THE PROPOSED KISUMU COUNTY ASSEMBLY.

VOLUME I – SPECIFICATIONS AND STANDARD METHODS OF MEASUREMENTS

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SPECIFICATIONS: GENERAL

PART I: GENERAL

1.1 MATERIALS GENERALLY

All materials used on the works shall be new and of the qualities and kinds specified herein and equal to approve samples. Deliveries shall be made sufficiently in advance to enable samples to be taken and tested if required. No materials shall be used until approved and all materials which are not approved or which are damaged, contaminated or have deteriorated in any way or do not comply in any way with the requirements of this specification shall be rejected and shall be immediately removed from the site at the Contractor's expense.

1.2 MATERIALS FOR WHICH THERE IS A KENYA BUREAU OF STANDARDS SPECIFICATION

All materials used in the works for which a KENYA Bureau of Standards Specification has been published shall conform with the latest edition thereof in every way. The Architect reserves the right to demand that the Contractor shall obtain at his own expense a certificate in respect of any materials to state that it is in accordance with the Kenyan Bureau of Standard Specification.

1.4 ALTERNATIVES TO PROPRIETARY BRANDS

Where materials are specified by their proprietary names or where fittings are specified by catalogue numbers, or descriptions, the contractor may offer materials or fittings of alternative manufacture which are of equal quality. Such alternative must be approved before being used in the works and the Contractor shall allow for this, but prior to tendering he may submit to the Architect for approval the names of any suppliers of manufacturers whose products he intends to use, together with catalogue numbers and descriptions and/or samples but the decision of the Architect shall be final.

SPECIFICATIONS: GENERAL

PART I: GENERAL

1.5 SAMPLES

The Contractor shall furnish for approval, with reasonable promptness all samples of materials and workmanship required by the Architect. The Architect shall check and approve such samples for conformance with the design concept of the works and for compliance with the information given in the Contract Documents. The work shall be in accordance with approved samples.

(a) All material samples shall be delivered to the Architect's office with all charges in connection therewith paid by the Contractor.

(b) Duplicate final approved samples, in addition to any required for the Contractor's use, shall be furnished to the Architect, one for office use and one for the site.

(c) Samples shall be furnished so as not to delay fabrication, allowing the Architect reasonable time for consideration of the sample submitted.

(d) Each sample shall be properly labelled with the name and quality of the material, manufacturers name, name of the project, the Contractor's name and the date of submission and the specification number to which the sample refers.

1.6 **MEASURING AND TESTING EQUIPMENT**

The Contractor shall provide the following equipment for carrying out measuring and control tests on the site and maintain in full working order:

(a) Straight edges 2 metres and 4 metres long for testing the accuracy of the finished concrete.

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

(c) Slump test apparatus.

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

(e) Two 30 metre steel tapes.

(f) One dumpy or quickset level and staff

(g) Micrometer

SPECIFICATIONS: DEMOLITIONS AND ALTERATIONS

PART 2: DEMOLITIONS AND ALTERATIONS

2.1 **DEMOLITION**

Demolitions, taking out and cutting away shall be carefully performed and every precaution shall be taken to ensure the safety of the works. If damage should occur in the carrying out of the demolitions or alterations the contractor shall reinstate and make good the same at his own expense.

2.2 **PROTECTION**

Supply, erect and maintain during the cutting of openings etc, all necessary protection to the existing premises against damage by weather or other causes.

2.3 **LAYING THE DUST**

Allow for laying the dust as far as possible during the alteration by watering with a hose or other means.

2.4 MAKING GOOD

All making good of blockwork, building up of openings etc, shall be in solid blockwork unless otherwise described, in cement mortar (1:4) properly cured, toothed and bonded and pinned up to existing work and pointed where necessary.

2.5 CREDIT FOR MATERIALS

Unless otherwise specified materials arising from the demolitions and alterations will become the property of the Contractor. If the Contractor wishes to allow a credit for any such materials the appropriate allowance should be included in the credit column of the Bills of Quantities.

