill capacity is effectively reduced by furniture corners, and connectors mounted within the furniture pathway systems.
    - Furniture pathways bend radius shall not force the installed cable to a bend radius of less than 25 mm (1 in.)
    - Furniture spaces designed to house slack storage, consolidation points, or multi-user telecommunications outlet assemblies shall provide space for strain relieving, terminating, and storing slack for the horizontal cables.
    - Slack storage and furniture pathway fill, shall not affect the bend radius and termination of the cable to the connector.
    - Furniture pathway openings shall comply with either of two sizes:
        - Standard NEMA opening (NEMA OS 1 (Ref D. 14), WD-6 (Ref D. 15))
        - Alternate opening:

Power/telecommunication separation requirements is governed by applicable electrical code for safety. Minimum separation requirements of Article 800-52 of ANS/NFPA 70 shall be applied.

TELECOMMUNICATIONS CLOSETS

Recognized location of the common access point for backbone and horizontal pathways.

Design:

- Dedicated to telecommunications function.
- Equipment not related to telecommunications shall not be installed, pass through or enter the telecommunications closet.
- Multiple closets on the same floor shall be interconnected by a minimum of one 78mm conduit, or equivalent pathway.
- Minimum floor loading 2.4 kPA (50 lbf/ft2).

Design Considerations:

- Minimum one closet per floor to house telecommunications equipment/cable terminations and associated cross-connect cable and wire.
- Located near the center of the area being served.

- Horizontal pathways shall terminate in the telecommunications closet on the same floor as the area served.

MISCELLANEOUS

- Fire stopping per applicable code
- Horizontal pathway separation from Electromagnetic interference (EMI) sources:
  - Separation between telecommunications and power cables (Article 800.133 of ANSI/NFPA 70)
  - Building protected from Lightning (BS EN 62305)
  - Surge protection (BS EN 62305)
  - Earthing (BS 7430:2011+A1:2015)
- Reducing noise coupling:
  - Increase separation from noise sources
  - Electrical branch circuit line, neutral, and grounding conductors should be maintained close together.
  - Use of surge protectors in branch circuits

2.45 Working drawings

The provisional telephone and data outlet positions have been indicated on the drawings. These may be adjusted, increased or decreased to suit Employer's and final design requirements.

The Contractor shall liase with the Engineer and produce working drawings showing all external data and telephone distribution and outlet points, conduit/trunking layouts and submit for approval by the Engineer and Employer.

2.46 Telephone and Data Outlets

Flush telephone and data outlets shall be provided where shown on the drawings and complete with white finish plate with PVC sleeve cord with internal diameter of 5mm complete with steel clamp to retain sleeve cord on underside.

2.47 Structured Cabling for Data and Telephone Network

This section of the Specification includes the inspection, delivery to site, unloading, complete installation, putting into commission and handing over in the approved working order, the whole of data, telephone cables and wiring as detailed herein and in the tender.

The work includes the supply, delivery and erection of all termination blocks, fibre optic cable and its accessories, unshielded twisted pair (*UTP*) cable CAT 6 (multi-core), terminal outlets, racks, cable cleats, Unistrut and fittings required for the support and accommodation of the cables and wiring, grouting of rag bolts for the fixing of cable racks, supports, and setting to work. The work includes the installation of the data and telephone cables and related wiring within the ducts, conduit, trunking and the proper protection, marking and terminations of all such data and telephone cables.

Under this project short distances will be covered. In this case only complete stretches of UTP cables, optic fibre cable etc will be used and no joints will be permitted. However, where joints are permitted by the Engineer for any reason they shall be of an approved type and manufacture. The data and telephone cabling network installation shall be as manufactured, installed and tested in accordance with the international standards following and in particular the ones described herein shall apply: -

Fibre optic cables provided shall comply with BS EN 60794-1-20:2014 and the relevant local by-laws.

Unshielded twisted pair (UTP) cables CAT 6 shall comply BS EN 50173-1:2011 (Information technology generic cabling), BS EN 50174-1:2009-A2:2014 (Specification and quality assurance) or approved equivalent standard.

The data network accessories shall comply with IEE 802-3 and BS EN 61000-6-4:2001 or approved equivalent standard.

All cables and accessories shall be delivered to site in the same coils and packing as dispatched from the manufacturer with the labels showing size, type and length. This shall be unpacked only in the presence of the Engineer or his representative and handed to him.

The Contractor shall agree with the Engineer and the Employer route of all cables, conduit and cable trunking and shall not install such trunking or conduits until agreement and approval has been given.

2.48 Fibre Optic cable

The fibre optic cable shall be of the multimode type and with top quality ceramic connectors and to final approval of the Employer or the Engineer. The fibre optic cable shall be manufactured by a renowned company and installation shall be carried out by authorised specialist only.

All fibre optic cable and the related accessories provided and installed under this section of the Specification shall comply with ISO/IEC 1180 (Information technology – Generic cabling for customer premises or approved equivalent standard.

The fibre optic cable supplied shall be multimode type, 4-core and have a maximum attenuation of 3.75 dB/Km at 850 nm and maximum of 1.5 dB at 1300 nm, Bandwidth 160 KHz/Km at 850 nm and 500 MHz at 1300 nm, cable size (3 x 6.1 mm), core diameter 62.5 μm, minimum bending radius 5 cm.

2.49 Unshielded Twisted Pair

The Unshielded Twisted Pair (*UTP*) cables CAT 6 shall meet all standards and have snag-free boots to prevent cable kinks and bent pins when removing from patch panels and they reduce cross talk and shall be subject to final approval of the Employer or the Engineer. The Unshielded Twisted Pair (*UTP*) cables CAT 6 shall be manufactured by a renowned company and installation shall be carried out by authorised specialist only.

All Unshielded Twisted Pair (UTP) cables CAT 6 and the related accessories provided and installed under this section of the Specification shall comply with BS EN 50173-1:2011 (Information technology generic cabling), BS EN 50174-1:2009+A2:2014 (Specification and quality assurance, ISO/IEC 11801 Category 6 Patch or approved equivalent standard.

The Unshielded Twisted Pair (UTP) cables CAT 6 supplied shall be 24 AWG, 4 pair stranded, tinned copper, PVC sheathed, and have a maximum attenuation of 26.1 dB/100m up to 350 MHz frequency, impedance 100 $\pm$ 5 Ω mutual capacitance 200pF/304.8 m and resistance of 24.3 Ω and RJ- 45 connectors.

2.50 Backbone Cabling

Backbone Cabling is the inter-building and intra-building cable connections in structured cabling between entrance facilities, equipment rooms and telecommunications closets. Backbone cabling consists of the transmission media, main and intermediate cross-connects and terminations at these locations.
The proposed backbone cabling will be done using of the multimode fiber with top quality ceramic connectors that supports speeds of up to 10Gbps and it shall comply center with BS EN 60794-1-20:2014 (code for practice for installation of the fibre optic cabling). Each access cabinet will have two fiber connections to the core swithes iniside the Server Room. This will ensure maximum redundancy and failover just incase the primary link fails.

2.51 Structured Cabling Warranty

All the cables to be installed in accordance with the requirements of the manufacturer together with ISO 11801 and EIA/TIA 568 Commercial Building telecommunication Wiring Standards, among many other Industry Standards. The Cabling products will be warranted for 15 years limited channel Warranty.
The ICT sub-contractor will be available to ensure that the Network installation performs as proposed herein during within the 15 year warranty period and beyond.

2.52 Active Equipment

2.52.1 Network Switches

The active equipment shall comprise of Network switches for distribution level. All the access switches will aggregate 24 Port switches and Gigabit Ethernet configurations. The Cisco Catalyst 3560 or an equivalent is an ideal access layer switch for small and large enterprise LAN access or branch-office environments, combining both 10/100/1000 and PoE configurations for maximum productivity and investment protection while enabling the deployment of new applications such as IP telephony, wireless access, video surveillance, building management systems, and remote at the data center. The distribution swithes will collapse to a Cisco Catalyst 3560G-24PS core switch or an equivalent. Additionaly there will be a 2960 LAN edge switch where the service providers will terminate their links.
The Cisco Catalyst 3560 Series or an equivalent is a line of fixed-configuration, enterprise-class switches that include IEEE 802.3af and Power over Ethernet (PoE) functionality in Fast Ethernet video kiosks. Customers can deploy networkwide intelligent services-such as advanced quality of service (QoS), rate limiting, access control lists (*ACLs*), multicast management, and high-performance IP routing-while maintaining the simplicity of traditional LAN switching.
All active equipment within the rack should be grounded to protect the equipment from lightening strikes.
Since the switches have POE capability, some of the external devices like wireless access points and IP cameras will be powered from the switch.

2.52.2 Wireless Connectivity

The wireless hotspots in the open areas/lobbies like the Exhibtion area, Meeting Rooms and Coffee lounge will provide wireless connectivity. Each floor will have several wireless access points based on location and signal strength and thus a single LAN outlet will be installed to connect the access point to the LAN. All the network equipment for wireless connectivity will be installed inside the Server Room.
The proposed design will comprise of LWAPP wireless system, Ruckus ZoneFlex H500 Access Points and Ruckus controller for managing the access points.

2.52.3 LWAPP Overview

Lightweight Access Point Protocol (*LWAPP*) is the underlying protocol used in centralized WLAN architecture. It provides for the configuration and management of WLANS. The various advantages of LWAPP are:-
Removing direct user interaction and management of the AP. Instead, the AP is managed by the WLC through its LWAPP connection. This moves the configuration and firmware functions to the WLC.
Having the AP download its configuration from the WLC, and be automatically updated when configuration changes occur on the WLC.
Having the AP synchronize its firmware with its WLC, ensuring that the AP is always running the correct software version.
Storing sensitive configuration data at the WLC, and storing only IP address information on the AP. In this way, if the AP is physically compromised, there is no configuration information resident in NVRAM that can be used to perform further malicious activity
Mutually authenticating LAPs to WLCs, and AES encrypting the LWAPP control channel.
In addition to the benefits described above, tunneling WLAN traffic in an LWAPP-based architecture improves the ease of deployment without compromising the overall security of the solution.

2.52.4 Wireless LAN Controller (WLC)

A centralized Wireless LAN architecture that provides configuration and management of the wireless network, in addition to tunneling WLAN client traffic to and from a centralized WLAN controller (*WLC*). The Cisco 2125 or an equivalent with Fast Ethernet ports comes in configurations that support up to 25 Lightweight access points. Some ports on this controller can be used to power additional access points since they have power over Ethernet. This controller can accommodate up to 25 AP’s but a new controller can be purchased and clustered to accommodate up to 50 AP’s this only depends on the software versions and model to be the same hence a scalable solution.
We recommend a centralized architecture at the main server room inside the network where all the access points will register and be managed centrally from a wireless LAN controller (*WLC*). WLC will also provide security policies and QOS.

2.52.5 Ruckus ZoneFlex H500 Access Points (e.g.)

This is an indoor access point appropriate for deployment in offices and similar radio frequency environments. It comes with integrated antennae and is easy to set up and manage. It supports both 802.11a and 802.11g standards. This enables it to provide a combined capacity of up to 108 Mbps. It is backward compatible with the 802.11b standard.

SECTION K 3

PART 3 - IPCCTV INSTALLATION PARTICULAR SPECIFICATIONS

3. CCTV (CLOSED CIRCUIT TELEVISION)

The scope of works includes the approval of shop drawings, inspection and approval of installation, testing and commissioning works by a consulting engineer and local authorities if any.

The CCTV system is required to provide discrete surveillance of critical areas of the development (The proposed Medical Centre internally and externally) as well as general monitoring of external areas and shall comply with relevant international standards and regulations.

The system shall provide user-friendly operation for all relevant staff.

The system shall be future proof, scalable and provide a low cost of lifetime ownership.

The CCTV system shall be on an IP platform utilizing the IP Network. The IP network is provided by others and the Security contractor needs to do the necessary coordination to ensure all the points as required are provided. The system shall be centrally controlled from the Control room. The system shall consist but not limited to the following:

- Video wall and management servers
- Network Video Recorders and storage expansion modules
- Video surveillance wall and playback monitors
- Control Keyboards
- Equipment Racks and cable management
- Cameras and cabling (Cabling for Head end equipment and patch lead from camera to data point only. TCP/IP Data network shall be provided by others).

3.1. PERFORMANCE OBJECTIVES AND OPERATIONAL PHILOSOPHY:

3.1.1. The CCTV system shall provide surveillance by means of fixed and Pan, Tilt and Zoom (PTZ) color cameras with pictures displayed on a bank of monitors in the Control room.

3.1.2. External cameras shall be suitable for operation at temperatures up to 50°C and 100% relative humidity. They shall be installed in housings with a rating of IP66. Cameras in front of house areas shall be of integrated smoked dome type.

3.1.3. Internal cameras shall be installed in inconspicuous low profile smoked dome housings with ceiling trim to match false ceiling color. The cameras shall be of low profile and in-ceiling type as far as possible.

3.1.4. Camera mountings and camera type for each location shall be to Engineer's approval. The system shall provide recording of the pictures from all cameras with a frame rate of 4CIF at 6 FPS minimum High risk cameras will be required to record at higher speeds (reception desk etc.). Recording shall use high-resolution digital compression techniques with on-line disk storage at the Recorder for a minimum of 30 days recording.

3.1.5. Operator controlled replay of pictures based on date, time and camera, together with a fast search facility, shall be provided on the playback monitors. The facility shall include fast forward and reverse replay, slow motion replay and single frame viewing. Single frame viewing shall include a zoom facility. The replay of recorded pictures shall not affect normal system operation or recording. It shall also be possible to drag a particular camera from the video wall onto any spot monitor.

3.1.6. Crisp and clear printing at A4 size in color of a single frame from the picture replay facility image, including pictures where the zoom facility has been used, shall be provided through a rack integrated color printer. The system should also be capable of copying the required images across date and time string onto a DVD for remote viewing. Necessary application software and DVD writer (DVD+/-RW) for each DVR shall be provided. The system shall also be capable of streaming video fast (MPEG 4 compression) to a backup device like digital tape, storage drive etc.

3.1.7. The system shall achieve or exceed the technical criteria detailed further in this specification.

3.1.8. The security video system shall be an IP network-based, fully distributed digital video system. The security video system will utilize local area networks (LAN), provided by others, as a transmission medium for video, POE to CCTV cameras and configuration must be coordinated with the IT sub-contractor. The security video system shall provide full video control at the Central Monitoring Locations, with additional full selection capability at any point within the network from a CCTV workstation or other CCTV viewing device. The security video system shall provide unlimited expansion capability for the addition or modification of video inputs and outputs.

3.1.9. The recorders shall be rack mountable and located in Server Room. These recorders shall be on a TCP/IP network (coordinate with structured cabling and Data networking contractor for LAN outlets) for remote viewing at Security Manager's and General Manager's PC. These PC's shall be provided with the necessary remote viewing software and license.

3.1.10. The entire CCTV system components shall be fed from the building UPS power supply for continual operation.

3.2. REQUIREMENTS:

3.2.1. CCTV Control station:

- Split screen capability Enabling 1, 2 or 4 pictures to be displayed on any monitor.
- Automatic camera sequencing to present pictures from each camera in a predetermined sequence to any monitor.
- Manual camera selection to permit the operator to select a specific camera for display on any monitor.
- Manual camera control to permit the operator to control any specific PTZ camera.
- Alarms the control station shall provide a visible and audible indication of any system malfunction.
- Interface The system should interface with the security system head end for

instant real time recording and alarm in case of any security breach.

- Programmability all functions of the system shall be programmable under password control. It shall be possible to program new configurations without disrupting the system operation and to store up to four system configurations.

- Camera pre-set positions PTZ cameras to be able to have pre-set positions/view stored in the system memory.

- Camera sequencing PTZ cameras shall be capable to automatically sequencing through series of predetermined preset positions/views.

3.2.2. SELECTION & SITTING OF CAMERAS:

The Closed Circuit Television System must provide useful recorded information with respect to the activities in the areas described on the drawings and on the schematic diagrams. The system integrator shall study each and every location in detail to ensure that the cameras are located and selected appropriately. The cameras must be sited and have the necessary technical specification to ensure that the images are of high quality.

Typical installation details shall be submitted to highlight the installation heights in coordination with surround ceiling elements and profile and shall also note the day and night light lux levels and should take consideration of any stray external natural or artificial light filtering in. Any presence of strong backlighting, high contrast lighting or spot lighting causing images to be obscured shall also be taken into consideration. Cameras shall have special features if install in areas where the following is likely to occur:

Material submittal shall include for a schedule with details of mounting, type of camera etc. with each camera identified with the unique reference number, location and an accompanying photo showing the details.

Detailed layouts highlighting the angle of view, area of coverage and primary objective for each and every camera should be submitted for approval. Digital site photos with camera positions marked shall be submitted for approval well in advance of fixing the camera to ensure the cameras are located appropriately.

The Cameras selected for each area selected shall be suitable for the location, bearing in mind the light levels, stray light infiltration and the size of the area to be viewed. Each Camera should fall under one of the following four categories and shall meet MOI requirements:

- **Monitoring**: to watch the flow of traffic or the movement of people where you do not need to pick out individual figures.

- **Detecting**: to detect the presence of a person in the image without needing to see their face. Recognizing: to recognize somebody you know or identify that somebody is not known to

- **Identifying**: to record high quality facial images that can be used as identification evidence in a criminal trial.

  The target visualization on the above classification of camera vision shall be as follows:

- **Monitoring** – image produced is a target note of 5% of the volume of vision on the display screen.

- **Detecting** – image produced is a target note of 10% of the volume of vision on the display screen

- **Recognizing** – image produced is a target note of 50% of the volume of vision on the display screen.

- **Identifying** – image produced is a target note of 120% of the volume of vision on the display screen.

  CCTV cameras shall be configured to the above parameters based on the following areas of installation:

  The above target visualization shall be based on the ability to see the size of the human body of 1.6m, height and the image quality shall be measured against the rotation standard using test target of 1.6m height, 0.4 meters wide and mat black in color.

3.2.3. CAMERAS GENERAL SPECIFICATIONS:

- The network camera shall offer dual video streams with up to SVGA resolution (800 x 600) in progressive scan format. Color and day/night models shall be available. Alarms input and relay output shall be built in for integration with hard wired external sensors. The network camera should provide a removable, local storage medium (Micro SD/ SD) for scheduled and event-based recording of images

- Shall be able to record using h.264 high profile encoding to lower bandwidth and storage.

- The network camera shall be capable of firmware upgrades remotely, over the network. In addition, a built-in accessory jack shall provide hardware expansion capabilities for future accessories such as two way audio, hard drive, and so forth.

- The network camera shall provide advanced low-light capabilities for color and day/night models with sensitivity down to 0.12 lux in color and 0.03 lux in black-white (B-W)

- The network camera shall support two simultaneous, configurable video streams. H.264, MJPEG, and MPEG-4 compression formats shall be available for primary and secondary streams with selectable Uncast and Multicast protocols. The streams shall be configurable in a variety of frame rates and bit rates.

- The network camera (day/night model) shall have movable IR cut filter mechanism for increased sensitivity in low-light installations. The presence or absence of the IR cut filter as well as the light level at which it is triggered shall be configurable through a Web browser.

- IEEE 802.3af to supply power to the camera over the network. The network camera shall also offer 24 VAC power input for use where PoE is not feasible or available. Network must be designed to ensure POE can be used to power CCTV cameras.

- The network camera shall use a standard Web browser interface for remote administration and configuration of camera parameters including ABF. The browser interface shall support multiscreen remote monitoring for up to 16 cameras on the same virtual local area network (VLAN).
- Fixed cameras shall be fitted with a varifocal lens in compliance to the sitting requirements described earlier.
- PTZ cameras shall be fitted with lens having an optical zoom of 35X and 12X digital zoom. Zoom speed shall be adjustable from 3.2 – 6.6 seconds. These cameras shall be day-night cameras with a wide dynamic range of 128X; Cameras shall be provided with video motion detection; Cameras shall be fitted with an auto-iris lens; Cameras shall have automatic backlight compensation;
- Megapixel cameras to be used where required by ADTA / MOI

3.2.4. CAMERA SPECIFICATIONS

- Imaging Device 1/3-inch, effective
- Imager Type CMOS
- Imager Readout Progressive scans
- Maximum Resolution 800 x 600
- Signal-to-Noise Ratio 50 dB
- Auto Iris Lens Type DC drive
- Electronic Shutter Range 1~1/100,000 sec
- Wide Dynamic Range 60 dB
- White Balance Range 2,000° to 10,000°K
- Sensitivity f/1.2; 2,850K; SNR >24dB
    a. Color (1x/33ms) 0.50 lux
    b. Color SENS (15x/500 ms) 0.12 lux
    c. Mono (1x/33ms) 0.25 lux
    d. Mono SENS (15x/500 ms) 0.03 lux
- Dome Attenuation
    a. Clear Zero light loss
    b. Smoke f/1.0 light loss

3.2.5. VIDEO SPECIFICATIONS

- Compression H.264 in base profile, MPEG-4, and MJPEG

- Video Streams Up to 2 simultaneous streams, the second stream variable based on the setup of the primary stream
- Frame Rate Up to 30, 25, 24, 15, 12.5, 12, 10, 8, 7.5, 6.5, 4, 3, 2, and 1 (depending upon coding, resolution, and stream configuration)
- Resolutions
    a. 0.5 MPx 800 x 600; 4:3 aspect ratio; 30.0 ips max.,
    b. 5.8 Mbps bit rate for MJPEG; 25.0 ips max.,
    c. 1.6 Mbps bit rate for H.264; n/a for MPEG-4
    d. Protocols TCP/IP, UDP/IP (Unicast, Multicast IGMP), UPnP, DNS, DHCP, RTP, RTSP, NTP, IPv4, SNMP, QoS, HTTP, HTTPS, LDAP (client), SH, SL, STMP, FTP, MDNS (Bonjour)
- Users
    a. Unicast Up to 20 simultaneous users 2 Multicast Unlimited H.264 or MPEG-4
    b. Security Access Password protected
    c. Software Interface Web browser view and setup, up to 16 cameras
    d. Open IP Integration IP camera API

3.2.6. ELECTRICAL SPECIFICATIONS

- Connectors RJ-45 for 100Base-TX, Auto MDI/MDI-X
- Cable Cat6 cable or better for 100Base-TX
- Input Voltage POE unit 24 VAC as applicable
- Power Consumption <6 W
- Current Consumption
    a. PoE <200 mA maximum
    b. 24 VAC <295 mA nominal; <390 mA maximum
- Local Storage Micro SD/ SD
- Alarm Input 10 VDC maximum, 5 mA maximum

3.2.7. MECHANICAL SPECIFICATIONS

- Lens Mount CS mount, adjustable
- Pan/Tilt Adjustment
    a. Pan 368°

b. Tilt 160° (10° to 170°)

c. Rotate 355°

3.2.8. System:

- All elements of the system shall be consistent in quality and connectivity and shall be PAL based;
- System performance shall not be degraded by the transmission cabling;
- A peak invert facility shall be provided to remove picture highlights;
- Performance and resolution criteria along with the image quality shall be tested against a ROTAKIN test standard in compliance to the requirements of PSDB, UK-Performance testing of CCTV Surveillance system (using retaken standard test target) and CCTV Application Guidelines Standard EN 50132 – 7;

3.2.9. Lenses:

Lenses should be of the auto iris varifocal lens variety throughout, even where cameras with electric light compensation (ELC) are used. The focal length of the lenses for each camera will differ and shall be selected and adjusted depending upon the fields of view and compliance to the sitting requirements described earlier that are required at the individual camera locations.

Lenses must be varifocal type and comply with the specification as detailed below:

- Video Iris (Auto, direct Drive):
- Focal Length: to be appropriately selected
- o Relative aperture: as per lens selected
- Mount: CS
- Minimum Object Distance: 0.2m
- Horizontal Angle Of View: as per lens selected
- Filter: as per lens selected

3.2.10. WIDE DYNAMIC RANGE CAMERAS:

These cameras shall be day and night, wide dynamic range with high resolution.

3.2.11. NUMBER PLATE READING CAMERAS (if applicable for external areas cameras):

These cameras shall be able to read and record the car license plates under all lighting conditions as they drop off or pick passengers at the designated point at the Porte cohere or when the cars drive through the parking barriers. As a minimum these cameras shall be wide dynamic, day and night and of high resolution.

3.2.12. CAMERA HOUSINGS:

For car parks, loading bay, external and wet areas, the cameras shall be housed in IP66 rated enclosures with sun shroud and shall be of lightweight aluminum construction.

Cameras in front of house areas should be in-ceiling or wall mounted with smoked dome.

External cameras wherever applicable should be of pole mounted.

All mounting arrangements shall be submitted for the approval of the Engineer and Interior Designer/Architect.

The outdoor enclosure shall allow the use of cameras with fixed focal length lenses or motorized zoom lenses (with or without auto iris operation) and shall allow for indoor/outdoor applications. The enclosure shall have a front / top hinged lid to provide easy access to the removable camera sled/ tuning of camera lenses and shall have adjustable glands on the bottom of the enclosure for easy installation of the power / video cables. Enclosures should have heater-defroster, blower, and sun shroud as applicable

The outdoor enclosure shall meet or exceed the design and performance specifications. Supporting documents/ calculations should be submitted.

3.2.13.1 DOME-DOME CAMERA (USED IN THE Offices/Meeting rooms/stores/ICT rooms)

Megapixel camera with features and characteristics as follows:

A. Imaging

- Image Sensor: Progressive Scan CMOS
- Sensor Size: 1/2.8 inch
- Effective Pixels: 1984(H) x 1225(V) (2MP)
- Horizontal Resolution (TV lines): 1100 TVL
- S/N Ratio: 52 dB

B. Minimum Scene Illumination

- Color: 0.18 Lux at F1.4 (2400 ºK, 30 IRE).
- Black and White: 0 Lux (IR LED on).

C. IR Illuminators

- IR Sensitivity Range: 700 – 1100 nm
- Adaptive IR LED (IR Exposure Compensation) x 15 (850 nm)
- IR Working Distance: 30m (0 Lux, 30 IRE, Max exposure gain)

D. Lens

- Focal Length: Vari-focal, f3.3-12 mm
- Aperture: F1.4
- Iris: P-Iris Control
- Focus: Remote focus and zoom
- Lens Mount: Board Mount

- Horizontal Viewing Angle: 82º- 24º
- Viewing Angle Adjustment: Pan: 0° - 350°°; Tilt: 17° - 163°; Rotate:0°-350°

E. Day/ Night

- Day/Night switching: ISP based switch, configurable
- Mechanical IR Cut Filter: Yes

F. Electronic Shutter:

- Manual Mode : 1/5 – 1/2,000 sec
- Auto Mode : 1/5 – 1/10,000 sec
- Functions
- Superior Low Light Sensitivity (SLLS) : Automatic
- Basic WDR (75 dB)
- White Balance: Auto/ hold /manual.
- Brightness
- Contrast
- Automatic Sharpness
- Automatic Gain Control
- Digital Noise Reduction
- Flicker less
- Image Orientation: Image Flip / Image Mirror
- Privacy Masks: 4 configurable regions
- Text Overlay: User defined text on video
- On-Screen Graphics: User defined image layer on video
- Calendar function with on-chip clock (Real-time clock)
- Alarm: Alarm trigger, Video motion detection, motion regions, sound detection, external device through digital regions
- Alarm Response: Notify control center, Change camera settings, Change camera settings, Command other devices, E-mail notification with snapshots, Save video or snapshot to local storage, Upload video, snapshot to FTP server, Activate external device through digital output

G. Video Analytics:

System requirement

- PC based Smart Search Tool, IVS Server or ALPR Server is required
- Software Based Analytics:
- Motion Detection
- Line crossing
- Enter Area
- Missing Object
- Unattended Object
- Tamper
- Object Counting
- People Counting
- License Plate Recognition

H. Compression: H.264 (Baseline/ Main/ High profile) / MJPEG.

I. Picture Resolution:

- 1920 x 1080
- 1280 x 720
- 800 x 600
- 640 x 48
- 320 x 240

J. Maximum Image Frame Rate:

- 30 fps at 1920 x 1080
- 30 fps at 1280 x 720
- 30 fps at 800 x 600
- 30 fps at 640 x 480
- 15 fps at 320 x 240

K. Bit Rate: 28k – 6Mbps per stream; Support Constant and Variable Bit Rate Mode.

L. Multi-Streaming: Simultaneous dual streams based on two configurations.

M. Audio

- Audio: two-way
- Compression: PCM 8 kHz, 16 bit encoding, mono; G.711 aLaw/uLaw
- Audio Input: 1, Terminal block
- Audio Output: 1, Terminal block
- Interface:
  - External Button: Reset button for factory default setting
  - Local Storage: MicroSDHC/MicroSDXC memory card slot (card not included)
  - Digital Input: 1, terminal block.
  - Digital Output: 1, terminal block

N. Networking

- Network Port: 1, Ethernet (10/100Base-T) via RJ-45 connector.
- Protocol: TCP, UDP, HTTP, HTTPS, DHCP, PPPoE, RTP, RTSP, IPv4, IPv6, DNS, DDNS, NTP, ICMP, ARP, IGMP, SMTP, FTP, UPnP, SNMP, Bonjour, ONVIF Compliant.
- Security: IP address filtering; HTTPS encryption; Password protected user levels; Anonymous login; IEEE 802.1X network access control.

O. Integration

- Unified Solution: Fully compatible with software
- ISV Integration: Software Development Kit (SDK) available; ONVIF Compliant
- GPS position by manual setting
- Firmware Access Browser: Microsoft Internet Explorer 8.0 or newer (full functionality); Safari with QuickTime installed, and other browsers with VLC installed (partial functionality)

P. Mount Type:

- Surface, Pendant, Wall, Corner, Pole, Flush, Gang Box

Q. Environmental Casing

- Vandal Resistant (IK09 rated)
- Transparent Dome Cover

R. Power Source / Consumption

- PoE Class 2 (IEEE802.3af) / 6.49W

S. Physical Characteristics:

- Dimensions (Ø x H): 146 mm x 113.9 mm (5.8” x 4.5”)
- Weight: 538 g (1.186 lb)

T. Temperature

- Starting Temperature: -10ºC - 50ºC (14ºF - 122ºF)
- Operating Temperature:-10ºC - 50ºC (14ºF - 122ºF)

U. Operating Relative Humidity: 10% ~ 85% RH

V. Approvals:

CE (EN 55022 Class B, EN 55024), FCC (Part15 Subpart B Class B), IK09, UL (for optional PoE injector)

3.2.13.2 ZOOM DOME CAMERA (IF ANY)

Megapixel camera with features and characteristics as follows:

A. Imaging

- Image Sensor: Progressive Scan CMOS
- Sensor Size: 1/3 inch
- Effective Pixels: 2048(H) x 1536(V) (3.15 MP)
- Horizontal Resolution (TV lines): 1450 TVL
- S/N Ratio: 52 dB

B. Minimum Scene Illumination

- Color: 0.1 Lux at F1.2 (2400 ºK, 30 IRE).
- Black and White: 0 Lux (IR LED on).
- IR Illuminators
- IR Sensitivity Range: 700 – 1100 nm
- Adaptive IR LED (Object & Zoom Adaptive IR) x 10 (850 nm)
- IR Working Distance: 40m (0 Lux, 30 IRE, Max exposure gain)

C. Lens

- Focal Length: Zoom, f3 ~ 9 mm
- Aperture: F1.2 ~F2.1
- Zoom Ratio: 3x optical
- Zoom Speed: 1 sec (1x to 3x)

- Iris: DC Iris
- Focus: Auto Focus
- Lens Mount Type: Board Mount
- Horizontal Viewing Angle: 84.5°- 29.8°
- Viewing Angle Adjustment: Pan: 0° - 350°°; Tilt: 5° - 170°; Rotate:0°-350°

D. Day/ Night

- Day/Night switching: ISP based switch, configurable
- Mechanical IR Cut Filter: Yes

E. Electronic Shutter:

- Manual Mode: 1/5 – 1/2,000 sec
- Auto Mode : 1/5 – 1/10,000 sec

F. Functions

- Superior WDR (110 dB)
- White Balance: Auto/ hold /manual.
- Brightness
- Contrast
- Automatic-Sharpness
- Automatic Gain Control
- Digital Noise Reduction
- Flicker less
- Image Orientation: Image Flip / Image Mirror
- Text Overlay: User defined text on video
- Provide at least 32 Zoom preset points
- On-Screen Graphics: User defined image layer on video
- Calendar function with on-chip clock (Real-time clock)
- Alarm:
    - Alarm Trigger: Video motion detection, motion regions, and Sound detection, External device through digital input
- Alarm Response:

  - Notify control center
  - Go to Zoom preset point or preset tour
  - Change camera settings
  - Command other devices
  - E-mail notification with snapshots
  - Save video or snapshot to local storage
  - Upload video, snapshot to FTP server
  - Activate external device through digital output
- Video Analytics:
  - System requirement:
  - PC based Smart Search Tool, IVS Server or ALPR Server is required
- Software Based Analytics:
  - Motion Detection
  - Line crossing
  - Enter Area
  - Missing Object
  - Unattended Object
  - Tamper
  - Object Counting
  - People Counting
  - License Plate Recognition
  - Compression: H.264 (Baseline/ Main/ High profile) / MJPEG.

G. Video Resolution:

- 2048 x 1536
- 1920 x 1080
- 1280 x 720
- 800 x 600
- 640 x 480
- 320 x 240

H. Maximum Image Frame Rate:

- 15 fps at 2048 x 1536
- 30 fps at 1920 x 1080
- 30 fps at 1280 x 720
- 30 fps at 800 x 600
- 30 fps at 640 x 480
- 15 fps at 320 x 240

I. Bit Rate: 28k – 6Mbps per stream; Support Constant and Variable Bit Rate Mode.

J. Multi-Streaming: Simultaneous dual streams based on two configurations.

K. Audio

- Audio: two-way
- Compression: PCM 8 kHz, 16 bit encoding, mono; G.711 aLaw/uLaw
- Audio Input: 1, Terminal block
- Audio Output: 1, Terminal block

L. Digital Inputs/ Outputs:

- Digital Inputs: 2 inputs, terminal block.
- Digital Output: 2 outputs, terminal block.

M. Local Storage:

- MicroSDHC/MicroSDXC memory card slot(card not included)

N. External Buttons:

- Factory default Button : 1 ,reset to factory default setting

O. Networking

- Network Port: 1, Ethernet (10/100Base-T) via RJ-45 connector.
- Protocol: TCP, UDP, HTTP, HTTPS, DHCP, PPPoE, RTP, RTSP, IPv4, IPv6, DNS, DDNS, NTP, ICMP, ARP, IGMP, SMTP, FTP, UPnP, SNMP, Bonjour, ONVIF Compliant.
- Security: IP address filtering; HTTPS encryption; Password protected user levels; Anonymous login; IEEE 802.1X network access control.

P. Integration

- Unified Solution: Fully compatible with software

- ISV Integration: Software Development Kit (SDK) available; ONVIF Compliant
- GPS position by manual setting
- Firmware Access Browser: Microsoft Internet Explorer 8.0 or newer (full functionality); Safari with QuickTime installed, and other browsers with VLC installed (partial functionality)

Q. Power Source / Consumption

- DC Power (adapter not included): 12 VDC / 8.44W (with Heater On)
- PoE Class 3 (IEEE802.3af) / 9.76W (with Heater On)

R. Physical Characteristics:

- Dimensions (Ø x H): 152.80 mm x 114.50 mm (6.0” x 4.5”)
- Weight: 1260g (2.77 lb)

S. Environmental Casing

- Weatherproof (IP67)
- Vandal Proof (IK10)
- Transparent Dome Cover

T. Mount Type

- Surface, Pendant, Wall, Corner, Pole, Flush, Gang Box

U. Temperature

- Starting Temperature: -40ºC - 50ºC (-40ºF - 122ºF) within 30 minutes
- Operating Temperature: -40ºC - 50ºC (-40ºF - 122ºF)

V. Operating Relative Humidity: 10% ~ 85% RH

W. Approvals:

CE (EN 55022 Class B, EN 55024), FCC (Part15 Subpart B Class B), IP67, NEMA 4X, IK10, UL (for optional PoE injector and power adapter)

3.2.13.3 BULLET-BULLET CAMERA (EXTERNAL AREAS, GATE AND GATE HOUSE)

Megapixel camera with features and characteristics as follows:

A. Imaging

- Image Sensor: Progressive Scan CMOS
- Sensor Size: 1/4 inch
- Effective Pixels: 2592(H) x 1944(V) (5.04 MP)

- Horizontal Resolution (TV lines): 1350 TVL
- S/N Ratio: 52 dB

B. Minimum Scene Illumination

- Color: 0.18 Lux at F1.4 (2400 ºK, 30 IRE).
- Black and White: 0 Lux (IR LED on).

C. IR Illuminators

- IR Sensitivity Range: 700 – 1100 nm
- Adaptive IR LED (IR Exposure Compensation) x 15 (850 nm)
- IR Working Distance: 30m (0 Lux, 30 IRE, Max exposure gain)

D. Lens

- Focal Length: Vari-focal, f2.8-8 mm
- Aperture: F1.4
- Iris: Fixed Iris
- Focus: Manual focus
- Lens Mount: Board Mount
- Horizontal Viewing Angle: 84º - 39º

E. Day/ Night

- Day/Night switching: ISP based switch, configurable
- Mechanical IR Cut Filter: Yes
- Night mode 0.05Lux

F. Electronic Shutter:

- Manual Mode: 1/5 – 1/2000 sec
- Auto Mode: 1/5 – 1/10,000 sec

G. Functions

- Basic WDR (74 dB)
- White Balance: Auto/ hold /manual.
- Brightness
- Contrast

- Automatic Sharpness
- Automatic Gain Control
- Digital Noise Reduction
- Flicker less
- Image Orientation: Image Flip / Image Mirror
- Privacy Masks: 4 configurable regions
- Text Overlay: User defined text on video
- On-Screen Graphics: User defined image layer on video
- Calendar function with on-chip clock (Real time clock)
- Alarm: Alarm Trigger, Video motion detection, motion regions, Sound detection, External device through digital input
- Alarm Response:
- Notify control center
- Go to Zoom preset point or preset tour
- Change camera settings
- Command other devices
- E-mail notification with snapshots
- Save video or snapshot to local storage
- Upload video, snapshot to FTP server
- Activate external device through digital output

H. Video Analytics:

- System requirement:

  PC based Smart Search Tool, IVS Server or ALPR Server is required

- Software Based Analytics:

- Motion Detection
- Line crossing
- Enter Area
- Missing Object
- Unattended Object
- Tamper
- Object Counting
- People Counting
- License Plate Recognition

I. Compression: H.264 (High Profile)/ MJPEG.

J. Picture Resolution:

- 2592 x 1944
- 2048 x 1536
- 1920 x 1080
- 1280 x 720
- 800 x 600
- 640 x 480
- 320 x 240

K. Maximum Image Frame Rate:

- 15 fps at 2592 x 1944
- 15 fps at 2048 x 1536
- 30 fps at 1920 x 1080
- 30 fps at 1280 x 720
- 30 fps at 800 x 600
- 30 fps at 640 x 480
- 15 fps at 320 x 240

L. Bit Rate: 28k – 6Mbps per stream; Support Constant and Variable Bit Rate Mode.

M. Multi-Streaming: Simultaneous dual streams based on two configurations.

N. Audio

- Audio: two-way
- Compression: PCM 8 kHz, 16 bit encoding, mono; G.711 aLaw/uLaw
- Audio Input: 1, cable with 3.5mm phone jack
- Audio Output: 1, cable with 3.5mm phone jack

O. Interface:

- External Button: Reset button for factory default setting
- Local Storage: MicroSDHC/MicroSDXC memory card slot (card not included)
- Digital Input: 1, cable without connector
- Digital Output: 1, cable without connector

P. Networking

- Network Port: 1, Ethernet (10/100Base-T) via RJ-45 connector.
- Protocol: TCP, UDP, HTTP, HTTPS, DHCP, PPPoE, RTP, RTSP, IPv4, IPv6, DNS, DDNS,NTP, ICMP, ARP, IGMP, SMTP, FTP, UPnP, SNMP, Bonjour, ONVIF Compliant.
- Security: IP address filtering; HTTPS encryption; Password protected user levels; Anonymous login; IEEE 802.1X network access control.

Q. Integration

- Unified Solution: Fully compatible with software
- ISV Integration: Software Development Kit (SDK) available ; ONVIF Compliant
- GPS position by manual setting
- Firmware Access Browser: Microsoft Internet Explorer 8.0 or newer (full functionality); Safari with QuickTime installed, and other browsers with VLC installed (partial functionality)

R. Environmental Casing

- Weatherproof (IP68)
- Vandal proof metal casing (IK10)

S. Mount Type:

- Wall, Ceiling, Corner, Pole.
- Power Source / Consumption
- PoE Class 2 (IEEE802.3af) / 5.76W (IR LED on)

T. Physical Characteristics:

- Dimensions (Ø x L): 77 mm x 218 mm (3.04" x 8.58")
- Weight: 955 g (2.105 lb)

U. Temperature

- Starting Temperature: -20ºC - 50ºC (-4ºF - 122ºF)
- Operating Temperature:-40ºC - 50ºC (-40ºF - 122ºF)

V. Operating Relative Humidity: 10% ~ 85% RH

W. Approvals:

CE (EN 55022 Class B, EN 55024), FCC (Part15 Subpart B Class B), IP68, NEMA 4X, IK10 (metal casing), UL (for optional PoE injector)

- **NUMBER PLATE READING CAMERAS (IF APPLICABLE):**

These cameras used at the gate entrance and gate house shall be able to read and record the car license plates under all lighting conditions as they drop off or pick passengers at the designated point at the Porte cohere or when the cars drive through the parking barriers. As a minimum these cameras shall be wide dynamic, day and night and of high resolution.

- **CAMERA HOUSINGS**:

For car parks, loading bay, external and wet areas, the cameras shall be housed in IP66 rated enclosures with sun shroud and shall be of lightweight aluminum construction.

Cameras in front of building areas should be in-ceiling or wall mounted with smoked dome.

External cameras wherever applicable should be have pole or wall mounted.

All mounting arrangements shall be submitted for the approval of the Engineer and Architect.

The outdoor enclosure shall allow the use of cameras with fixed focal length lenses or motorized zoom lenses (with or without auto iris operation) and shall allow for indoor/outdoor applications. The enclosure shall have a front / top hinged lid to provide easy access to the removable camera sled/ tuning of camera lenses and shall have adjustable glands on the bottom of the enclosure for easy installation of the power / video cables. Enclosures should have heater-defroster, blower, and sun shroud as applicable

The outdoor enclosure shall meet or exceed the design and performance specifications. Supporting documents/ calculations should be submitted.

3.2.14 NETWORK VIDEO RECORDER SOFTWARE OVERVIEW

A. Introduction

The Network Video Recorder software is a Windows-based server that provides distributed network video surveillance solution with full functionality. This software supports centralized management, real-time monitoring and recording of up to 200 video streaming devices from local or remote network, with rule-based services to trigger multiple schedules and events.

B. Basic Architecture

The Network Video Recorder is a typical web-based server/client system. In a video surveillance system architecture, the Server serves as a video management service provider, aimed to run 24/7 offering non-stop services for clients. A Client makes requests of monitoring video streams or playback recordings to Server, which can reside on the same computer with server program (as from local) or on another computer (as from remote). Server starts automatically as soon as the **Server computer** (where it is installed) boots up, and operates in the background without requiring login by administrator. It would provide services over the TCP/IP network to multiple **Clients** upon request through HTTP Protocol.

It should support two types of **Clients**: **Web Client** and **Workstation Client**.

Live view, PTZ, Playback, e-Map, event management and setup functions are available through Web Client and Workstation Client.

1. Web Client: the web interface to access NVR server without need of installing any client program to become a client. Logging in the NVR server is as simple as visiting a website through Microsoft Internet Explorer browser.

2. Workstation Client: the client application making accessing NVR server free from the use of browser .The workstation includes a set of programs that provide interface between users and the NVR server.

C. IP Camera and Video Encoder Support

The NVR server supported IP cameras and video encoders to provide the different resolution from VGA to 10-Megapixel resolution and Audio, DI/DO, Motion Detection and PTZ.

Maximum Number of Clients: 1 local, 3 remote (concurrent)

Maximum Number of IP devices: 200 channels

Free Bundled License: 64 channels

Maximum License: 200 channels

Supported Video compression: H.264, MPEG-4, MJPEG

Supported Audio compression: PCM, G.711 a-law/u-law

(Audio function is supported on local recording and remote live view/playback, not support local live view/playback)

Supported frame rate: The live view and playback frame rate may vary between 1fps and 30fps, depending on the number of channels, current layout or CPU performance

D. Account Management

The system shall provide users account management, multi-level access permissions and be able to add user account from Microsoft Active Directory.

E. System Log

The system log records the system information and users operations.

F. License

It should come with 64-channel free and maximum is 200-channel.

G. Mobile solution

Active Mobile Client is a free application to remotely access NVR 3.0 server on iPhone, iPad, iTouch and Android devices. It provides the following functions- live view, PTZ control, playback, event and time based search.

H. Software Installation and Upgrade

The new release version shall be downloaded from website. To follow the instructions of Install Shield Wizard to proceed and complete the installation. The server would start its service right after installation completes, without the need to restart the server computer.

I. Maximum local display resolution: 1920 x 1080

J. Key Features

1.8-bay Rack mount (2U) with hardware RAID (0, 1, 5, 10)

2.Manage up to 200 IP cameras or video encoders

3.Recording up to 200 Channels

4.Support H.264/MPEG-4/MJPEG formats up to 5-Megapixel resolution

5.Support rewrap function with fisheye view technology

6.PTZ and speed control, preset points and tours, mouse PTZ

7.Live view local up to 16 channels, remote up to 64 channels

8.Live view with for 4:3 monitor and 16:9 wide screen monitor

9.Instant playback in live view window

10. Synchronized playback local up to 9 channels, remote up to 64 channels

11. Time and event based search

12. Export video with Raw and AVI formats

13. Event trigger, response and notification

14. Scheduled, event triggered, manual recording and snapshot

15. Remote access with Mobile Client, Web Client or Workstation

16. Location-based management with eMap

17. eMap with camera icons, mini live views, view linker and event status

18. 64-channel free license included
19. Compatible with Redundancy Server

It shall support different brand cameras via licensed Camera Device

3.2.15 CCTV CONTROL ROOM AND SERVER ROOM SPECIFICATIONS (HEAD END)

3.2.15.1 Virtual Matrix Controller

- Operator Console Management Server
- The management server shall support database redundancy by utilizing two servers and maintaining constant synchronization between the two servers. In the event of a system manager failure, the hot standby shall assume management responsibilities until the failed unit is restored. No loss of functionality, recording, or monitoring capability shall occur during the failover process.
- The management server shall serve as the security key server for the entire system and manage device registration and message authentication using the RSA 256-bit public/private key system.
- The management server software shall manage user rights and permissions. The system manager shall provide for an unlimited number of system operators with personal identification numbers (PINs) that define priority levels, operator facilities, system roles, and camera and monitor groupings. Cameras, monitors, and other system components can be structured in logical groups and user access to groups or individual elements can be restricted.
- The management server shall serve as an NTP Server for the IP video security system. The management server shall be synchronized to an external timeserver such as a GPS NTP server so that all system components function on the same time basis. All time-zone corrections shall automatically be provided in the system.
- The management server shall be capable of performing as a DHCP and UPnP server for the entire system and components. The management server shall provide all connection and management communications between system devices.
- The management server shall store a database of all user activity, alarms, and device diagnostic errors. Administrators shall have the ability to determine the retention time targeted for the information. All log entries shall be searchable and exportable through the system log window.
- The management server shall allow for connection to an intelligent uninterruptible power supply (UPS), and it shall allow for the initiation of a graceful shutdown should the UPS deplete its stored charge.

3.2.15.2 Video Encoders (if applicable)

- All Each of the video encoders shall support an asynchronous serial port that can be programmed for data rates up to 230 kbps and can be set to RS-422 or RS-485 signal levels. The RS-485 mode shall support two-wire and four-wire interfaces.

- The dual-stream video encoder shall offer two security modes, video loss indicator, and bidirectional audio support.

- The video encoders shall accept NTSC or PAL video signals from fixed color/black-white cameras, PTZ cameras, low light cameras, or any other camera that provides a composite NTSC encoders shall accommodate mounting into a standard EIA 19-inch rack or separately into a wall mount bracket. The rack unit shall be capable of redundant power.

- The video encoder shall transmit video, audio and data over the IP network.

- The video encoder shall support dual encoded stream capability from a single video source to allow simultaneous and independent viewing, recording, and/or quality. The first stream shall be the specified recording quality. The second stream shall be of lower quality for automatic selection for network and processor management.

- The dual-stream video encoder shall be a high performance, single, 8-, or 16-channel video encoding unit.

- The video encoder shall be able to convert live analog video signals into dual MPEG-4 or H.264 streams. The dual stream video encoder shall process up to 25 images per second (ips) per stream at 4CIF (PAL: 704x576) resolution. The encoding shall use motion adaptive de-interlacing technology to reduce jitter in 4CIF images.

- The dual-stream video encoder shall incorporate the ability to automatically serve the appropriate stream to a workstation, network decoder, or virtual console display based on the screen configuration of the display unit without affecting the recording rate. This shall save on both CPU processing power required to display all the cameras in the given configuration as well as reduce the network bandwidth required to transmit all the cameras to the display device.

3.2.15.3 PAL 1 Vp-p video signal.

- Each of the video encoders shall support three NO/NC dry-contact inputs and one relay output. The latching alarm shall continue to record until user acknowledgement can be programmed for a predetermined time-out.

- Each of the video encoders shall transmit all command and control messages using the TCP/IP protocol and use PKI RSA-256 bit encryption for secured communication. All compressed video will be digitally signed by the video encoder prior to transmitting across the network. This digital signature shall be utilized to validate the integrity of all exported video.

- Each of the Video encoders shall have the capability to provide an advanced built-in video motion detection separate from the Digital IP based recording system to activate recording with a pre-alarm capability of up to 24 hours

- Intelligent video encoders shall have the ability to run any selected video analysis software to detect selected behaviors and provide alerts to operators and the rest of the system.

- Environmental Specifications

- Operating Temperature 32° to 95° F (0° to 35°C) at unit air intake

- Operational Humidity 20% to 80%, non-condensing
- Storage Temperature -49° to 149°F (-45° to 65°C)
- Maximum Humidity Gradient 10% per hour
- Operating Altitude 50 ft to 10,000 ft (-16 m to 3,048 m) Video Decoders
- All video decoders shall accommodate mounting into a standard EIA 19-inch rack or separately into a wall mount bracket. The rack unit shall be capable of redundant power.
- The video decoder shall receive video, audio and data over the IP network.
- The video decoder shall support any digital video stream on the network and allow for the decoding of up to sixteen simultaneous streams from any IP camera, video encoder or recorder on a single monitor. It shall also allow for simultaneous and independent viewing at the recording frame and quality rate.
- The IP video decoder shall support MPEG4, H.264 baseline profile, H.264 main profile, and H.264 high profile encoded video streams.
- The IP video decoder shall decode up to 16 4CIF resolution, 30IPS video streams simultaneously, or up to 12 H.264 baselines, 4CIF resolution, 30IPS video streams simultaneously, or up to 2 1080p streams encoded in H.264 baseline profile.
- The IP video decoder shall drive two high-resolution monitors via a DVI connection for displaying the video footage.
- The IP video decoder shall manage the CPU processing requirements and network bandwidth requirements by automatically subscribing to a lower resolution, lower frame rate stream from a given camera depending on the screen configuration chosen.
- End-to-end pan-tilt-zoom control latency shall not exceed 160 ms at 4CIF resolution, 25IPS video, excluding network transmission latency.
- The IP video decoder shall detect the monitor native and adjust resolution and aspect ratio accordingly.

Environmental Specifications:

- Operating Temperature 32° to 95° F (0° to 35°C) at unit air intake
- Operational Humidity 20% to 80%, no condensing
- Storage Temperature -49° to 149°F (-45° to 65°C)
- Maximum Humidity Gradient 10% per hour
- Operating Altitude 50 ft to 10,000 ft (-16 m to 3,048 m) PC Workstation
- The PC workstation shall utilize a Microsoft based graphical user interface and keyboard/mouse for monitoring live and recorded video, and virtual matrix functionality that allows operators to see and respond to any alarm from any device on the network as well as direct any camera to any monitor on the

network.

- The PC workstation shall allow administrators to configure devices, set up users, adjust network settings, and create recording schedules. Permission to access these functions and all other system services can be configured to a fine level of detail.

- The PC workstation shall have advanced search capabilities, event logging, and alarm interface displays.

- The PC workstation shall export video and still images in multiple formats, including QuickTime MPEG-4, H.264, AVI, BMP, and JPG. A front panel USB port and DVD/CDRW drive make it capable of exporting video clips and still images to external media. Authentication software shall be exported automatically.

- The PC workstation shall allow users with authority to monitor content from standard resolution and mega pixel resolution cameras and encoders throughout the network. The PC workstation shall display content encoded in MPEG4, H.264 baseline, H.264 main, and H.264 high profile.

- The PC workstation shall be capable of decoding up to 16 simultaneous 4CIF resolution, 30 image per second video streams encoded in MPEG4, or 12 simultaneous 4CIF resolution, 30 images per second video streams encoded in H.264 baseline profile, or 2 simultaneous 1080p video streams encoded in H.264 baseline profile.

- The PC workstation shall be capable of minimizing the CPU processing load and network bandwidth required by automatically seeks out and subscribes to a secondary stream at a lower resolution when the display is changed to a multi-way display.

- The PC workstation shall support CCTV-style keyboard control for camera call-up, PTZ control, preset and pattern call, and multi-display layout.

- The PC workstation shall detect the monitor’s native resolution and provide users with a single, 2x2, 3x3, 4x4, 1+5, 1+12, 2+8 for 4:3 aspect ratio monitors and adds 3x2 and 4x3 for 16:9 aspect ratio monitors.

- The PC workstation shall retain the camera’s aspect ratio and allow mixing standard resolution and mega pixel resolution cameras on the same monitor.

- The PC workstation shall allow any combination of live or playback video on the same monitor at the same time. The workstation shall also provide synchronous playback of up to sixteen (16) cameras simultaneously.

- The PC workstation shall provide for digital zoom capability for any camera in live or playback mode.

- The PC workstation shall provide a feature that can generate up to six (6) independently controlled and zoomed images from a single image and allow operators to maintain a panoramic view of the scene while closely monitoring selected areas. This shall be accomplished without requiring additional network throughput.

- The system shall be capable of customizing the display area to suit user preferences. All aspects of the graphical user interface can be resized, torn-off and moved to other monitors, or simply hidden. Up to six (6) customizable video windows can be created and loaded with camera groups to facilitate easy and efficient monitoring. The system shall allow for up to two video display tear-offs accommodating up to thirty-two (32) camera display.

- The PC workstation shall automatically load a user's language preferences, camera groups, and screen configurations upon login. The PC workstation shall also support languages that do not utilize the Latin alphabet such as Chinese, Korean, and Arabic.

- The PC workstation shall notify operators of all alarms on the system in convenient alarm tab. Video thumbnails shall be available for visual verification within the alarm monitoring workspace. Alarms can be acknowledged or snoozed by the operator. The PC workstation application shall support the functionality to view procedures and instructions for given alarms; these procedures shall be triggered to appear during a certain event, and they can be used to provide detailed written or verbal instructions to the operator as to the actions to be taken. In addition, operators can enter their own feedback to the given alarm. All user alarms and user action shall be kept in the system log for audit purposes.

- The PC workstation application shall provide the ability to control and program any camera equipped with PTZ. The PC workstation shall be capable of the following:

- Manually control the PTZ

- Set the pan/tilt home positions for manual or alarm activation

- Automatically control the cameras through an alarm trigger

- Ability to set multiple preset positions

- Ability to set multiple tours

- Remotely set and clear the movement limits of the pan/tilt mechanism from the control room, through a telemetry unit at an outdoor camera site

- Adjust the zoom lens

- The ability to control the camera menu and setup the camera through the IP video security system

- The PC Workstation shall be available as a software package that can be loaded on multiple user purchased CPUs. Software licenses shall be available as single licenses, or in packs of 5, 10, 25, or as a site license for use on any CPU.

3.2.15.4 Network Storage Manager

- The network storage manager shall record video and audio streams from IP cameras and video encoders on the network.

- The network storage manager shall not utilize a separate NVR server to run the NVR software. Instead, the server functions and storage elements shall be integrated into a purpose-built chassis.

- The network storage manager shall utilize RAID6 parity across the storage drives to protect recorded data against a hard disk drive failure. There shall be no degradation of operation during RAID rebuild.

- The network storage manager's chassis shall be designed for video surveillance recording applications and encompass redundancy at all vital points:
- Redundant, hot swappable power supply modules
- Redundant, hot swappable internal chassis fans
- Hot swappable O/S drive
- Hot swappable rear exhaust fan
- The network storage manager's chassis shall be designed for on-line service and maintenance and shall not need to be removed from the rack when needing to replace hard disk drives, fans, power supplies, or operating system drives.
- The network storage manager shall utilize the SAS protocol to support direct attached storage expansion boxes. Up to 7 expansion boxes can be connected to a network storage manager to increase retention times.
- The storage expansion box shall have the same redundancy and service specifics as the network storage manager. The expansion boxes shall requires less power and produce less BTU then the network storage manager.
- The storage expansion boxes shall support a mechanism to daisy-chain storage boxes together via a SAS cable. All enclosure management and diagnostic messaging shall flow through the SAS connector to the host network storage manager.
- The network storage manager shall be built upon a reliable and robust Linux operating system.
- The network storage manager shall utilize distributed load balancing across other network storage managers configured in a storage pool and provide automatic network failover from any box to any box. Based on the configuration, one less than the total number of units in a pool can fail and recording will continue. The configuration shall be configured for a specified amount of time before retention is decreased. The duration of time between a unit failing and its associated cameras being equally distributed onto remaining storage managers shall not exceed 90 seconds.
- The network storage manager shall support a guaranteed recording throughput of 250Mbps per storage device with a minimum of 64Mbps of read throughput. This throughput shall be guaranteed under normal and error (RAID rebuild) conditions.
- The network storage manager shall support any number of cameras so long as the maximum throughput required is under 250Mbps.
- The network storage manager shall support the recording of MPEG4, H.264 baseline,
- H.264 main profile and H.264 high profile streams from standard resolution and mega pixel cameras.

- The network storage manager shall support continuous, scheduled, alarm/event (including analytics alarms), motion, and manual recording. Pre-and post-alarm periods shall be programmable up to the total capacity of the system.

- The network storage manager shall support bookmarking and locking/unlocking of video content on the drives.

- The network storage manager shall support privacy tools that allow administrators to establish maximum retention times for normal, alarm, and locked video.

- The network storage manager shall support an intelligent video grooming protocol that can reduce the frame rate of recorded video as the video's age passes a determined limit. Administrators shall have the flexibility to determine whether to groom alarm video or leave it at its real-time level.

- The network storage manager shall have the ability to report all diagnostic events, including software status diagnostics to a centralized user interface. In addition, SNMP traps shall be available for monitoring via a third party SNMP management console.

- The network storage manager shall be fully managed from a remote workstation, including the ability to configure settings and update firmware and software.

Environmental Specifications:

- Operating Temperature 50° to 95° F (10° to 35°C) at unit air intake

- Operational Humidity 20% to 80%, non-condensing

- Storage Temperature -49° to 149°F (-45° to 65°C)

- Maximum Humidity Gradient 10% per hour

- Operating Altitude 50 ft to 10,000 ft (-16 m to 3,048 m)

3.2.15.5 Virtual Matrix Controllers (If any)

- The virtual matrix controllers provide a user interface to the IP video security system. When used with the keyboard controller, the video console display shall allow a user to operate the system like a traditional matrix using the joystick, jog shuttle, and keypad to control the video display. The video console display shall also provide NVR-like functionality allowing users to record, play back, and export video.

- The virtual matrix controllers shall be a high performance, multiple stream decoding units. It shall convert up to 16 4CIF/30IPS MPEG-4 streams, or 12 4CIF/30IPS H.264 baseline profile streams, or 2 1080p H.264 baseline profile streams into video signal to be viewed on digital monitors.

- The virtual matrix controllers shall decode and display up to 16 MPEG4 4CIF/30IPS streams, or 12 H.264 4CIF/30IPS baseline profile streams, or 2 1080p H.264 baseline profile streams simultaneously.

- The virtual matrix controllers shall drive up to two (2) 4:3 or 16:9 digital monitors connected via DVI connectors and support up to 32 cameras per console.
- The virtual matrix system shall accommodate growth by adding additional virtual matrix controllers, keyboards, and network decoders to decode additional video inputs and drive monitor walls.
- When multiple images are displayed, the IP Video Security System shall automatically seek and display a lower resolution stream to conserve CPU processing requirements and network bandwidth.
- The virtual matrix controller shall provide full access to operations, through user-friendly, highly intuitive, and semi-transparent on-screen menus. An on-screen graphical overlay shall allow users to turn on and off the overlay with a single button push of the keyboard controller. The video console display shall have on- screen PTZ, device playback, property controls, and alarm interface display.
- The virtual matrix controller shall be controlled by an attached keyboard or through the PC workstation.

3.2.15.6 Operator Console

All cameras shall be displayed on high resolution 43" LCD displays hereafter referred to as the video wall. The system shall further be enhanced with operator control stations for view and review purposes. It shall be possible to drag and drop any camera to any display at any time without interfering with the operation of the recording of the system. It should also be possible to import a Site Map indicating cameras for camera selection via the map. The GUI for the map should have 10 maps as a minimum.

Only purpose made CVBS LCD color monitors shall be used. The Video wall shall consist of 43" high resolution (1920 x 1080) LCD monitors with a minimum lamp life of 50 000 hours. The spot and review monitors shall be min 23" LCD displays with keyboard controller to view and review any camera on the network at any time. The video wall and the playback monitors are to be installed onto purpose made wooden console to the approval of the architect. Proper cable management shall be provided and the design shall include a table top for keyboard and security personnel management.

3.2.16 CABINETS/EQUIPMENT RACK:

All the equipment as mentioned as part of the Head end shall review and view be installed in self-contained nineteen inch lockable racks with a glass door. The cabinets shall accommodate the NVR's, Video Wall Controllers, Management system, Storage servers, Workstations and other related equipment. The cabinet shall be provided with an in-line UPS having autonomy of 20 minutes and shall have a redundant power supply unit fed from this UPS. Normal power supply will be from the building UPS.

3.2.17 CABLING AND INSTALLATION:

All cabling should be concealed. Use discrete cable management even for surface mounted camera units. Submit detailed installation drawings for approval for each type of camera and each typical location.

All cables must be properly marked with purpose made cable markers. The use of masking tape or hand written pen markings is deemed unacceptable.

All internal cameras shall be mounted firmly on fixed brackets, which should blend with the color of the camera, where surface mounted (not allowed for public areas).

Glazed and framed schematics showing camera location/colour snapshot of the area (3”x2” min) / type / reference no. /primary purpose (screen fill and intended coverage), cabling and head end infrastructure should be affixed on wall at the Main Risk Command Centre.

Another glazed and framed schematic as above should also be placed at the Main Risk Command Centre.

Network

An IP CCTV data network shall be provided which is separate from the hotel data network. This Ancillary data network shall only be interfaced to the hotel network at server level if required by operator.

3.2.18 CONTAINMENT

Shall be supplied and installed by MEP contractor in coordination with system provider

SECTION K 4

FIRE ALARM INSTALLATION PARTICULAR SPECIFICATION

4 FIRE DETECTION AND EVACUATION SYSTEM

4.1 SCOPE OF INSTALLATION

4.1.1 The scope of these works covers the engineering, supply, installation, testing and commissioning of the entire Fire Detection Alarm and Voice Evacuation as indicated on the drawings and specifications. All works shall be to the requirements of project rational fire design and relevant NFPA and BS standards (NFPA72, NFPA101, NFPA 2001 and their annexure). All system components related to this scope of works shall be UL listed.

4.1.2 The development shall have a fully addressable networked system consisting of the following:

a. The main fire detection & alarm control panel (FACP) shall be located in the Control Room with subpanels as indicated on the schematic drawings. The Network repeater Panel shall be located in operators' office. A personnel computer (graphics PC) shall be linked to the Main Panel and shall graphically indicate the complete commercial area development's fire detection system and shall be located at the ICT Room.

b. The main fire alarm panel subpanels and repeaters (in case needed) shall be networked together. The network shall be highly resilient and allow true peer to peer communication allowing full monitoring and control from any one of the networked panels. It shall allow bi-directional signaling and offer a high level of integrity and shall be interconnected through cable recommended by manufacturer and as approved by Engineer. The Network connections shall be via Fire Proof cabling.

c. An addressable smoke detector with sounder base and a separate voice evacuation speaker shall be installed in different areas except parking areas we shall have an addressable heat detector to be installed. Voice evacuation speaker with strobe be installed in accessible public toilets. Addressable smoke detectors, heat detectors etc. shall also be located strategically throughout the public and back of mall and office tower areas. Furthermore flush mounted Sounders/break glass units shall be installed at escape entrances, escape routes and parking areas and wired to the alarm panel.

d. In addition evacuation loudspeakers/combined flasher sounder units will be located strategically in public areas including passages, fire escape stairs and throughout the escape route. Sounder with strobe shall be provided for large mechanical, electrical and other plant rooms.

e. A low pressure automatic clean agent fire suppression system to relevant NFPA standards (NFPA 2001) and to the requirements and approval of Engineer shall be provided to protect the Main Server Room and shall be interfaced with the fire detection network.

f. The entire works for the fire detection alarm and voice evacuation system is to be engineered, installed, tested and commissioned by a specialist Engineer approved contractor. In addition the shop drawings, schematics, cause and effect matrix and all components and materials shall be fully approved by Engineer should it be required.

4.2 SYSTEM PHILOSOPHY

4.2.1 The system shall consist of all necessary hardware equipment and software programming tools to perform the following functions:

a. Smoke and Fire detection and alarm operations

b. Control and monitoring as relevant of elevators, smoke control equipment, door hold-open devices, fire suppression systems, mechanical plants, life and other equipment and other equipment as indicated in the drawings and specifications.

c. Two-way supervised firefighter's phone operations

d. One way supervised automatic voice alarm operation.

e. Remote accessing of the fire Alarm Panel through LAN/WAN/Internet connection. It should also be possible to generate e -mail automatically to report alarm and system related trouble messages. All necessary interface units/cards in the main panels to achieve this facility shall be included

f. Actuation of the complete fire alarm system shall be initiated by, but shall not be limited to any or all of the following means:

- Manual pull station initiation
- Automatic detection
- Sprinkles system flow switch activation
- Extinguishing system operation

g. All devices, including smoke detectors, break glass units, relays etc. shall be provided with an engraved label, identifying the loop circuit reference. All devices visible to public view shall be low profile (semi-flush) and powder coated with RAL color to match the ceiling around.

h. All devices shall be manufactured by a single manufacturer.

i. All devices shall be suitable for the location with appropriate enclosures/back boxes including weatherproof arrangement for external wet areas and plant rooms.

4.3 SYSTEM DESCRIPTION

Provide a complete, non-coded, analogue addressable, microprocessor-based fire alarm system with initiating devices, notification appliances, and monitoring and control devices as indicated on the drawings and as specified herein.

4.3.1 Software: The fire alarm system shall allow for loading and editing instructions and operating sequences as necessary and to the Engineers approval of Cause & Effect Matrix and system philosophy and as required by Consultant. The system shall be capable of storing, and downloading while the system is in operation, a second set of operating software resident in the control panels as backup in case primary operating software is corrupted. All software operations shall be stored in a non-volatile programmable memory within the fire alarm control unit. Loss of primary and secondary power shall not erase the instructions stored in memory.

a. History Logs: The system shall provide a means to recall alarms and trouble conditions in chronological order for the purpose of recreating an event history. A separate alarm log of 600 events and trouble log of 600 events (total 1200 events log) shall be provided.

b. LAN/Internet Interface: System shall be capable of generating e-mail messages for Fire Alarms, System Troubles, and Supervisory Troubles to inform pre- defined user accounts. The same interface shall also facilitate the access of FACP thru standard Internet Browser from and any desktop Computer or PDA devices connected to LAN/Internet.

c. Printer The printout shall include the type of signal (alarm, supervisory, or trouble) the device identification (unique reference number and location), date and time of the occurrence. The printout differentiates alarm signals from all other printed indications.

4.4 WIRING/SIGNAL TRANSMISSION:

a. The wiring styles shall be to the requirements of NFPA and approval of the Engineer as well as local codes.

b. System connections for initiating (signaling) circuits and notification appliance circuits shall be Class A.

c. Circuit Supervision: Circuit faults shall be indicated by a trouble signal at the FACP. Provide a distinctive indicating audible tone and alphanumeric annunciation.

4.5 NETWORK COMMUNICATION: PROVIDE NETWORK FOR THE FIRE ALARM SYSTEM AS FOLLOWS:

a. Network node communication shall be through a token ring configuration.

b. A single open, ground or short on the network communication loop shall not degrade network communications. At the same time the status of the communication link shall be reported on LCD display of each FACP panel.

c. If a group of nodes becomes isolated from the rest of the network due to multiple fault conditions, that group shall automatically form a sub-network with all common interaction of monitoring and control remaining intact. The network shall be notified with the exact details of the lost communications.

d. Network shall be expandable up to 396 Nodes (FACP's) and Network shall support 17000 Feet distance between Nodes using 24 AWG cable.

e. The communication method shall be NFPA 72 style 7.

4.6 REMOTE ACCESS:

a. FACP shall have the capability to generate e-mails to predefined e-mail addresses informing the trouble and alarm status of the system. It shall also be possible to Access FACP through standard Internet Browser.

b. In addition to that FACP shall have the capability to provide Remote Access through a Dial-Up Service Modem using the public switched telephone system. A personal computer or technician's laptop, configured with terminal emulation software shall have the ability to access the FACP for diagnostics, maintenance reporting and information gathering.

4.7 REQUIRED FUNCTIONS:

The following are required system functions and operating features:

a. Priority of Signals: Fire alarm events have highest priority. Subsequent alarm events are to be queued in the order received and shall not affect existing alarm conditions. Priority Two, Supervisory and Trouble events have second-, third-, and fourth-level priority respectively. Signals of a higher-level priority take precedence over signals of lower priority even though the lower-priority condition occurred first. Annunciate all events regardless of priority or order received.

b. Annunciation: Operation of alarm and supervisory initiating devices shall be annunciated at the FACP's, repeater panel and at the Graphics PC indicating the location and type of device.

c. General Alarm: A system general alarm shall include: A detailed cause and effect matrix shall be submitted for approval to the Engineer and the Commercial area Operator.

d. Indication of alarm condition at the FACP's, the repeater panel (in case needed) and at the graphics PC.

e. Identification of the device that is the source of the alarm at the FACP's, the repeater panel (in case needed) and at the graphics PC.

f. Operation of audible and visible notification devices throughout the building until silenced at FACP.

g. Closing doors normally held open by magnetic door holders as shown on the drawings.

h. Unlocking designated doors as shown on the drawings.

i. Shutting down supply and return fans serving zone where alarm is initiated.

j. Smoke management or smoke control systems.

k. Generation of email massage giving all details of alarm to be forwarded automatically to pre-programmed email recipients.

l. Initiation of elevator recalls when specified sensors are activated and shall be with alternate landing facility.

m. Indication of operation of Kitchen canopy fire suppression system.

4.8 SUPERVISORY OPERATIONS:

Upon activation of a supervisory device such as fire pump power failure, low air pressure switch, and tamper switch, duress alarm in accessible guest rooms the system shall operate as follows:

a. Activate the system supervisory service audible signal and illuminate the LED at the control unit and the graphic PC.

b. Pressing the Supervisory Acknowledge Key will silence the supervisory audible signal while maintaining the Supervisory LED "on" indicating off-normal condition.

c. Record the event in the FACP historical log.

d. Generation of email massage giving all details of supervisory condition to forward automatically to pre-programmed email recipients.

e. Transmission of supervisory signal to remote central station.

f. Restoring the condition shall cause the Supervisory LED restore system to normal

4.9 ALARM SILENCING:

If the “Alarm Silence” button is pressed, all audible and visible (Xenon Flashers) alarm signals shall cease operation.

4.10 SYSTEM RESET

a. The “System Reset” button shall be used to return the system to its normal state. Display messages shall provide operator assurance of the sequential steps (“IN PROGRESS”, “RESET COMPLETED”) as they occur. The system shall verify all circuits or devices are restored prior to resetting the system to avoid the potential for re-alarming the system. The display message shall indicate “ALARM PRESENT, SYSTEM RESET ABORTED.”

b. Should an alarm condition continue, the system will remain in an alarmed state

4.11 DRILL:

A manual evacuation (drill) switch shall be provided to operate the notification appliances without causing other control circuits to be activated.

4.12 WALK TEST:

The system shall have the capacity of 8 programmable passcode protected one person testing groups, such that only a portion of the system need to be disabled during testing. The actuation of the “enable one person test” program at the control unit shall activate the “One Person Testing” mode of the system as follows:

a. The suppression release circuits shall be bypassed for the testing group. Control Relay functions associated to one of the 8 testing groups shall be bypassed.

b. The control unit shall indicate a trouble condition.

c. The alarm activation of any initiation device in the testing group shall cause the audible notification appliances assigned only to that group to voice announcement to identify the device.

d. The unit shall automatically reset itself after signaling is complete.

e. Any opening of an initiating or notification appliance circuit wiring shall cause the audible signals to voice announce indicating the trouble condition.

4.13 ANALOG SMOKE SENSORS:

a. Monitoring: FACP shall individually monitor sensors for calibration, sensitivity, and alarm condition, and shall individually adjust for sensitivity. The FACP shall maintain a moving average of the sensor’s smoke chamber value to automatically compensate for dust, dirt, and other conditions that could affect detection operations.

b. Programmable Sensitivity: Photoelectric Smoke Sensors shall be UL listed and shall have 8 selectable sensitivity levels ranging from 0.2% to 3.7%, programmed and monitored from the FACP. Sample of the sensor shall be submitted to display the UL label and Sensitivity range of the Sensor.

c. Sensitivity Testing Reports: The FACP shall provide sensor reports that meet NFPA 72 calibrated test method requirements. The reports shall be viewed on the graphics PC and printed for annual recording and logging of the calibration maintenance schedule.

d. The FACP shall automatically indicate when an individual sensor needs cleaning by giving three progressive trouble alarms. The first level shall indicate “ALMOST DIRTY.” The second level is reached; a “DIRTY SENSOR” condition shall be indicated at the FACP and a third level shall be annunciated, at FACP as “EXCESSIVELY DIRTY SENSOR” trouble condition.

e. Sensors shall be very fast in responding to almost all types of smokes in realistic atmosphere. Slow responding Sensors will not be acceptable.

f. Sensor shall support Magnet Test for easy maintenance. Magnet test activation of smoke sensors shall be indicated as an alarm, but distinguished by its label and history log entry as being activated by a magnet.

g. Audible Alarm Notification: By voice evacuation and tone signals on loudspeakers in areas as indicated on drawings.

h. Automatic Voice Evacuation Sequence:

- The audio alarm signal shall consist of an alarm tone for a maximum of five seconds followed by an automatic clear digital voice message both in English and Bantu Swahili/ Local Language as required by Engineer. The message content shall also be to the approval of Engineer. At the end of the voice message, the alarm tone shall resume. This sequence shall sound continuously until the Alarm Silence" switch is activated.

- Audible alarm notification appliances shall of such character and so distributed as to be effectively heard above the average ambient sound level that exists under normal conditions of occupancy. Audible alarm signals shall be distinctive from audible signals used for other purposes in the building.

- All audio operations shall be activated by the system software so that any required future changes can be facilitated by authorized personnel without any component rewiring or hardware additions.

4.14 MANUAL VOICE PAGING:

a. The system shall be configured to allow voice paging. Upon activation of any speaker manual control switch, the alarm tone shall be sounded over all speakers in that group.

b. The Main Fire Alarm control panel operator at the control room shall be able to make announcements via the push-to-talk paging microphone over the pre-selected speakers.

c. Facility for total building paging shall be accomplished by the means of an "All Call" switch.

d. Each caller shall be identifiable through a user defined address at the main station of the control room.

4.15 SYSTEM POWER REQUIREMENTS

a. The fire alarm control panel and repeater panel shall receive 230 VAC essential (standby generator power backed up) via a dedicated fused un-switched spur outlet. The incoming power to the system shall be supervised. The graphics PC shall receive essential power via the building UPS fed local DB.

b. The system shall be provided with sufficient battery capacity to operate the entire system upon loss of normal 230 VAC power in a normal supervisory mode for a period of 24 hours with 30 minutes of alarm operation at the end of this period. The system batteries shall be supervised so that a low battery or a depleted battery condition, or disconnection of the battery shall be indicated at the control unit and displayed for the specific fault type.

c. FACP LCD Display shall provide detail information about Power Supply including each NAC (Notification Appliance Circuit).Circuit real-time Current and Voltage ratings, Battery Charger Voltage and Current Draw, Battery Voltage etc.

d. All circuits requiring system-operating power shall be 24 VDC and shall be individually fused at the control unit.

4.16 SYSTEM COMPONENTS

All items of the Fire Alarm & Evacuation system shall be listed as a product of a single manufacturer.

4.17 FIRE ALARM CONTROL PANEL (FACP)

a. Fire Alarm control Panel shall be a state of the art panel with minimum 2,000 device capacity CPU with Dual Configuration microprocessor to act one as back-up. Any combination of 2000 devices (including sensors, monitoring / control modules. interface units) shall be supported by FACP. System having limitation on Number of Sensors and Modules and limits in programming of zones and compliance to approved cause and effect matrix will not be acceptable.

b. Tenderers could also use a combination of panels as indicated on the schematics to cater for the device capacity, both option would be acceptable. Battery voltage and ammeter readouts from the LCD Display should be possible. Three (3) Class B or A (Style Y/Z) Notification Appliance Circuits (NAC; rated 3A@24VDC, resistive). Four (4) form “C” Auxiliary Relay Circuits (Form C contacts rated 2A @ 24VDC, resistive); operation is programmable for trouble, alarm, supervisory of other fire response functions. [Relays shall be capable of switching up to ½ A @ 120VAC, inductive].

c. The FACP shall support five (5) RS-232-C ports and one service port.

d. Front LCD Display shall have at least five Programmable LED/Switch Modules to select individual control of Exhaust Fans, Pressurization fans, and AHUs.

e. Remote Unit Interface: supervised serial communication channel for control and monitoring of remotely located Annunciator and I/O panels.

f. If required due to site conditions, provide Modular Network Communications Card with Copper or Fiber or MODEM Media Modules. Network Module shall allow the mix and match of Copper, Fiber and MODEM media modules. MODEM Media Module Shall support Network Communication over Telephone Lines.

g. Internet/LAN/WAN Interface Module: FACP shall have the capability to provide alternate access to system information using familiar interface of standard Internet Browser. This interface shall also have the capability to generate automatic email messages for configured system events including alarms and system troubles. Compatible Pagers, cell phones, Personnel Digital Assistants can receive e-mail messages forwarded from user accounts.

4.18 VOICE EVACUATION COMPONENTS:

a. The Fire Alarm System shall incorporate a true digital integrated Voice Evacuation system into the network, multiplexing 8 independent audio channels over a single pair of wires. The system shall include Distributed zoned Audio Amplifiers, one for each speaker circuit, for the ultimate in system survivability.

b. The system shall be capable of selecting the proper tones and phrases based upon Engineer requirement, sort and transmit the audible information and repeat the transmission as many times as required.

c. The system shall have the ability to generate pre-programmed digitized phrases, words and alarm tones to all or specific areas of the building. The message contained in the fully digitized message unit shall have the facility to be edited and modified or even recorded in the field via a normal computer. System shall have the capability of message splicing. Message splicing shall allow the system to annunciate specific zone and/or device numbers while system is in testing mode, and shall also allow the system to annunciate coded messages informing the security personnel about the Fire Condition in specific zone or device. System supplier shall demonstrate the system message splicing capability to the Engineer. Systems using just recorded massages for each zone shall not be acceptable.

d. One-way communications of announcements and messages originating at the Control Room shall be via speakers located throughout the building. Speakers shall be in ceiling mount with rear fire dome and shall be wired into two (2) circuits class "A" for each floor. Speakers shall match the ceiling color around and the frequency response and sound noise ratio shall be suitable for voice message playback, live voice paging and to the requirements of relevant NFPA standards and Engineer.

e. One dedicated amplifier shall be available for each speaker circuit. Each Amplifier shall have its own independent built-in back-up amplifier. The system shall have the ability to automatically or manually sound the evacuation tone on the floor of alarm, while at the same time being able to sound the first stage alert tone or voice instruction to other areas of the building.

f. The master control panel located in the Control Room shall include the master microphone, master telephone handset, and the following indicators, switched and components:

g. One Switch and Two LED’s (Red and Yellow) for each speaker circuit zone to allow emergency voice communication selection for EVAC, Alert and Paging.

- Switches for speaker "All Call", "Page to EVAC", "Page to Alert", "All Call Minus".
- One flashing red LED for each phone circuit to indicate an in-coming call from the Fire Fighters Phone circuit.
- Red LED for each speaker zone shall indicate when that zone is in Evacuation mode.
- Yellow LED for each speaker zone to indicate when that zone is in the Alert mode.
- One switch for general evacuation alarm for each building.
- One switch for general Paging for each building.
- The Microphones shall be a push-to-talk, dynamic noise cancelling type with a frequency response from 200 to 2,000 HZ. Any automatic alarm, which has been in operation, shall be overridden by the use of the microphone. When the manual voice announcements are completed the system shall revert back to the previous alarm unless reset or restored to normal by authorities in charge.
- Amplifiers shall supply a 70-volt signals for the voice paging, alerting and evacuation tones to the speaker circuit. All amplifiers shall be sized to accommodate the speaker load plus an additional 20% spare per speaker zone to accommodate future addition. The amplifier shall be continuously supervised for proper operation. Each audio power amplifier shall have integral audio signal de-multiplexes, allowing the amplifier to select any one of eight digitized audio channels. The channel selection shall be directed by the system software. Up to 8 multiple and different audio signals must be able to broadcast simultaneously from the same system network panel.
- Amplifiers shall have built-in Back-up amplifier. In case of Primary amplifier failure, speaker circuits shall automatically get connected to back-up amplifier and system operation continues without interruption. In the event of a total loss of audio data communications, all amplifiers will default to the local "HORN" tone. If the local panel has an alarm condition, then all amplifiers will sound the Horn signal on their connected speaker circuits. Audio amplifiers shall automatically detect a short circuit condition on the connected speaker circuit wiring, and shall inhibit it from driving into that short circuit condition.

4.19 GRAPHIC COMMAND CENTER/GRAPHIC PC:

4.19.1 A color graphic command center shall be installed in control room to monitor and control the field devices and control circuits. When a fire alarm status changes, color graphics shall display an indication of the type of alarm or other activity and its location. The operator then uses the mouse control to access a more detailed view of the alarmed zone or device. With proper access code, the operator shall be able to acknowledge alarm conditions, silence audible alarms and extinguish visible notification appliances, and perform system reset directly from the color graphic screens. GCC shall accommodate up to 4 network card and each network capable of accommodating up to 99 nodes.

4.19.2 The PC shall use high resolution color XVGA LCD monitor for display. The PC shall be provided with appropriate software, licenses and tools to import Auto cad drawings and build the graphic package including color floor plans, device addresses, zoom functions etc. Graphics and sequence tree for user interface shall be user friendly and to Engineers approval. PC specifications as a minimum shall be 3Ghz &Dual core,
4GB RAM, 120GB hard disk drive, graphics hardware acceleration, sound blaster pro with speaker, DVD ± RW, 2 serial + 1 parallel port, optical mouse, network 10/100 Mbps interfaced with Windows 2003, Service Pack 2 operating system. It shall provide history logging up to 400,000 historical events.

4.20 DISTRIBUTED SYSTEMS ARCHITECTURE MODULE OPERATION

4.20.1 FACP shall support Distributed operation whereby Addressable loops, Signaling Module, Amplifiers, Speaker/Bell/Notification circuits, Auxiliary Control Circuits, and Power Supplies can be located remotely in a Transponder. In case of communication failure from the MFACP, Transponder should work as stand-alone panel with local mode programming stored in the Transponder.

4.21 BREAK GLASS UNIT / MANUAL PULL STATION:

4.21.1 Approved flush mounted break glass/manual pull station units shall be installed at fireman's lift lobbies, escape stairs, emergency exits, escape routes, plant rooms and any other areas as may be required by local regulations and NFPA standards and also as shown on the plan layouts. These units shall be wired to the control panel through the addressable loop.

4.21.2 All break glass fire alarm units shall be addressable and alarm activation shall automatically cause an audible alarm to operate at the control panel.

4.22 CONTAINMENT AND CABLING:

4.22.1 Cabling shall be carried out using approved red color fire resistant cabling through cable trays on vertical risers and within ceiling voids when installed in surface all containment works shall be dedicated to the system.

4.22.2 Containment should not be shared with other systems.. All accessories used including cable ties, saddles, glands shall be purpose made for the type of cable and shall retain their integrity during fire condition. Trunking and conduits passing through fire compartments shall be filled with approved fire barriers.

4.22.3 Maximum loop lengths shall be noted on schematics and cable runs shall be within this limit. Appropriate test shall be carried out to confirm.

4.22.4 No cabling splices or joints will be allowed. In case of damage or the length being short, the cables need to be re-pulled.

4.22.5 Detectors shall be mounted on appropriate Appleby type cable through junction boxes. Surface termination onto back boxes shall be through appropriate panels and glands.

4.23 SPECIAL REQUIREMENTS

The entire fire detection system shall be analogue addressable type to Architects requirements and approval and cause and effect programming.

Zoning for evacuation purposes and cause and effect programming shall be in terms of Engineer requirements.

Sensitivity of the smoke detectors shall be adjusted automatically to give minimum response time while eliminating false alarms due to deterioration in the sensitivity of the head.

Smoke detectors shall be addressable and identifiable. Removal of a head or a faulty head shall be clearly identified on the control panel. Removal of a head shall not disturb communication with the remaining heads on the line.

Short circuit isolators shall be provided for every interface unit and for every 20 devices to the approval of Engineer. Allow for 15% spare capacity on each addressable loop.

Allow for at least 1No interface unit (Input & Output) module at each shell core and or retail unit.

The system shall in addition be protected from spurious noise interference both R.F.I. and E.M.I. Alarms activated by smoke detectors shall be activated by either two cross zoned smoke detectors or a single smoke detector monitored by an approved verification method.
Sitting of Detectors:

Detectors shall be located as per the requirements of NFPA and Engineer and shall be in compliance to the following requirements:

a. 500mm away from light, supply air source and any obstructions.

b. Shall suit the prevailing conditions around the area and shall be suitable for the room/area.

c. Shall be semi flush mounted and low profile with appropriate kit.

d. Shall be suitable for the mounting height and shall be mounted at the highest point in the area in compliance to NFPA and Engineer requirements

e. Shall be easily accessible for maintenance and replacement.

f. Shall be installed to give full 360^0 coverage.

g. Maximum coverage per detector shall be as prescribed by NFPA

h. Ceiling and floor voids 800mm or above shall be installed with accessible smoke detectors in coordination with services around. Spacing between detectors shall be as prescribed by Engineer and NFPA. Mounting details for easy accessibility shall be to NFPA & CDD requirements and to Engineers approval. Provide a ceiling mounted remote indicator at each void for visual and location detection.

i. Provide explosion proof zone classified detector with appropriate power supply at location housing flammable substances like gas yard / room , chemical store , paint store/ room etc/

j. Wall mount detectors will only be allowed under special circumstances and will be subject to Engineers approval.

k. Unless specifically designed and listed for the conditions, smoke detectors should not be installed if any of the following ambient conditions exists:

- Temperature below 00C
- Temperature above 380C
- Relative humidity above 93%
- Air velocity greater than 1.5m/sec.

4.24 DETECTORS/SENSORS:

The detectors shall operate on a 24 Volt DC power supply, and be suitable for connection in the addressable circuit to the control panel using fire resistant cabling. Smoke detectors shall be of optical type and heat detector shall be of rate of rise type with temperature fixed at 58^0C.

The detector base section shall be suitable for easy removal and replacement of the detectors, and shall allow for the interchanging of the different types of detectors without any modifications being necessary. The base to be employed shall depend on the special mounting conditions required and shall be suitable for one or more of the following: Recess mounting. Surface mounting. Mounting in damp rooms. Suspended mounting. A visual alarm detection indication lamp shall be incorporated on each detector which shall illuminate or flash when the detector is activated or when the detector is polled in normal condition.

Where a detector is hidden from view, a remote indicator lamp is to be provided:

a. On the ceiling tee directly below the ceiling void detector.

b. On the wall adjacent to the detector concealed by equipment etc.

c. Where specifically indicated on the drawings.

d. Sensitivity of each sensor is to be individually adjustable, device by device, from the control panel.

4.25 INTERLOCK/INTERFACE WITH OTHER SERVICES:

The fire alarm system shall be wired to the following systems/equipment within the building via addressable interface units for appropriate control/monitoring during fire condition:

a. A/C equipment.

b. Smoke extract and other extract fans

c. Smoke curtains

d. Staircase pressurization fans

e. Motorized smoke and fire dampers

f. Lobby pressurization fans

g. Lifts (dual contacts per lift for alternate lift landing).

h. Emergency exit door

i. Access doors

j. Sprinkler zone subsidiary valves and flow switch

k. Air sampling early smoke detection system (Alarm, Action , Fire1 and Fire2)

l. Parking access barriers

m. Kitchen canopy fire suppression system

n. Kitchen DB’s and SMDB’s

o. Fire Pumps

p. Background Music system

q. LPG Gas system

r. Emergency lighting System

s. Smoke and Draft doors

t. Clean agent fire extinguishing system (Stage1 & Stage2)

u. All other equipment requiring interface as per rational fire design, Civil defense and NFPA standards.

v. BMS

Ratings of all interfaces and interlocks shall suit and be compatible and wiring shall be fire rated. The interface unit module shall be independently addressable and easily accessible within 2 meter height and located away from public areas. The units shall be uniquely labeled and referred as such on the cause and effect matrix and the interface unit schedule. The interface unit modules shall be mounted within a propriety enclosure.

4.26 LINE MONITORING

The addressable line shall be monitored for short circuit, open circuit and earth leakage. A single open circuit shall result in all devices continuing to operate normally with the panel indicating a line fault.

Device Types:

It shall be possible to connect the following sensors/devices to the address lines of the Fire Panel:

a. Optical Smoke Sensors Analogue addressable

b. Heat Sensors

c. Break glass 'call-point' Units/Manual pull Station

d. Line Relays

e. Line Sounder Drivers

f. Interface Units (various types)

g. Conventional Detectors

h. Extinguishing Gas Control Unit

i. Very Early Warning Smoke Detectors

j. Linear Beam Smoke Detectors

k. Ionization Sensors

l. Heat Sensors

m. Interface Units

n. Manual Call Points

4.27 DEVICE STATUS:

a. Analogue addressable

b. Addressable Addressable

c. Non-Addressable Addressable

d. Addressable Intrinsically safe addressable intrinsically safe

Each addressable device shall be polled by the panel every 5 seconds or less. The analogue status and equipment condition shall be read and stored in the panel on every scan.

4.28 PRINTER

A 132 EPSON column printer shall be provided and capable of printing the following:

a. Alarms.

b. Faults.

c. Maintenance Data.

d. Panel Operations.

e. Outputs Operated

Operation of the printer shall not inhibit, delay or affect the functioning of the Detection Polling System in any way.

The printer shall indicate the following information for each alarm or signal:

Type of Alarm or Fault:

a. Device Type.

b. Device Number.

c. Zone Number.

d. User Message (40 Characters).

e. Day.

f. Date.

g. Time.

It shall be possible to set the printer to print alarms, faults, panel operations, or outputs operated, all of these, or any combination.

4.29 AUDIBLE FIRE ALARM SYSTEM:

The audible fire alarm system shall consist of a central transmitter station installed adjacent to the fire control panel, connected to a network of loudspeakers or sirens installed throughout the building, as required by local regulations and NFPA standards. Two distinctive tones for alert and evacuation shall be provided and the zoning and redundant speaker cabling shall suit the local regulations.

a. It shall be ensured that the speakers are capable of providing undistorted sound levels which will be expected to exceed ambient levels of each specific area by at least 15dB.

b. Interface units must be provided so that the background music system can be muted in the event of an evacuation procedure in the relevant area.

c. Loudspeakers in passageways shall be so installed and constructed to ensure that alarm tones are audible throughout the respective rooms, notwithstanding walls and shall comply with the requirements of Engineer. Buzzing is to be eliminated by the use of appropriate wires.

d. The loudspeakers shall be driven by dual amplifiers and circuited in a staggered alternative pattern for 50% coverage in an area in case of failure of one circuit.

e. The speakers shall be of the recessed type installed flush in ceilings with approved grilles (color to architects approval) and fire dome.

f. The central transmitter shall be provided with a panel of switches and pilot lights to enable either alarm signal to be transmitted to each floor individually, or to any combination of floors as required by Engineer.

g. The central transmitter shall be provided with two inputs for automatic initiation of both alarm tone signals.

4.30 SPRINKLER FLOW SWITCHES AND ZONE SUBSIDIARY VALVES

4.30.1 Sprinkler flow switches and zone subsidiary valves shall be independently monitored by the fire panel on an individual basis.

4.30.2 The fire panel shall generate an alarm should any flow switch or valve be active. The graphics PC and the main FACP shall indicate these and all other alarm signals both graphically and audibly

4.31 PHOTOELECTRIC SMOKE SENSORS/OPTICAL SMOKE SENSORS / DETECTORS PLUG-IN ARRANGEMENT:

4.31.1 Sensor and associated electronic components shall be mounted in a module that connects to a fixed base with a twist-locking plug connection. Base shall provide break-off plastic tab that can be removed to engage the head/base locking mechanism

4.31.2 Sensor and associated electronic components shall be mounted in a module that connects to a fixed base with a twist-locking plug connection. Base shall provide break-off plastic tab that can be removed to engage the head/base locking mechanism. Each sensor base shall contain an LED that will flash each time it is scanned by the FACP. In alarm condition, the sensor base LED shall be on steady.

4.31.3 Each sensor base shall contain a magnetically actuated test switch to provide for easy alarm testing at the sensor location. Each sensor shall be scanned by the FACP for its type identification to prevent inadvertent substitution of another sensor type. Upon detection of a “wrong device”, the control unit shall operate with the installed device at the default alarm settings for that sensor; 2.5% obscuration for photoelectric sensor, 135-deg F and 15-deg F rate-of-rise for the heat sensor, but shall indicate a “Wrong Device” trouble condition.

4.31.4 Addressability: Sensors include a communication transmitter and receiver in the mounting base having a unique identification and capability for status reporting to the FACP. Sensor address shall be located in base to eliminate false addressing when replacing sensors.

4.31.5 Type: Smoke sensors shall be of the photoelectric type.

4.31.6 Duct Smoke Sensor: Photoelectric type, with sampling tube of design and dimensions as recommended by the manufacturer for the specific duct size and installation conditions. Sensor shall include for relay as required for fan shutdown.

4.31.7 The Duct Housing shall provide a supervised relay driver circuit for driving up to 15 relays with a contact rated to suit the Air handling unit fan circuit (AHU). This auxiliary relay output shall be fully programmable

4.31.8 Duct Housing shall provide a relay control trouble indicator Yellow LED.

4.31.9 Compact Duct Housing shall have a transparent cover to monitor for the presence of smoke.

4.31.10 Duct Housing shall provide a magnetic test area and Red sensor status LED.

4.31.11 For maintenance purposes, it shall be possible to clean the duct housing sampling tubes by accessing them through the duct housing front cover.

4.31.12 Duct smoke sensor shall be provided for all AHU with capacity of 2000 cfm and above.

4.31.13 HEAT SENSORS

4.31.14 Thermal Sensor: Combination fixed-temperature and rate-of-rise unit with plug-in base and alarm indication lamp; 135-deg F fixed-temperature setting except as indicated.

4.31.15 Thermal sensor shall be of the epoxy encapsulated electronic design. It shall be thermistor-based, rate-compensated, self-restoring and shall not be affected by thermal lag.

4.31.16 Sensor fixed temperature sensing shall be independent of rate-of-rise sensing and programmable to operate at 135-deg F or 155-deg F. Sensor rate-of-rise temperature detection shall be selectable at the FACP for either 15-deg F or 20-deg F per minute.

4.31.17 Sensor shall have the capability to be programmed as a utility monitoring device to monitor for temperature extremes in the range from 32-deg F to 155-deg F.

4.32 PROJECTED PHOTO ELECTRIC BEAM DETECTOR

4.32.1 Projected photoelectric beam smoke detection shall be used to protect large showroom areas, where spot type smoke detection is impractical due to mounting height.

4.32.2 The unit shall be state of the art microprocessor based long range beam smoke detector consisting of a separate transmitter and matching receiver providing accurate and repeatable monitoring of smoke passing through the light beam.

4.32.3 The transmitter shall produce a crystal controlled, infrared beam which is monitored by the receiver to determine smoke obscuration. When the receiver measures beam intensity below a preset, selectable threshold, an alarm output is generated.

4.32.4 Complete beam blockage and dust accumulation that reduces signal level to 50% shall initiate a trouble output. Intermittent beam blockage, such as cleaning, shall be ignored. Tamper switches shall monitor the access covers and cause a circuit trouble if activated. Installation shall be simplified by convenient beam alignment adjustments and easy receiver calibration.

4.32.5 The transmitter beam shall have a format signature that allows the receiver to minimize interference from external light sources. Mounting details and color of the unit shall be to Engineers approval.

4.33 ADDRESSABLE INTERFACE UNITS/MODULES:

4.33.1 Addressable Interface Modules: These units shall monitor one or more system components that are not otherwise equipped for addressable communication. Modules shall be used for monitoring flow switches, zone subsidiary valves, non-addressable devices, and for control of life and safety systems.

4.33.2 The following types of modules in coordination with the equipment system to be interfaced shall be provided:

4.33.3 The interface units shall be capable of initiating input and output circuit interface.

4.33.4 The input circuit shall provide location specific addressability to an initiating device by monitoring normally open dry contacts. This module shall communicate four zone status conditions (normal, alarm, current limited, trouble) to the FACP.

4.33.5 The output control circuit provides a non-supervised relay switching.

4.33.6 All Circuit Interface Module/Units shall be supervised and uniquely identified by the FACP control unit. Module identification shall be transmitted to the FACP for processing according to the program instructions. Modules shall have an on-board LED to provide an indication that the module is powered and communicating with the FACP. The LEDs shall provide a troubleshooting aid with the LED blinking on poll whenever the peripheral is powered and communicating.

4.33.7 Line powered Short Circuit Isolator Module: Provide Line powered Isolator for both Power and Communication Circuit after every 20 devices or as required by Engineer and for every addressable interface unit. The Power and communications shall be supplied by the Addressable Controller; dual port design shall accept communications and power from either port and shall automatically isolate one port from the other when a short circuit occurs. The following functionality shall be included in the Isolator module:

4.33.8 Report faults to the host FACP

4.33.9 On-board Yellow LED provides module status.

4.33.10 After the wiring fault is repaired, the Isolator modules shall test the lines and automatically restore the connection.

4.34 LOUD SPEAKERS

4.34.1 Loudspeakers shall be either wall or ceiling mounting type to suite the site conditions. These shall provide high quality tone and voice reproduction. Round or square models shall be installed, to the approval of the Engineer. Generally, wall mounted units shall be constructed of high impact, flame retardant ABS thermoplastic. All speakers shall have 70 V line transformers with tapings at 1/4W, ½W, 1W and 2W. Frequency response shall be 125Hz for general signaling and sensitivity of the speakers shall be 85dBA 1W, 10ft. All ceiling mounted speakers shall have 160o dispersion angle with fire dome. The color of the speakers shall be to the approval of the architect.

4.35 AUDIO/VISUAL ALARM INDICATING APPLIANCE

4.35.1 Audio/Visual units shall be provided on a common enclosure for the fire alarm audible and visual alarm devices. The housing shall be designed to accommodate either horns, bells, chimes or speakers. The unit shall be complete with a resistant, pyramidal shaped lexan lens with "Fire" lettering visible from a 180o Field of view.

4.35.2 The front panel or bezel may be inverted so that the lens is below the audible device. The lamp assembly shall incorporate a built-in reflector for more efficient light propagation and special shock-mounding arrangement to resist bulb failure due to vibration.

4.35.3 Lamp shall provide 4 wire connections to insure properly supervised in/out system connection. Unit shall be complete with all mounting hardware including back- box. Audiovisual unit shall be UL listed for its intended purpose.

4.36 DC VIBRATING BELLS

DC vibrating bells shall be installed externally for indicating an alarm condition. Alarm Bells shall be of red finish, 150 in diameter with a 24VDC heavy vibrating solenoid action. Sound output shall be 90DB at 1 meter. Mounted hardware shall be suitable for surface, flush and weatherproof fixings as appropriate for the location with appropriate back box.

4.37 MAGNETIC DOOR HOLDERS

Description: Magnetic door holders shall be UL listed and equipped for floor/wall mounting as required and shall be complete with matching door plate. Units shall operate from a 240VAC source, and develop a minimum of 25lbs. holding force. Finish shall match the door. Installation shall be coordinated with the door manufacturer/installer to Architects approval.

4.38 REMOTE PRINTERS

Fire Alarm Control Unit shall be capable of operating remote printers; output shall be ASCII from RS232-C connection with an adjustable baud rate.

4.39 REMOTE LCD ANNUNCIATOR / REPEATERS PANEL

Provide remote LCD Annunciator with the same “look and feel” as the FACP operator interface. The Remote LCD Annunciator shall use the same Primary Acknowledge, Silence, and Reset Keys, Status LEDs and LCD Display as the FACP.

Annunciator shall have LCD display with two lines of 40 characters each. Annunciator shall be provided with four (4) programmable control switches and associated LEDs.
Under normal conditions the LCD shall display a “SYSTEM IS NORMAL” message and the current time and date.

Should an abnormal condition be detected the appropriate LED (Alarm, Supervisory or Trouble) shall flash. The unit audible signal shall pulse for alarm conditions and sound steady for trouble and supervisory conditions.

The LCD shall display the following information relative to the abnormal condition of a point in the system:

- 40 character custom location label.
- Type of device (e.g., smoke, manual pull station, flow switch).
- Point status (e.g., alarm, trouble).
- Operator keys shall be key switch enabled to prevent unauthorized use. The key shall only be removable in the disabled position. Acknowledge, Silence and Reset operation shall be the same as the FACP.

4.40 CONTROL ROOMS

This room shall contain the following system head – end to the approval of Engineer.

a. Voice fire alarm system panels and controls.

b. Two way telephone communication service panels and controls

c. Fire detection and fire alarm systems annunciation panels.

d. Elevator floors location and operation Annunciator and elevator intercom system.

e. Sprinkler valve and water flow Annunciator.

f. Emergency generator status indicators (Remote Annunciator Panel)

g. Fire Pump status indicators

h. Telephone for Engineer use with control access to the public telephone system.

4.41 LOW PRESSURE CLEAN AGENT FIRE EXTINGUSIHNG SYSTEM:

4.41.1 A low pressure clean agent fire extinguishing double knock system to relevant NFPA 2001 standards (covering room space, ceiling void and below raised floor) shall be provided in the hotel server room. The control panel for the system shall be interfaced to the fire alarm system and activate the building fire alarm system as per approved cause & effect matrix.

4.41.2 The system shall comprise of appropriate number of steel cylinders connected to a system of pipe-work and nozzles and fitted with valves specifically designed to allow the clean agent contents liquefied under pressure to discharge rapidly along with necessary detection devices, alarm bell, flashing beacon outside the room and main control panel for each protected area. The panel and cylinders shall be located to the approval of Engineer .Each room to be protected with an independent system.

4.41.3 Clean agent systems are designed to extinguish fires involving flammable liquids, gases and in electrical equipment. It extinguishes via a combination of chemical and physical means without significantly reducing the levels of oxygen available in the protected enclosure. Any extract requirements shall be included.

4.41.4 The clean agent fire extinguishing system proposed in this project is designed as a total flooding system and shall be in accordance with NFPA 2001 and manufacturer standards. All system components shall be UL listed.

4.41.5 The cylinder shall have both electrical actuation via a solenoid (activated by a signal from the control panel) and Mechanical actuation via a manual release strike knob mounted to the top of the cylinder. Required detectors shall be provided within the room space, ceiling void and floor void offering full protection to the room.

4.41.6 The design concentration/retention time shall be maintained for a sufficient period of time to allow effective emergency action and shall be to the approval of Engineer.

4.41.7 During the 1st stage, any one detector in the 1st loop shall operate (also the corresponding remote indicator LED shall operate). This will give an indication to the Control Panel. The Control Panel shall send signal to first stage alarm bell to operate. Also, the control panel shall have a volt free contact (VFC) that shall be interfaced with building fire alarm control panel to give indication on the building fire alarm control panel.

4.41.8 During the 2nd stage, any one detector in the 2nd loop shall operate (also the corresponding remote indicator LED will operate). This will give an indication to the Control Panel. The control panel shall send signal to 2nd stage sounder and beacon to operate. The sounder and beacon shall operate by flashing and giving intermittent sound. The second stage shall initiate a time delay period of 32 seconds (can be adjustable up to a maximum of 60 seconds) for the FM200 agent discharge. The panel shall have a volt free contact (VFC) that shall be interfaced with building fire alarm control panel to give indication on the building control panel/to shutdown A/C / to close the fire dampers before the gas discharge.

4.41.9 At the end of time delay period the control panel shall send a fire signal to solenoid actuator mounted on the main cylinder to discharge the gas into the protected area. During the gas discharge the intermittent sound of sounder and beacon shall change to continuous mode. Also, the control panel shall have a gas-discharged indication on the control panel.

4.41.10 Visual inspection and room /enclosure integrity test using pressurized air (door fan test) to check for leakages shall be carried out at each location prior to testing and commissioning of the system, all as per the requirements of NFPA 2001. The door fans used for this purpose shall achieve a pressure approximating that which would be created during an actual discharge of the clean agent system. Method statements and equipment used shall be to Engineer's approval.

4.41.11 Clean agent can be FM200 subject to Engineer's approval. It shall be contractors' responsibility to ensure that the clean agents proposed is approved /acceptable by Engineer.

4.42 WIRING INSTALLATION

All wiring associated with the fire detection and evacuation system shall be 300/500V enhanced grade fire resistant red color to BS-5839-1, BS8434-2 (930^{0}C for 120min, 60min with fire and mechanical shock plus 60min with fire, mechanical shock and water), EN50200 PH120 (120min at 830^{0}C with fire and mechanical shock), BS 6387 (CWZ) and LPCB approved.

4.43 SHOP DRAWINGS

The MEPD sub-contractor shall liaise with the specialist manufacturer and submit the following shop drawings, matrix and schedules for approval to the Engineer. All drawings and schedules shall be approved and stamped by the specialist manufacturer prior to the submission to the Engineer.

a. Shop drawing showing containment, builders work, power supplies, panel location (Plan & Section) device location, type, typical mounting and cable connection detail etc shall be submitted.

b. Interface unit schedule, Device list schedule highlighting device reference numbers, identification address assigned and the interfaces.

c. Material submittals and relevant samples shall be submitted for approval.

d. Cause and effect matrix including integrated cause and effect testing methodology shall be submitted for approval.

e. System and Operational philosophy shall be submitted for approval.

f. All works on site shall be in full compliance to the comments and approval on the above documents by the Engineer.

g. The MEPD subcontractor in coordination with the specialist manufacturer shall liaise with Engineer and ensure that Engineer's requirements are complied with. In addition they shall also obtain all necessary approvals from Engineer for their shop drawings, schedules and schematics, installation, testing and commissioning related to the system.

4.44 INSTALLATION, TESTING & COMMISSIONING:

The entire installation, testing and commissioning shall be in compliance to the requirement of NFPA72. As a minimum the following testing and commissioning activities shall be carried out to the approval of the engineer.

a. Visual Inspection compliance on location and type of detectors and other devices, cabling integrity etc.

b. Loop continuity test.

c. Loop resistance test

d. Battery discharge and recharge testing

e. Device address and status report test

f. Functional test including self-diagnostics

g. 100% of devices shall be tested by Engineer approved contractor and signed off by

h. Specialist manufacturer.

i. Integrated cause & effect testing/Black building test including power outage simulation, generator start, fire alarm activation, Emergency lighting system in operation etc. and check activation of all interfaces.

j. Room integrity test/door fan test for clean agent, fire extinguishing system at the server room. Functional and operational testing for clean agent fire extinguishing system.

k. Each of the alarm conditions that the system is required to detect should be introduced on the system.

l. Close each ZSV and verify alarm at FACP

m. Verify activation of flow switches.

n. Open initiating device circuit , signaling line circuit (SLC) and notification appliance circuit (NAC) and short NAC and SLC and verify from the signal activate.

o. Ground all circuits and verify response of trouble signals.

4.45 OPERATOR TRAINING:

The scope includes for full training of the Hotel Operator and Facilities Management in the operation and maintenance (trouble shooting, servicing, preventive, and routine) of the Fire Alarm and Voice Evacuation and the related systems as described in the above clauses.

Necessary software licenses shall be included and training to be imparted for software programming changes.

4.46 MAINTENANCE PERIOD:

A one-year free maintenance period shall be included and fully covered by a warranty from the date of issue of formal take over certificate by the Client.

This free maintenance period shall cover labor, travelling, spare parts and materials, pre-emptive/proactive inspections (minimum 6 site visits), attending service and defect calls and all other inputs required to ensure proper maintenance and full optimum working order of the entire system.

SECTION K 5

ACCESS CONTROL SYSTEM INSTALLATIONS SPECIFICATIONS

5 Access Control:

The scope of these works covers the engineering, supply, installation, testing and commissioning of the entire Access Control as indicated on the drawings and specifications. All works shall be to the requirements of BS standards BS EN 60839-11-2:2015 (Alarm and electronic security systems. Electronic access control systems)

5.1 GENERAL:

The definition of access control is a way of limiting access to a system or to physical or virtual resources. There are four main elements that make up an access control system, which are credentials, readers, locking devices and controllers/panels.

5.2 Credentials:

Credentials are defined as a physical or tangible object, a piece of knowledge or a facet of a person's physical being, that enables an individual access into a physical facility or a PC-based information system.

Some examples of credentials include card, token, PIN code, fingerprint, face and more.

Credentials must be presented by the user before they can be granted access to a secured are

5.3 INTELLIGENT DOOR CONTROLLER

Provide the gateway between the control points (door, check point) and the ACS server. On the door side, they process the reader data, report the door position (open, closed), accept a request to exit from the secure side, and order the electric door strike to open, or remain closed. On the server side, they respond to polls, report intrusion, alarms, credential problems, tamper alarms, and a number of other information as required making the area safe.

Panels hold user credential data on flash memory in case the communication between the panel and the server is unavailable. Panels will operate on stand-alone until the communication is restored. There are many flavors of panels, and interfaces connecting the panel to the server.

Some panels communicate with the server on Ethernet protocol, some on RS-485 multi-drop bus. On the check-point side however, the signals are fairly standard. The garden variety panels normally control 2 check-points (doors), but there are panels with expansion slots that can extend to several doors.

The door controller shall be in a small enclosure. It shall be a versatile access control panel to extend the main access control system as detailed in the general information's page with advanced access control functions as real time alarm and access control on doors. The door controller should be able to operate off-line with no degradation in performances. Standard features of the controller include;

a. Real time alarm & access control on 4 doors
b. Full mirror database for offline condition
c. Global anti-pass back
d. Region control
e. User counter, interlocking, card + PIN
f. alarm inputs on board
g. Local RS485 bus for up to 16 readers
h. Support for wide range of third party readers
i. relays on board for lock strikes
j. programmable outputs

5.4 SMART CARD READER

Is composed of a biometric, reader, door position switch, request to exit button, and an electric door strike. There are many varieties of readers, with different technologies. Wigand format data (data0, data1), Magnetic stripe format (data, clock), and biometric decoders (finger print readers, Iris scanners). The readers employ a wire winding to produce a magnetic field.

When a card is presented to the reader, the magnetic field produces an electric field in the card winding, supplies power to the processor in the card, and the data packet containing the user information is transferred from the card to the reader.

The reader transmits the data to the control panel, which actuates a relay to apply power to the door strike to open (if the user has access), or report an invalid card (if the user does not have access to the area). There are many card formats used in the industry ranging from 26-bit to FIPS-201 compliant formats with FASC-N length of 200 bits. Many organizations exceed the 200-bit card format, extending to 512, or 1024 bits

5.5 Heavy duty smart card reader

The device is used to "read" the access credentials in order to verify a user's access to a secured area. The Card Readers should be attractive, cost effective, well suited for door mullion or narrow stile mounting. The reader should be manufactured with the highest quality UV-resistant materials to inhibit discoloration in all types of environmental conditions, including direct sunlight. The readers should be featuring potted electronics and circuitry for protection against inclement weather. Standard features of the card reader shall include;

a. Read Range: up to 6 – 10cm

b. Tri-state LED (red, green, amber): Visual indicator and audio feedback representing status and activity information.

c. Environment: accommodates interior, exterior, metal and non-metal installation environments.

5.6 Locking Devices

There are several types of locking devices used in a card-based access control system:

a. Electromagnetic (EM) Lock

Uses the magnetic force generated from the electromagnet to secure the doors.

Has a built-in safety feature, which will disable the lock during emergencies.

b. Electric Drop-bolt System

Consists of a locking system which can be installed either on the floor or on the top of the door frame.

Designed to retract during a power failure or when the emergency break-glass switch is activated.

c. Electric Door Strike System

Replaces the locking plate on the existing door locking system.

d. Rim Lock

A locking device that attaches to the surface of a door.
Easy to install and provides both primary and backup security on any door without much restrictions.
Can match any door design as it can be installed in any desired height and location

5.7 Request to exit

Is a momentary closure switch that is normally de-bounced, when pressed the circuit closes and signals the panel to release the door lock to allow graceful exit from a secure area.

SECTION L

BOREHOLE DRILLING AND EQUIPPING INSTALLATIONS SPECIFICATION

1 PART B

1.1 GENERAL MECHANICAL SPECIFICATION

1.1.1 GENERAL

This section specifies the general requirements for plant, equipment and material forming part of the Sub-Contract Works and shall apply except where specifically stated elsewhere in the specification or on the contract Drawings.

1.1.2 QUALITY OF MATERIALS

All plant, equipment and materials supplied as part of the Sub-contract works shall be new and of first-class commercial quality, shall be free from defects and imperfections and where indicated shall be of grades and classifications designated herein.

All products or materials not manufactured by the Sub-contractor shall be products of reputable manufacturers and so far as the provisions of the Specification is concerned shall be as if they had been manufactured by the Sub-contractor.

The Sub-Contractor as called for by the Specification and Contract Drawings shall supply materials and apparatus required for the complete installation unless mention is made otherwise.

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

Defective equipment or that damaged in the course of installation or tests shall be replaced as required to the approval of the Engineer.

1.1.3 REGULATIONS AND STANDARDS

The Sub-Contract Works shall comply with the current edition of the following:-

i) The Kenya Government Regulations
ii) The United Kingdom Institution of Electrical Engineering (*IEE*) Regulations for the electrical equipment of buildings.
iii) The United Kingdom Chartered Institute of Building Services Engineers (*CIBSE*) Guides.
iv) British Standards and Codes of Practice as published by the British Standards Institution (*BSI*).
v) The Local Council By-laws.
vi) The Electricity supply Authority By-Laws.
vii) Local Water Authority By-Laws.
viii) The Kenya Building Code of Regulations.

1.1.4 ELECTRICAL REQUIREMENTS

Plant and equipment supplied under this Sub-Contract shall be complete with all necessary motor starters, control boards, and other control apparatus. Where Control Panels incorporating several starters are supplied, they shall be complete with a main isolator.

The supply power up to and including local isolators shall be provided and installed by the Electrical Sub-Contractor. All other wiring shall be as described in the "Particular Specification".

The Sub-Contractor shall supply three copies of all schematic, cabling and wiring diagrams for the Engineer's approval.

The starting current of all electric motors and equipment shall not exceed the maximum permissible starting currents described in Kenya’s power utility Company's By-Laws.

All electrical plant and equipment supplied by the Sub-Contractor shall be rated for the supply voltage and frequency obtained in Kenya that is 415 volts, 50Hz, 3-phase or 240 volts, 50Hz 1-phase as specified in the "Particular Specification".

The Consultant may reject any equipment that is not rated for the above voltages and frequencies

1.1.5 TRANSPORT AND STORAGE

All plant and equipment shall, during transportation be suitably packed, crated and protected to minimise the possibility of damage and to prevent corrosion or other deterioration.

On arrival at site, all plant and equipment shall be examined and any damage to parts and protective priming coats made good before storage or installation.

Adequate measures shall be taken by the Sub-Contractor to ensure that plant and equipment do not suffer any deterioration during storage.

Prior to installation all piping and equipment shall be thoroughly cleaned.

If, in the opinion of the Consultant any equipment has deteriorated or been damaged to such an extent that it is not suitable for installation, the Sub-Contractor shall replace this equipment at his own cost.

1.1.6 SITE SUPERVISION

The Sub-Contractor shall ensure that there is an English-speaking supervisor on the site at all times during normal working hours.

1.1.7 INSTALLATION

Installation of all special plant equipment shall be carried out by the Sub-Contractor under adequate supervision from skilled staff provided by the plant and equipment manufacturer or his appointed agent in accordance with the best standards of modern practice and to the relevant regulations and standards described under Clause 3 of this section.

1.1.8 TESTING

3.1.8.1 GENERAL

The Sub-Contractor's attention is drawn to Part "A", Sub-Clauses 2.1.44 and 2.1.45 on Pages 2.11 and 2-12 respectively of the "Preliminaries and General Conditions".

The following sub-clauses are intended to define the Sub-Contractor's responsibilities with respect to testing and inspection.

3.1.8.2 MATERIAL TESTS

All material for plant and equipment to be installed under this Sub-Contract shall be tested, unless otherwise directed, in accordance with the relevant B.S. specification concerned.

For materials where no B.S. specification exists, tests are to be made in accordance with the best modern commercial methods to the approval of the Engineer, having regard to the particular type and application of the materials concerned.

The Sub-Contractor shall prepare specimens and performance tests and analyses to demonstrate conformance of the various materials with the applicable standards.

If stock material, which has not been specifically manufactured for the plant and equipment specified is used, then the Sub-Contractor shall submit satisfactory evidence to the Consultant that such materials conform to the requirements stated herein in which case tests of material may be partially or completely waived.

Certified mill test reports of plates, piping and other materials shall be deemed acceptable.

3.1.8.3 MANUFACTURED PLANT AND EQUIPMENT - WORKS TESTS

The rights of the Consultant relating to the inspection, examination and testing of plant and equipment during manufacture shall be applicable to the Insurance Companies or Inspection Authorities so nominated by the Engineer

The Sub-Contractor shall give two weeks’ notice to the Consultant of the manufacturer's intention to carry out work tests and inspections.

The Consultant or his representative shall be entitled to witness such tests and inspections. The costs of such tests and inspections shall be borne by the Sub-Contractor.

Six copies of all test and inspection certificates and performance graphs shall be submitted to the Consultant for his approval as soon as possible after the completion of such tests and inspections.

Plant and equipment which is shipped before the relevant test certificate has been approved by the Consultant shall be shipped at the Sub-Contractor's own risk and should the test and inspection certificates not be approved, new tests may be ordered by the Consultant at the Sub-Contractor’s expense.

3.1.8.4 PRESSURE TESTING

All pipe work installations shall be pressure tested in accordance with the requirements of the various section of this specification. The installations may be tested in section to suit the progress of the works but all tests must be carried out before the work is buried or concealed behind building finishes. The Consultant or his representative must witness all tests and the Sub-Contractor shall give 48 hours’ notice to the Consultant of his intention to carry out such tests.

Any pipe work that is buried or concealed before witnessed tests have been carried out shall be exposed at the expense of the sub-contractor and the specified tests shall then be applied.

The Sub-Contractor shall prepare test certificates for signature by the Consultant and shall keep a progressive and up-to-date record of the Sections of the work that have been tested.

1.1.9 COLOUR CODING

Unless stated otherwise in the Particular Specification all pipe work shall be colour coded in accordance with the latest edition of B.S. 1710.

1.1.10 WELDING

3.1.10.1 PREPARATION

Joints to be made by welding shall be accurately cut to size with edges sheared, flame cut or machined to suit the required type of joint. The prepared surface shall be free from all visible defects such as lamination, surface imperfections due to shearing or flame cutting operation, etc., and shall be free from rust, scale, grease and other foreign matter.

3.1.10.2 METHOD

All welding shall be carried out by the electric arc process using covered electrodes in accordance with B.S. 639.

Gas welding may be employed in certain circumstances provided that prior approval is obtained from the Engineer

3.1.10.3 WELDING CODES AND CONSTRUCTION

All welded joints shall be carried out in accordance with the following specification:-

a) Pipe Welding
All pipe welds shall be carried out in accordance with the requirements of B.S.806.
b) General welding
All welding mild steel components other than pipe work shall comply with the general requirements of B.S. 1856.

3.1.10.4 WELDERS QUALIFICATIONS

Any welder employed on this Sub-contract shall have passed the trade tests as laid down by the Government of Kenya.

The Consultant may require seeing the appropriated certificate obtained by any welder and should it be proved that the welder does not have the necessary qualifications the Consultant may instruct the Sub-Contractor to replace him by a qualified welder.

2 PART C

2.1 PARTICULAR MECHANICAL SPECIFICATIONS FOR BOREHOLE DRILLING AND EQUIPPING INSTALLATIONS

2.1.1 BOREHOLE CONSTRUCTION

4.1.1.1 GENERAL

A typical borehole section is shown in ***annex: 7.*** Basic methods of drilling are indicated below as a basic guide, mostly to maintain a few key dimensional specifications.

4.1.1.2 DRILLING METHODS

The preferred method of drilling in consolidated compact formations is rotary percussion with air and/or foam flush. Boreholes will be drilled with 6½ inch drill bits and reamed with a **minimum diameter of 8 inches** for sanitary protection or for lowering temporary casings.

In unconsolidated loose, unstable, collapsing formations, rotary with appropriate drilling stabilizer will be used**.** In such a case the drilling diameters will be telescopic starting with diameter large enough to lower temporary casing in upper collapsing formations and continue drilling with a **final minimum diameter of** 6½ **inch bit.** If other chemical fluids or solids are used to arrest collapsing of formations, the Contractor has to use proper borehole development and cleaning methods to make the use of borehole water is safe for drinking purposes. The Contractor will use such fluids or solids with the agreement of the Client. **In no case will the use of Bentonite mud be allowed.** Boreholes will be constructed with UPVC casing, screen and sand trap. The Contractor will decide appropriate lengths of slotted screen in the aquifer intervals. **All cost of using proper drilling fluids and solids is included in the rate per meter quoted.** No additional payments will be made by client.

4.1.1.3 BOREHOLE DEPTH

Boreholes shall be drilled to such depths as to penetrate below the shallow water table aquifers and tap the first potential deeper aquifer or aquifers in confined/semiconfined conditions with a minimum discharge of ***2.5 liters per second*** to sustain continuous pump testing for 6 hours to ensure reliable operation of hand pumps fitted on them. The depth to be drilled should be at least 40 metres and at least ***six (6) meters*** below the main aquifer to provide proper installation of a hand pump and to provide a sand trap of 3 meters. If the discharge is less than 2.5 liters/sec., a decision to abandon the borehole or continue to drill deeper will be at the discretion of the Contractor.

4.1.1.4 BOREHOLE DIAMETER

Boreholes will be drilled with telescopic diameters.

The first 6 meters from the surface will have concrete grouting for sanitary protection. For this the borehole will be reamed to a minimum diameter of 8 or 10 inches and concrete grouting placed in the annular space between the casing and open borehole wall.

Borehole will be drilled with 6½ inch bit. The reaming diameter will be based on the type of temporary casing the contractor will use and not less than 8 inches to install Class 10 PVC casing of 140mm outside diameter for the total depth of the borehole.

The contractor must take into account the depths he has to drill and lower temporary casing to complete the drilling. This cost must be built in the quoted unit cost for drilling.

The client will not be responsible for any loss of temporary casing which the contractor is unable to pull out or lost due to snapping or breaking from the completed boreholes.

4.1.1.5 SCREEN

The Contractor will use proprietary; factory-made Class 10 UPVC slotted screens, the slot size and screen length depending on the aquifer materials and aquifer thickness. The Contractor will take sole responsibility of designing the well assembly and placing screen and casing at appropriate depths to match the positioning of the aquifer(s).

Slotted screens should be of DIN 4925/8061 or equivalent approved by international standards and have the following dimensional specifications: U-PVC casing pipe, Class 10, drinking water standards, non toxic and in standard lengths of three (3) meters, ***Nominal diameter of 125mm***, OD 140mm, flush jointed, male female trapezoidal threads, slot width 0,75 mm and not more than 1mm, and open area as percentage of internal surface area 9.26% per linear meter. Depending on the aquifer, the Contractor may choose an appropriate slot width other than 0.75mm.

4.1.1.6 CASING PIPE AND SAND TRAP

Casing pipe should be of DIN 4925/8061 or equivalent approved by international standards, and have the following dimensional specifications: ***U-PVC Class 10,*** drinking water standards, non toxic and in standard lengths of three (3) meters in length, **Nominal diameter 125mm**, outer diameter 140mm, WT 7.5mm, for installation down to 90 meters, flush jointed for internal and external diameter, male /female trapezoidal threads and in lengths of 3 meters.

The boreholes will be fully cased to bottom. The threads both male and female are properly cleaned with a clean brush and cloth before they are joined. If the pipes used are with bell and socket, these are cleaned using fluids and cemented with recommended solvent cement by the manufacturers of the casing pipes and screen. Wait for recommended time for the joint to set firmly before lowering into the borehole.

The Contractor will take all necessary precautions during the transportation and storage of casing pipes from their warehouse to drilling sites to prevent distortions, ending or deformation of the pipe that could result in eccentricity along the length of the pipe.

A maximum of 3 meter length of sand trap will be part of the well design when boreholes are cased to the bottom. The sand trap will be from UPVC casing pipe with specifications described above, fitted to the end of last screen and bottom end with an end-cap. The end cap is glued with appropriate solvent cement or solutions as recommended by the UPVC manufacturer. Note that the joint sections are properly cleaned with cleaning fluids and recommended time given for the joint to set firmly before lowering into the borehole.

4.1.1.7 GRAVEL PACKING AND GROUTING

The annular space between the casing and borehole wall is filled with filter packing materials in the screen intervals and back filling materials. The gravel packing mixture to be used depends on the sieve analysis results and the slot size of the screen. The contractor will do the sieve analysis and then determine the gravel pack materials. Gravel packing material will be stored in a way so as to avoid contamination or rain washing finer materials. Iron and Calcareous grains will not be included in the gravel pack materials.

Gravel packing is carried out as continuous feed operations done usually by two people filling uniformly around the circumference of the pipe. It is advisable to add some water with a pipe so that the gravel flows down. If the gravel gets inside the temporary casing, the casing is slowly pulled out and gentle well development is done to allow gravel to settles properly to a height of 3 meters above the top of the screen interval or the targeted water bearing formation. More gravel is added with development if the gravel settles down.

Backfilling and grouting is done when the ***Minimum acceptable yield of 2.5 liters/ second*** is confirmed by development. The borehole cuttings or clayey soils are back filled up to 6 meters below the ground surface.

The grouting is done with a concrete mix in the ratio of 1:2:3 of cement sand and gravel respectively. The gravel size should be not more than 6mm. Insert a 3 meter Steel casing of 6 inches diameter on to the PVC casing, both protruding above ground level by at least 60cm to facilitate installation of Bush Pump Type B (see manual for details).

2.1.2 BOREHOLE DEVELOPMENT

On completion of drilling, the Contractor will choose a suitable and appropriate borehole development method. The borehole shall be developed for a period of at least three hours in order to obtain a maximum yield of water that is free of suspended matter. Developing shall be carried out by airlift pumping and surging, jetting and block surging, or other techniques the contractor feels is more appropriate and efficient to suit the casing, hydro-geological and drilling conditions prevailing in that borehole. All boreholes shall be presented for testing free of any bridging or obstruction to the total depth. The Contractor should provide the equipment required for verticality testing as described in NEMA regulations. Developing will be for a minimum period of 3 hours.

2.1.3 PUMPING AND RECOVERY TEST

A pumping test is required on a routine basis for each borehole. The Contractor will estimate the discharge from the air lifting rates or blow test during borehole development. Based on the estimated discharge, the Contractor will certify the borehole as either "successful" or "lost". For successful boreholes for hand pumps, the Contractor will undertake a seven hour pump testing of which the first one hour is a three step draw down test. The discharges for the step drawdown test will be fixed by the contractor based on the well development results. High yielding boreholes, with a discharge of more than 2.5 litre/second may be pump tested for 72 hours. The 72 hours pump test is conducted if the borehole is intended for a motorised pump. After conducting the step drawdown tests the borehole should be allowed to recover almost to the original static water level (1 hour) before the constant yield test is undertaken continuously for 4 hours at the chosen/predetermined rate.

The first step could be minimum acceptable discharge of 2.5 liters / sec. The second step will be at an estimated discharge from blow test (during the well development) and the third step will be 50 to 75% more than the estimated discharge from blow test. As a thumb rule the range of the three steps could be 5 liter/Sec or above depending of development results, 7.5 liters /Sec and 2.5 liters/ Sec. and each step for 20 minutes (total 1 Hours) the continuous test of 4 hours will be carried out at a discharge at which the dynamic water level will stabilize. ***Annex 9 and 10*** show the formats for recording pump test data. ***If the discharge is below 2.5 liters/second or dynamic water level is below 45 meters then the borehole will be regarded as "Lost"***.

Recovery test will be for one hour or such time when there is at least recovery of 80% of the static water level noted at the start of the pump test. The pump test data and the results of pump test is presented in the standard form.

The Contractor shall have on site a 90° V-notch weir, preceded by a tank with baffles, for the measurement of flows. Small flows (less than 2.5 liters/second) can be measured by timing the filling of a vessel of known volume. The Contractor shall also have on site an operating electric dip meter, calibrated in centimeters, and with visual/audible indicator of when the water level is reached.

Readings of flow and water level shall be taken at the intervals defined on the test pumping form. For accurate measurement, an electrical/ sonic water level indicator with graduated tape for taking water level readings should be utilized. Recovery readings shall be taken for a minimum of 1 hour, during which period pumping equipment shall **not** be removed from the borehole.

2.1.4 WATER QUALITY TESTING

The contractor shall, make sampling and quality analysis of water from every borehole.

The water quality test should be conducted at a competent testing laboratory that is authorized by the client.

The parameters to be tested are given in table below and standards will be according to WHO guidelines for drinking water quality***.***

Water samples for chemical analysis should be collected at the end of the test pumping process and analyzed at the approved laboratory at the earliest possible time to facilitate timely handing over of the borehole for use by the community. Thus the pump handle should only be fitted after acceptable chemical analysis results. Samples for biological testing will be collected later in suitable batches so as to meet the time limit of 48 hours between collecting and analysis in the laboratory

2.1.5 SAMPLING AND DRILL TIME LOGS

Representative samples of the strata intersected shall be collected every one meter or less depending on the change of geological formation. For collection, the Contractor shall cease drilling, circulate all cuttings to the surface, resume drilling and collect the cuttings then brought to the surface. The Contractor shall take every possible precaution to guard against sample contamination due to poor circulation, borehole erosion, or caving. Cutting samples shall be bagged, labeled with borehole depth at time of collection, and stored in a position where they will not be contaminated by site conditions or drilling operations. The Contractor shall supply strong, transparent sample bags and indelible labels as required. The driller in-charge will also record the drill time logs/penetration rate of each rod or at every three meter interval.

2.1.6 PROTECTION

During the contract period, when work is not in progress, the boreholes shall be kept capped in such a manner as to prevent the entrance of foreign materials. The Contractor shall remove any foreign matter at his own expense. On completion of each borehole, the Contractor shall supply and fit an approved permanent lock-up cap. Casing shall terminate not less than 0.5 meters above ground level and are fitted with the approved lock-up cap.

After successful completion of drilling, casing and testing head-works will be constructed in line with the guidelines given in the Head-work Manual which forms part of the documentation of this contract.

2.1.7 ABANDONMENT

The Client shall have the right at any time during the progress of the Works to order the abandonment of the borehole. The Contractor shall thereupon remove the drilling rig, withdraw any casing and screen and salvage all such materials as the Client shall direct, and shall fill and leave the borehole to the satisfaction of the Client. In such case all works done and materials used will be paid by client.

2.1.8 "LOST" (UNSUCCESSFUL) BOREHOLES

"Lost" boreholes are either "dry" boreholes or "uncompleted" boreholes.

4.1.8.1 DRY BOREHOLES

Dry boreholes are defined as:

a) A borehole having no water bearing zones/aquifers.

b) A Borehole that has insufficient discharge (less than 0.25 liters/second) for 6 hours of continuous pumping test.

c) A borehole with stabilized Dynamic Water Level of more than 45 meters at minimum acceptable discharge of 0.25 liters/second.

d) A borehole that has failed verticality test

e) Hand pump facility is unable to provide discharge of 0.25 liters per second. The hand pump installed on such borehole is unable to sustain continuous use by the communities throughout the day*.

* This situation may arise with time within the Guarantee period because of one or more constructional defects such as ruptured / cracked casing, sections of boreholes collapsed, heavy silting closing the screen, screen chocked; lowering the discharge, or poor sitting of borehole with no potential sustainable aquifers, drilling up to insufficient depths to tap potential sustainable aquifer. In the above case the Contractor shall either improve the discharge by appropriate well development methods or if the dynamic water level is less than 40m, lower the pump inlet with additional riser pipes and connecting rods. In the case of any remedial works not being effective the Contractor shall

drill a new borehole at an alternative site mutually agreed with the Water Committee and the Contractor. If, after investigations, the Contractor feels that there are no possibilities of drilling a successful borehole in the village/ community, then the Contractor can move to a new location. This should, however, be after two failed attempts to drill the borehole in the same location. If the contractor is unable to remove the defects, abandoned due to any other reason then the borehole is classified as “Dry” and contractor has to refund the payment made by the client for that borehole.

4.1.8.2 UNCOMPLETED BOREHOLES

For any reasons, contractor is unable to continue drilling and complete the construction of borehole then this borehole is deemed to be an “uncompleted “borehole.

In case of ‘"uncompleted" boreholes, no payment shall be made for that borehole either for drilling or materials that cannot be salvaged and the rig's unproductive time spent. If the Contractor chooses to deviate from standard procedure and the agreed method of drilling, and wishes to adopt any other procedure or techniques that involves any additional cost and time required it will be done so entirely at the Contractor's own risk and cost.

2.1.9 TEST OF ACCEPTABILITY AND REPORTS

Subject to meeting the requirements of the maintenance period, the borehole shall be accepted for payment on presentation of the following reports at schedules shown in the table below and sample of the formats given in the annexes:

NAME	DESCRIPTION	FREQUENCY
1. Sketch Map showing the drilling plan.	A table showing the location, name, borehole number, and distances in kilometers from the last drilling location along with a sketch map showing the above information and sequence in which the drilling will progress i.e. route of movement of the rig.	Once, before the starting of drilling operations.
2. Results of Geophysical surveys	A table showing the location by District and Wards, borehole number, GPS co-ordinates, and results of geophysical surveys showing geology type, type of resistivity sounding curve with the thickness of interpreted layers and their thickness, recommended depth to be drilled.	Once after the completion of geophysical survey. Submitted to client before drilling commences and also as part of final report.
	Detailed report on resistivity surveys on each borehole with i) sketch map showing the locations of three sites investigated , ii) ii)data collection sheet for Vertical Electrical Sounding(VES); iii) iii) VES curves with interpretation on a log-log paper showing with thickness	Once - One report for each district. To be submitted along with the invoices for final payment.

	and resistivity and recommendations for drilling.	
3. Strata log, penetration rate Log and location of main strikes.	An accurate record of strata passed through and the depths at which strata were intercepted; also progressive measured (Vnotch) airlifted yields after reaching water.; An accurate record of the penetration rates achieved in minutes for each meter drilled, together with type, size and grade of bit.	Recorded daily as drilling progress. Submitted to client with invoices for payment
	An accurate record of time spent each day on different phases of drilling, to include rig down time, with causes.	
	A record of depth at which the water zones were struck during the drilling. This information can be combined with strata log and penetration log.	
4. Pumping Test data and recovery test results.	A detail report on the pump test, including the data of draw down with time and recover test, specific yield and draw down, recommendations on hand pump installation.	Once, recorded during pump test Submitted to client with invoices for payment.
5. Construction log	An accurate record and a figure showing the details of well construction- position of all casing, slotted casing, sand trap, end cap placed in the borehole, their quantities, hand pump installation-position of cylinder, number of connecting rods and riser pipes.	Recorded for each borehole after completing borehole construction. Submitted to client with invoices for payment.
6. Invoices for works done.	Invoices in same form in which rate schedule were quoted for each borehole and a summary sheet of all invoices.	Once after completion bathes of 10 boreholes.
7. Certificate of Completion ion	A certificate of Completion & .acceptance of hand pump facility constructed from Client staff.	Once after the inspection of hand pump facility by Client staff and Submitted to client with the invoices.

The Contractor is expected to submit four (3) bonded copies of the **above reports for each district separately and a summary in the beginning for each installment of payment. Client will provide Standard report format to the contractor.**

SECTION M

WATER FEATURE INSTALLATIONS SPECIFICATIONS

1 PART B

1.1 GENERAL MECHANICAL SPECIFICATION

1.1.1 GENERAL

This section specifies the general requirements for plant, equipment and material forming part of the Sub-Contract Works and shall apply except where specifically stated elsewhere in the specification or on the contract Drawings.

1.1.2 QUALITY OF MATERIALS

All plant, equipment and materials supplied as part of the Sub-contract works shall be new and of first-class commercial quality, shall be free from defects and imperfections and where indicated shall be of grades and classifications designated herein.

All products or materials not manufactured by the Sub-contractor shall be products of reputable manufacturers and so far as the provisions of the Specification is concerned shall be as if they had been manufactured by the Sub-contractor.

The Sub-Contractor as called for by the Specification and Contract Drawings shall supply materials and apparatus required for the complete installation unless mention is made otherwise.

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

Defective equipment or that damaged in the course of installation or tests shall be replaced as required to the approval of the Engineer.

1.1.3 REGULATIONS AND STANDARDS

The Sub-Contract Works shall comply with the current edition of the following:-

i) The Kenya Government Regulations
ii) The United Kingdom Institution of Electrical Engineering (*IEE*) Regulations for the electrical equipment of buildings.
iii) The United Kingdom Chartered Institute of Building Services Engineers (*CIBSE*) Guides.
iv) British Standards and Codes of Practice as published by the British Standards Institution (*BSI*).
v) The Local Council By-laws.
vi) The Electricity supply Authority By-Laws.
vii) Local Water Authority By-Laws.
viii) The Kenya Building Code of Regulations.

1.1.4 ELECTRICAL REQUIREMENTS

Plant and equipment supplied under this Sub-Contract shall be complete with all necessary motor starters, control boards, and other control apparatus. Where Control Panels incorporating several starters are supplied, they shall be complete with a main isolator.

The supply power up to and including local isolators shall be provided and installed by the Electrical Sub-Contractor. All other wiring shall be as described in the "Particular Specification".

The Sub-Contractor shall supply three copies of all schematic, cabling and wiring diagrams for the Engineer's approval.

The starting current of all electric motors and equipment shall not exceed the maximum permissible starting currents described in Kenya's power utility Company's By-Laws.

All electrical plant and equipment supplied by the Sub-Contractor shall be rated for the supply voltage and frequency obtained in Kenya that is 415 volts, 50Hz, 3-phase or 240 volts, 50Hz 1-phase as specified in the "Particular Specification".

The Consultant may reject any equipment that is not rated for the above voltages and frequencies

1.1.5 TRANSPORT AND STORAGE

All plant and equipment shall, during transportation be suitably packed, crated and protected to minimise the possibility of damage and to prevent corrosion or other deterioration.

On arrival at site, all plant and equipment shall be examined and any damage to parts and protective priming coats made good before storage or installation.

Adequate measures shall be taken by the Sub-Contractor to ensure that plant and equipment do not suffer any deterioration during storage.

Prior to installation all piping and equipment shall be thoroughly cleaned.

If, in the opinion of the Consultant any equipment has deteriorated or been damaged to such an extent that it is not suitable for installation, the Sub-Contractor shall replace this equipment at his own cost.

1.1.6 SITE SUPERVISION

The Sub-Contractor shall ensure that there is an English-speaking supervisor on the site at all times during normal working hours.

1.1.7 INSTALLATION

Installation of all special plant equipment shall be carried out by the Sub-Contractor under adequate supervision from skilled staff provided by the plant and equipment manufacturer or his appointed agent in accordance with the best standards of modern practice and to the relevant regulations and standards described under Clause 3 of this section.

1.1.8 TESTING

3.1.8.1 GENERAL

The Sub-Contractor's attention is drawn to Part "A", Sub-Clauses 2.1.44 and 2.1.45 on Pages 2.11 and 2-12 respectively of the "Preliminaries and General Conditions".

The following sub-clauses are intended to define the Sub-Contractor's responsibilities with respect to testing and inspection.

3.1.8.2 MATERIAL TESTS

All material for plant and equipment to be installed under this Sub-Contract shall be tested, unless otherwise directed, in accordance with the relevant B.S. specification concerned.

For materials where no B.S. specification exists, tests are to be made in accordance with the best modern commercial methods to the approval of the Engineer, having regard to the particular type and application of the materials concerned.

The Sub-Contractor shall prepare specimens and performance tests and analyses to demonstrate conformance of the various materials with the applicable standards.

If stock material, which has not been specifically manufactured for the plant and equipment specified is used, then the Sub-Contractor shall submit satisfactory evidence to the Consultant that such materials conform to the requirements stated herein in which case tests of material may be partially or completely waived.

Certified mill test reports of plates, piping and other materials shall be deemed acceptable.

3.1.8.3 MANUFACTURED PLANT AND EQUIPMENT - WORKS TESTS

The rights of the Consultant relating to the inspection, examination and testing of plant and equipment during manufacture shall be applicable to the Insurance Companies or Inspection Authorities so nominated by the Engineer

The Sub-Contractor shall give two weeks' notice to the Consultant of the manufacturer's intention to carry out work tests and inspections.

The Consultant or his representative shall be entitled to witness such tests and inspections. The costs of such tests and inspections shall be borne by the Sub-Contractor.

Six copies of all test and inspection certificates and performance graphs shall be submitted to the Consultant for his approval as soon as possible after the completion of such tests and inspections.

Plant and equipment which is shipped before the relevant test certificate has been approved by the Consultant shall be shipped at the Sub-Contractor's own risk and should the test and inspection certificates not be approved, new tests may be ordered by the Consultant at the Sub-Contractor's expense.

3.1.8.4 PRESSURE TESTING

All pipe work installations shall be pressure tested in accordance with the requirements of the various section of this specification. The installations may be tested in section to suit the progress of the works but all tests must be carried out before the work is buried or concealed behind building finishes. The Consultant or his representative must witness all tests and the Sub-Contractor shall give 48 hours' notice to the Consultant of his intention to carry out such tests.

Any pipe work that is buried or concealed before witnessed tests have been carried out shall be exposed at the expense of the sub-contractor and the specified tests shall then be applied.

The Sub-Contractor shall prepare test certificates for signature by the Consultant and shall keep a progressive and up-to-date record of the Sections of the work that have been tested.

1.1.9 COLOUR CODING

Unless stated otherwise in the Particular Specification all pipe work shall be colour coded in accordance with the latest edition of B.S. 1710.

1.1.10 WELDING

3.1.10.1 PREPARATION

Joints to be made by welding shall be accurately cut to size with edges sheared, flame cut or machined to suit the required type of joint. The prepared surface shall be free from all visible defects such as lamination, surface imperfections due to shearing or flame cutting operation, etc., and shall be free from rust, scale, grease and other foreign matter.

3.1.10.2 METHOD

All welding shall be carried out by the electric arc process using covered electrodes in accordance with B.S. 639.

Gas welding may be employed in certain circumstances provided that prior approval is obtained from the Engineer

3.1.10.3 WELDING CODES AND CONSTRUCTION

All welded joints shall be carried out in accordance with the following specification:-

a) Pipe Welding
   All pipe welds shall be carried out in accordance with the requirements of B.S.806.
b) General welding
   All welding mild steel components other than pipe work shall comply with the general requirements of B.S. 1856.

3.1.10.4 WELDERS QUALIFICATIONS

Any welder employed on this Sub-contract shall have passed the trade tests as laid down by the Government of Kenya.

The Consultant may require seeing the appropriated certificate obtained by any welder and should it be proved that the welder does not have the necessary qualifications the Consultant may instruct the Sub-Contractor to replace him by a qualified welder.

2 PART C

2.1 PARTICULAR SPECIFICATIONS FOR SWIMMING POOL AND WATER FEATURE INSTALLATIONS

2.1.1 CIRCULATION SYSTEM

4.1.1.1 WATER QUALITY

Source water and water quality in pools must be acceptable to the health authority and meet the requirements outlined in the Pool Regulation. The health authority may require that potable water as defined in the *Drinking Water Protection Act* be used in wading or spray pools, and to fill a pool.

4.1.1.2 WATER CIRCULATION

a) Design Flow Rate

All pools, except flow-through pools, should circulate water continuously as per standard requirement.

Where a pool serves a combination of uses (e.g., a water slide catch pool, leisure pool and training pool), the maximum turnover period should be adjusted accordingly to account for changes in the expected bathing and associated pollution loadings.

The water circulation rate affects the size of recirculation equipment and velocities through the main drain. Operationally, higher pool recirculation rates enable more pool water to move through the filters, potentially reducing chlorine demands and improving operational stability. However, higher rates may create suction entrapment hazards. All these factors should be considered when selecting the recirculation rate for the pool, in addition to the maximum turnover periods stated above.

b) Flow-Through Pools

Flow-through pools (including hot springs and natural spas covered under the regulation) should have water added continuously at a design flow rate that would achieve the same turnover period as a recirculating pool. The quality of water added must be approved by the health authority and maintained to meet requirements of the regulations.

c) Multiple Pools

All pools should be on separate and independent circulation systems. This prevents cross-contamination between pools, reduces the likelihood of rapid water-level fluctuations when bather loads in adjacent pools suddenly change, and allows individual pools to be isolated, closed and maintained without affecting the operation of other pools in the complex. Independent recirculation systems are also beneficial for the control and maintenance of pool water quality and chemistry.

Where the piping configuration enables water from one pool to be used to fill another, the piping should:

- Enable pool water to fill a hot tub, but not vice versa.

- Not interfere with the ability of the independent recirculation systems to function continuously.

d) Water Velocity

The maximum velocity of water through any drains or suction fittings must be equal or less at the design flow rate, in accordance with Section 10(2) (k) of the Pool Regulation.

4.1.1.3 CIRCULATION EQUIPMENT

a) Piping

All piping should have minimal friction losses and carry the required quantity of water at recommended velocities for both supply and suction pipes

Piping must conform to the requirements of the B.C. Plumbing Code (current edition) and should be of nontoxic material, resistant to corrosion by pool water, able to withstand operating pressures and installed according to the manufacturer's recommendations. Piping should be securely mounted and routed away from high-traffic areas to minimize the risk of breakage.

Piping related to pool operation should be properly identified through a standard system of colour coding, flow directional arrows and function labeling. Pipes may also have labeling requirements as part of a WHMIS program. Refer to the Occupational Health and Safety Regulation for details.

b) Pumps

Pumps should be either self-priming or located below the level of the pool. The pump should be protected from damage and securely mounted on a housekeeping pad.

4.1.1.4 CROSS-CONNECTION CONTROL

Cross-connection control ensures that potential contamination in a pool does not impact the potable water supply or water quality in another pool. Cross-connection control measures in a pool should include:

- Approved backflow preventers on connections to a potable water supply, including:
  - Pool fill-lines, including automatic pool fillers.
  - Hose bibs.
- The ability to isolate a pool’s circulation system from another pool’s circulation system.
- The pool filter backwash pipe should discharge to waste through an air gap that is at least twice the inside diameter of the backwash pipe.

Notwithstanding any of the above, the pool must comply with any other requirements of the *Drinking Water Protection Act* and the B.C. Building Code.

a) Equipment Room Water Supply

The water supply into the equipment room should be equipped with a Reduced Pressure Backflow Prevention Assembly (RPBA). The AWWA Canadian Cross Connection Control Manual (Edition #1, 2007), Section IV, Table I assigns pools a moderate hazard rating. The table further notes that where a higher hazard exists (due to toxicity or health hazard), additional area protection with an RPBA is required. The potential for a health hazard exists should there be a fecal accident in the pool basin. Such a situation would increase the hazard rating for this application; therefore an RPBA is strongly advised.

4.1.1.5 WINTER HAZARDS

Pools operating in conditions where there is a possibility of water freezing on the deck or edge of the pool should provide an effective method of heating the deck, access walkways and stairs to prevent ice formation and maintain an ice-free condition.

Consideration should be given to preventing ice formation on pool features to which pool users have access, such as water slides.

Pools that are shut down in the winter may require special design consideration and maintenance procedures to prevent damage to the pool during winter.

2.1.2 POOL BASIN EQUIPMENT

4.1.2.1 POOL INLETS

Pool inlets should be:

- Submerged at least 61cm (2 ft.) below the average operating.
- Placed as near to the pool floor as possible if the pool water depth is less than the 61cm (2 ft.).
- Floor-level type if the pool is a beach entry or zero-depth pool.
- Located to produce, in so far as possible, a uniform circulation of water and maintain a uniform disinfectant concentration throughout the entire pool.
- Spaced at least 1.5m (5 ft.) away from any skimmer, where possible.

a) Inlet Fittings

Inlet fittings should:

- Be of a type whereby the rate of flow and directional angle can be adjusted to improve circulation.
- Be placed in the pool wall and spaced no more than the maximum required distance apart measured from the perimeter of the pool or one fitting for each required pool volume, whichever is more.

b) Floor Inlets

Where pool sidewalls are more than 13.4m (44 ft.) apart, floor inlets should be used. If floor inlets are used, the inlets should be:

- At least equal in quantity to the number of wall inlets calculated.
- Arranged to carry surface water to the gutters or skimmers.

4.1.2.2 GUTTERS AND SKIMMERS

Pool gutters and skimmers should be designed to collect 100% of the pool design flow rate. Section 10(2)(j) of the Pool Regulation requires that at least 50% of the design flow passes through gutters and skimmers to increase the cleansing action on the water surface and reduce suction at the main drain(s).

A flow meter should be installed in either the main drain line or gutter/skimmer line to determine flow rates through the main drain and the proportion of recirculation flow through the gutters/skimmers.

a) Gutters

Gutters commonly used in pools include raised-edge (conventional), deck-level and roll-out gutters. Generally, gutters should extend along the entire perimeter of pools having a surface area of more than the maximum required area

Gutters should be installed:

- To rapidly remove surface water at a rate equal to or greater than the pool design flow rate.
- To prevent the gutters from becoming flooded.
- With an interior of not less than 7.6 cm (3 in.) wide and 7.6 cm (3 in.).
- To prevent entrance or entrapment of bathers' arms or legs.
- To provide easy access for cleaning.
- To provide gutter drains at intervals of not more than 4.6 m (15 ft.) and at least 5 cm (2 in.) in diameter.
- To provide a finger hold (bull nose at the pool edge) or handhold so patrons can grab the pool edge.

Raised edge (conventional) gutters should be designed:

- So that the opening into the gutter beneath the coping or deck is not less than 10 cm (4 in) and the interior of the gutter is not less than 7.6 cm (3 in) wide and 7.6 cm (3 in) deep.
- To serve as a handhold so that their edges or lips are rounded and not thicker than 6.4 cm (2½ in) for the top 5 cm (2 in).
- To extend along the entire perimeter of the pool except at steps and recessed ladders.

For deck-level and roll-out gutters, refer to the design guidelines provided in section 3.2. For deck-level and roll-out gutters, refer to the design guidelines provided in section 3.2.

b) Skimmers

Skimmers may be used in place of gutters to remove surface water from a smaller pools with a given required maximum pool surface area.

The number of skimmers a pool should have is the greater of:

- The number calculated at the rate of one skimmer for every given required pool surface area or portion thereof.
- The equivalent number calculated based on a given required flow rate of design flow per cm of weir.
- Each skimmer should:
    - Have a means to regulate the flow of water through it.
    - Have a weir.
    - Have a lid vented to the pool deck.
    - Be positioned to remove surface water from the pool.
    - Have valves separate from the rest of the circulation system in the mechanical room.
    - Have equalizer lines that connect to the main drain piping, rather than terminating in the pool basin (suction hazard).

c) Beach-Like Edge Pools

For beach-like edge pools with a continuous gutter along the entire length of the beach-like edge and flush with the pool floor, skimmers can be used instead of gutters between the continuous floor gutter and the point where the water reaches a depth of 91 cm (3 ft.). Enough skimmers should be provided to achieve a theoretical turnover period of less than one hour in the area to which the skimmers relate.

4.1.2.3 MAIN DRAIN AND SUCTION ENTRAPMENT HAZARDS

The main drain induces water circulation in the deeper part of a pool, draws water into the circulation system for filtration, and is used to empty a pool. A poorly or inadequately designed, installed or maintained main drain and/or drain cover are potential suction hazards.

Suction hazards in pools have led to cases of fatal limb entrapment, hair entanglement, and/or evisceration. Poorly designed or malfunctioning main drain outlets can cause suction strong enough to entrap body parts or hair, causing a bather's head to be held under water, potentially causing serious injury and/or death. Drowning deaths have also occurred after the body or a limb has been held against a drain by suction of the circulation pump. Any open drain or flat grating that the body can cover completely, combined with a plumbing layout that allows a build-up of suction if the drain is blocked, can result in this kind of hazard.

In the United States, deaths due to pool entrapment have led to the enactment of the *Virginia Graeme Baker Pool and Spa Safety Act (VGBPSSA).* The act outlines provisions to minimize the risk of entrapment, including vacuum covers, pool barriers and main drain requirements. While the *VGBPSSA* is not law in B.C., the Ministry of Health supports the efforts to reduce suction hazards.

Strategies to prevent accidents from suction entrapment should address five areas:

- Pool design.
- Pool maintenance (see *B.C. Guidelines for Pool Operation*).
- Training of pool personnel (see *B.C. Guidelines for Pool Operation*).
- Emergency procedures (see *Pool Safety Plan Guide for Pool Operators*).
- Public awareness (see *Pool Safety Plan Guide for Pool Operators*).

This section of the guidelines addresses pool design aspects for minimizing suction entrapment risks, including pool main drain, main drain cover, piping, and equalization fittings. For spray pools and other zero-depth aquatic areas, refer to the spray pool guidelines in section 11.4. Operational aspects are covered in the *B.C. Guidelines for Pool Operation*.

a) Pool Main Drain

The pool main drain should:

- Be at the deepest point in the pool to permit the pool to be completely and easily emptied.
- For frame- and grate-type main drains, have a sump depth of at least 1½ pipe diameters to create equal suction velocity across the drain.
- Have each opening covered by a grating that is not readily removable by bathers and precludes the possibility of a body forming a seal against the cover.

To minimize suction and entrapment hazards, it is strongly recommended, as an engineering best practice, that a minimum of two drains be installed in a pool. The drains should be spaced at least 92 cm (36 in) apart so that a body could not cover both simultaneously to create a vacuum. The installation of a second drain splits the suction induced by the pump between two outlets, reducing the suction at a blocked drain.

If it is not possible to install two drains (such as a pool retrofit), all outlet and discharge pipes should be adequately guarded to prevent an adverse suction hazard. Design considerations to minimize suction hazards where two drains are not feasible include:

- Installing a side/vertical mounted suction fitting, as long as the main drain line and suction fitting are interconnected and the velocity through the suction fitting is less than a given required velocity at the design flow rate.
- Installing onto the main drain line an airline (anti-suction system), supplemental vacuum relief system, or automatic pump shutoff that will relieve the suction if the intake gets blocked.
- Converting the drain plumbing into a gravity drainage system.

These devices will only minimize suction risks, not the risk of hair entanglement. Hair entanglement risks are mitigated through proper drain cover design.

b) Pool Main Drain Covers

The *VGBPSSA* requires that drain covers in the U.S. are tested and certified in accordance to ANSI/APSP-16-2011: Standard Suction Fittings for Use in Swimming Pools, Wading Pools, Spas and Hot Tubs. There are a number of *VGBPSSA*-compliant drain covers on the market, but it is important to note that compliance with the *VGBPSSA* requirements does not ensure compliance with the Pool Regulation. Flow rates through any drain cannot exceed given required velocity at the design flow rate. (For pools with more than one main drain, the flow rate calculation should be based on the design flow divided by the number of drains, assuming no blockage).

New or replacement drain covers should have the following properties:

- A flat or low-profile design for pool areas less than a given required depth, to minimize tripping hazards.
- A grating opening that will not entrap toes, fingers, hair or limbs.
- No sharp corners.

c) Pool Main Drain Piping

The pool main drain piping should:

- Be separately valved from the gutters or skimmers and discharge into the circulation pump suction, surge tank or an approved drain.
- Have a capacity equal to 100% of the design flow rate.

d) Hydrostatic Relief Valve Requirement

Pools that are not designed to resist hydraulic uplift should be provided with a hydrostatic relief valve.

e) Drain Connection To Circulation System

All pools with overflow gutter systems should have all overflow gutters connected to the circulation system through a properly designed surge tank.

f) Equalization Fittings

Skimmer equalization fittings may also pose as suction hazards. Measures to minimize suction hazards from these fittings include the following:

- Excluding equalization fittings from the pool basin (below the water line) in new pool designs.
- All skimmer equalizer lines should be routed through the main drain piping rather than to the pool basin.
- Existing skimmer equalizer lines that end below the water line should be rendered inoperable to prevent an entrapment hazard.

g) References

Guidelines for Entrapment Hazards: Making Pools and Spas Safer, U.S. Consumer Product Safety Commission, March 2005. Washington, D.C. 2007

Virginia Graeme Baker Pool and Spa Safety Act, Title 14 of the *U.S. Energy Independence and Security Act* (2007).

4.1.2.4 VACUUM CLEANING SYSTEMS

Where a pool vacuum-cleaning system is installed, it should be capable of cleaning the entire pool floor. Vacuum cleaning systems should be designed so as to not create a suction or entrapment hazard when not in use. In order to minimize suction and entrapment hazards, the use of portable systems or robotic cleaners is preferred.

If the vacuum cleaning system is an integral part of the circulation system, connections should be located in the walls of the pool at least 20 cm (8 in) below the water level. To minimize the risk of an entrapment or suction hazard to pool patrons, a cap or cover is required for the suction fitting to the vacuum cleaning system. The cap should be manufactured in compliance with IAPMO SPS 4 (current edition) or equivalent.

If the vacuum cleaning system is an on-deck pump, the outlet should go to the circulation system or to waste. If fecal matter is being vacuumed, however, the outlet should only go to waste.

Electrical outlets for vacuum cleaning systems shall be installed in accordance with the B.C. Electrical Code (current edition).

4.1.2.5 OTHER ENTRAPMENT HAZARDS

Entrapment is any condition that impedes withdrawal of a body or body part that has penetrated an opening. While suction may be a major cause of entrapment, there are other situations where a person may become trapped resulting in risk of injury, strangulation or drowning. This may happen where younger children may not have the necessary cognitive ability or motor skills to extricate themselves, especially if frightened or panicked.

Examples of features that may pose a risk of entrapment and require special attention:

- moveable bulkheads
- movable floors
- play equipment
- water features
- portable stairs

- lifts
- skimmers in lazy rivers that may trap hands
- exits of slides/water slides

Much of this risk can be eliminated through careful design to minimize entrapment hazards. The equipment should be used only for the purpose for which it is designed.

4.1.2.6 SURGE CAPACITY

Surge capacity in a pool is achieved through free-board in pools with skimmers. In pools using gutters, the gutter, transit piping and the surge tank all contribute to the volume of surge capacity in the pool. Surge capacity increases the pool's ability to maintain a steady water level in response to sudden changes in pool use. This ensures that gutters, skimmers, and water intakes remain below the surface to the water to prevent loss of effective filtration or other circulation problems.

The surge capacity of pools should be designed for the maximum bathing load. For all pools equipped with gutters, 84 L (3 ft3) of surge capacity per bather should be provided.

4.1.2.7 SURGE TANKS

A surge tank should be installed in pools using gutters. The surge tank should have:

- A working capacity of at least 57 L (2 ft3) per bather, based on the maximum bathing load.
- A working capacity exclusive of pipe or channel capacity required for recirculation rates. The balance of the surge capacity may be provided by pool gutters and piping capacity.
- "T" fittings vented to the atmosphere on a suction pipes to reduce the risk of a suction hazard to workers conducting surge tank maintenance.
- Hatches with a locking mechanism to prevent bather entry, if located in bathing areas.
- Hatches that are slip-resistant and not a tripping hazard, if located on the pool deck.
- Designed to reduce the risk of accidental entry.

4.1.2.8 MAXIMUM BATHING LOAD

a) Pools

The following formulas can be used to calculate maximum bathing load. Pool depths of less than 60 cm (2 ft.) need not be considered in the calculations.

Imperial: Maximum Bathing Load = (D/27) + (S/10)

Where D = area of pool in sq. ft. where the water depth is greater than 5 ft., and

Where S = area of pool in sq. ft. where the water depth is less than 5 ft.

Metric: Maximum Bathing Load = (D/2.5) + (S/0.93)

Where D = area of pool in m^2 where the water depth is greater than 1.5 m, and

Where S = area of pool in m^2 where the water depth is less than 1.5 m.

b) Hot Tubs

Bather load for hot tubs may be determined based on increments of 60 cm (2 ft.) of seating per person.

c) Spray Pools

The bather load for spray pools should be 1 person per m^2 of spray pad surface.

2.1.3 POOL WATER TREATMENT

4.1.3.1 FILTRATION

Filtration is an essential part of the circulation system as it removes dirt, oils and debris from the water, which helps maintain safe and desirable water quality. Effective filtration will also reduce chlorine demands, helping to maintain low levels of combined chlorine in the pool water.

a) Filter Piping

The filter piping arrangement should be as simple as possible to accomplish the filtration and backwashing or cleaning.

The pool filter backwash pipe should discharge to waste through an air gap that is at least twice the inside diameter of the backwash pipe.

b) Filter Units

The filter units should be:

- Capable of operating at continuous design flow rate.
- Equipped with pressure, vacuum or compound gauges as required to indicate the condition of the filter.

In vacuum-type filter installations where the circulating pump is 2 horsepower or more, an adequate automatic high vacuum shut off should be provided to prevent damage to the pump by cavitation.

c) Sand Filters

Sand filters should be designed for a maximum flow rate of approximately 600 L/min/m2 (15 US gpm/ft2) of filter area.

d) Diatomaceous Earth Filters

Diatomaceous earth (DE) filters should be designed for a maximum flow rate of 60 L/min/m2 (1.5 US gpm/ft2) of filter area. For regenerative-type DE filters, the flow rate should follow the manufacturer's recommendations.

On non-regenerative-type DE filters, backwashing releases the DE into the backwash water. The facility receiving the backwash water, whether through a permit or not, should be notified of the presence of DE in the wastewater, as it may affect downstream treatment.

e) Cartridge Filters

Cartridge-type filters should not be used in public or commercial pools.

4.1.3.2 DISINFECTION AND OTHER CHEMICALS

a) Pool Disinfection Equipment

Pool disinfection equipment should:

- Be automatic.
- Be easily adjustable to maintain recommended disinfectant residual levels during periods of both high and low use.
- Be properly sized for the pool and design flow rate.
- Have sufficient capacity to continuously feed free chlorine (or equivalent) into the circulation system at levels of up to (based on the design flow rate):
  - 3 mg/L for indoor pools
  - 8 mg/L for outdoor pools
  - 5 mg/L for indoor hot tubs
  - 8 mg/L for outdoor hot tubs

b) Automatic Disinfection

Acceptable forms of automatic disinfection include:

- chlorine gas injection
- sodium hypochlorite injection
- adjustable erosion feeders

Disinfection methods that are not considered to be automatic include:

- disinfection pucks in skimmer baskets and recirculation pump pre-filters
- manual application
- floating erosion feeders common in residential hot tubs

Erosion feeders utilizing tri-chloroisocyanuric acid (Tri-chlor) tablets should only be used in outdoor pools, because the tablets contain cyanuric acid. Use of Tri-chlor in indoor pools can lead to excess cyanuric acid in pool water resulting in a reduction in disinfection effectiveness. Such a buildup can be managed through diluting pools with make-up water.

c) Other Chemicals

Automatic feeders that add other chemicals should be sized to provide an appropriate rate of feed for the demand of the facility.

D) gas Chlorination

Chlorine disinfectant is available in a number of forms, including chlorine gas, liquid sodium hypochlorite, and onsite-generated sodium hypochlorite. Many pools use chlorine gas as a disinfectant. When used as intended, this provides an effective disinfectant; however, a chlorine gas leak can cause serious injury or death.

Proper design of chlorine gas facilities is crucial to managing the potential health and safety risks inherent in the use of this highly reactive gas. Chlorine gas leaks have the potential to harm public health as well as worker safety. The oversight for chlorine gas facilities is a shared responsibility between Worksafe BC, the Ministry of Health and health authorities.

The Worksafe BC Occupational Health and Safety Regulation contains a number of requirements for chlorine gas facilities that must be followed. Many of these requirements are outlined in Worksafe BC's *Chlorine Safe Work Practice Manual*14 and the PoolSafe BC guideline. The local health authority will also review the design from a public health protection perspective.

E) Onsite Chlorine Generation Systems (Salt Water Pools)

In pools using salt water disinfection systems, salt is added to the pool water. When the salt water passes through an electrolytic cell as part of the circulation treatment system, the salt is converted into sodium hypochlorite. Consequently, salt water systems are still chlorination systems. They should be designed with the same considerations as with more conventional forms of chlorine (gas, liquid sodium hypochlorite, etc.), in addition to technology specific considerations.

Onsite chlorine generation systems should:

- Be certified to NSF 50: Equipment for Swimming Pools, Spas, Hot Tubs and other Recreational Water Facilities.
- Have provisions to ensure continued disinfection (operational controls, equipment spares, back-up chemical dosing system, etc.) in the event of salt water system malfunctions (electronic malfunction, low salt levels, etc.).
- Be adequately sized to maintain the required chlorine residual in the pool at all times.
- Have adequate protection for all equipment components and surfaces in contact with the salt water.
- Meet the manufacturer's requirements for pool water quality parameters, including hardness and temperature.
- Be placed in a location with suitable ventilation to prevent hydrogen gas build-up.

Due to its salt content, the discharge of pool water should also be considered during the design stage. Consult with local authorities early on to determine if the discharge of salt water into the local sewer or receiving environment is permissible or if pretreatment is required.

F) UV Treatment

Ultraviolet light treatment is often used in pools as a supplementary form of disinfection to reduce chlorine consumption and disinfection byproduct formation or as a means of destroying chloramines. Reduction in the formation of disinfection byproducts can improve indoor air quality within the pool area.

Since UV disinfection cannot impart a residual disinfectant in the water, UV disinfection cannot replace chlorine, chlorine cyanurate, or bromine as primary disinfectants.

All UV systems should be certified to NSF Standard 50: Equipment for Swimming Pools, Spas, Hot Tubs and other Recreational Water Facilities. Large flow devices evaluated in accordance with other validation or certification protocols may also be considered.

a) For Supplementary Disinfection

UV treatment used as a supplemental form of disinfection should be certified to NSF Standard 50 for either:

- 3 log reduction of *Enterococcus faecium* and *Pseudomonas aeruginosa*; or
- 3 log reduction of *Cryptosporidium*.

b) For Chloramine Destruction

UV light is effective at destroying chloramines in pool water. The optimal dosage for chloramine destruction is 60 mJ/cm2 at 280 nm. This wavelength can only be achieved through medium-pressure UV lamps.

G) Ozone Systems

Ozone is commonly used in pools to oxidize organic matter, leading to a reduction in chlorine demand and therefore a reduction in the formation of chlorine disinfection byproducts (combined chlorine). Reduction in the formation of disinfection byproducts can improve indoor air quality in the pool area.

Since ozone dissipates rapidly, it is unable to maintain a residual in the water. For this reason, it cannot replace chlorine, chlorine cyanurate, or bromine as the primary disinfectant.

Protection of workers from ozone-related hazards falls under the jurisdiction of the WorkSafe BC, and designs must consider their requirements. Further information on WorkSafe BC requirements can be found on the WorkSafe BC website.16

Ozone systems should be certified to NSF 50 and must conform to WorkSafe BC requirements found in the *Ozone Safe Practices Manual* (BK 47)17 including:

- ventilation considerations
- destruction of ozone off-gas from contact tanks
- ozone room design requirements

4.1.3.3 MEASUREMENT OF CIRCULATION

a) Rate of Flow Indicator

A rate of flow indicator should be provided and maintained for each pool to show the rate of pool water circulation. This allows for verification of velocities through drains. The indicator should:

- Be conveniently located for ease of viewing.
- Be calibrated in either litres per minute or U.S. gallons per minute.
- Provide at least 90% accuracy.
- Be capable of flows measuring from 50% to 150% of the design flow rate.
- Not be at risk of plugging.

Rate of flow indicators should be installed on all return lines – including recirculation, water feature, skimmer/gutter, and water slide lines. Where a whirlpool jet pump system is in place, a rate of flow indicator should be located on the jet pump circulation system.

All flow indicators should be installed in accordance with the manufacturer's specifications. The required number of pipe lengths of straight pipe upstream and downstream of the flow indicator should be provided to achieve the stated flow reading precision and accuracy levels.

4.1.3.4 EQUIPMENT ROOMS

Equipment rooms must be designed to the B.C. Building Code (current edition). Additionally, equipment rooms should be designed to:

- Permit equipment to be easily installed, inspected, and maintained.
- Allow equipment to be mounted at or above floor level. For example, pumps and/or other electrical equipment should be installed on a minimum 75 mm (3 in) housekeeping pad.
- Provide the manufacturer's recommended maintenance area around equipment (height and floor area). Where the manufacturer does not specify a recommended maintenance area, sufficient space should be provided to dismantle equipment, remove components or contents, perform

routine maintenance, and, in some cases, replace equipment.

- Include floors sloped to drains.
    - Allow sufficient space for safe storage of auxiliary equipment.

4.1.3.5 CHEMICAL STORAGE AREAS

Proper design of chemical storage areas is essential to minimize the risks associated with storing dangerous goods. The B.C. Fire Code details chemical-storage-room design requirements. Aspects of note are outlined in Division B, Section 3.2 of the B.C. Fire Code (2012 version) and include, but are not limited to:

- Clearances (3.2.2.3)
- Storage limits (3.2.7.1)
- Prohibition of open flames or spark producing devices (3.2.7.2)
- Ventilation to prevent buildup of gases or chemical fumes (3.2.7.3)
- Separation distances from other chemicals. (Some incompatible goods must not be stored in the same fire compartment.) (3.2.7.6).
- Fire protection and suppression systems (3.2.7.9)
- Spill containment (3.2.7.11 and 3.2.7.17)
- Storage of gas fired appliances (3.2.8.2)
- Storage of compressed gases (3.2.8)

In addition to the storage separation minimums required of the B.C. Fire Code, adequate separation should be provided to minimize the risk of accidental chemical mixing during tank filling and chemical mixing/dilution

a) Individual Storage Requirements

Protection of workers from chemical hazards falls under the jurisdiction of WorkSafe BC, and designs must follow their requirements. Section 5.24: Incompatible Substances, in the *Occupational Health and Safety Regulation* states:

Substances which are incompatible must not be stored in a manner that would allow them to mix in the event of container leakage, breakage *or other such circumstance.*

Consult the Material Safety Data Sheets (MSDS) for each of the chemicals to be stored to determine incompatible chemicals and individual storage requirements

b) Reserve Containers

When sizing chemical storage rooms, consideration should be given to providing sufficient storage space for reserve containers of chemicals, especially in remote locations where chemical delivery may be infrequent. Adequate clearance should also be provided for chemical transporting equipment, such as forklifts, where applicable.

c) Spill Containment

In addition to the spill containment requirements of the B.C. Fire Code, chemical storage tanks should be double walled or separated by concrete enclosures, spill pallets or other spill containment system surrounding each tank. Each spill containment system should have an enclosure capable of containing 110% of the contents of each tank stored within the system.

Where possible, piping containing incompatible chemicals should be routed separately to minimize the potential for chemical reactions due to drips and leaks.