In the event that the Employer wishes to take possession of any such materials the contractor will only be entitled to receive compensation to the amount of credit indicate.

PART 3: EXCAVATION AND EARTHWORKS

3.0 GENERAL

3.1 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.

3.2 DISCREPANCIES IN DESCRIPTIONS

The drawings take precedence over the bills of quantities.

3.3 TEST 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.

3.4 SITE CLEARANCE

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

3.5 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 600 mm below formation.
3. Smaller stumps and roots of vegetation up to 25 mm thick shall be completely removed to a depth of 230 mm 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 approve material compacted to the same relative density as the surrounding material.

PART 3: EXCAVATION AND EARTHWORKS

3.6 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.

3.7 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 written permission from the Engineer and relevant Government Authority. Material which can be removed by pick or traxcavator, ripper or similar mechanical plant will not be classed as rock.

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 to 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.

PART 3: EXCAVATION AND EARTHWORKS

3.9 SURPLUS SOIL DISPOSAL

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

3.10 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.

3.11 FILLING UNDER SURFACE BEDS IN BUILDINGS

i) 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 150 mm thick and not greater than 230 mm 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% C.B.R. is obtained.

ii) 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 150 mm 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 230 mm.

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 25 mm 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.

3.12 **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 Architect.

PART 3: EXCAVATION AND EARTHWORKS

3.13 **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 230 mm finished thickness. Each layer to be well wetted and consolidated as described herein.

3.14 **INSECTICIDE TREATMENT**

Where described, the top surface of filling shall be treated with `Gladiator T C' Pesticide or equal and approved to be applied and approved firm and in accordance with the manufacturer's instructions and subject to a ten year guarantee to the satisfaction of the Architect.

3.15 **DIOTHENE SHEETING**

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

SPECIFICATIONS: CONCRETE

PART 4: CONCRETE WORK

4.1 CODES OF PRACTICE

All workmanship, materials, tests and performances in connection with reinforced concrete shall be in conformity with the latest edition of the British Standard for concrete works (B.S 8110 parts 1 & 2, BS 8004, B.S 8007) and any other approved Local and International Standards. Where inconsistency exists between these preambles and these Standards, the Contractor shall notify the Engineer in good time for his Clarification as to which of the two shall prevail. Such clarification shall not have cost implications on the Contract.

4.2 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.

As and when required by the Engineer the Contractor shall prepare and submit, before commencing the work, a time-chart (additional to the general programme) detailing the various operations for concrete works.

4.3 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, transportation, storing and placing concrete, the Contractor shall submit drawings for approval by the Engineer, showing proposed general plant arrangement, together with a general description of the equipment he proposes to use.

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

Where these Preambles, the Bills of Quantities or the Drawings require specific procedures to be followed, such requirements are not to be construed as prohibiting use by the Contractor of alternative procedures providing these have been approved by the Engineer in advance.

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

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4.4 LEVELS AND FOUNDATIONS

The foundations of the Works 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 the solid ground excepting where otherwise shown must be carefully filled in as directed by the Engineer.

All temporary timber 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.

4.5 TOLERANCES

On all setting out, dimensions of six metres and over, a maximum non-accumulative tolerance of plus or minus 6 mm will be allowed. On all setting out, dimensions under six metres, a maximum non-accumulative tolerance or plus of minus 3 mm will be allowed. On the cross sectional dimensions of structural members, unless otherwise required by the Drawings, a maximum tolerance of plus or minus 3 mm 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 h/3000 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.

4.6 MATERIALS GENERALLY

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

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4.7 SAMPLES AND TESTING

The Contractor shall provide on the site, equipment, staff and labour for carrying out the sampling and testing and shall carry out any or all of these tests at such times and with such frequency as may be requested by the Engineer.

All equipment shall be calibrated and checked from time to time by the relevant Government authority and/or as the Engineer may direct.

The Contractor shall provide all samples required by the Engineer as soon as possible after the contract is let. No deliveries in bulk shall be made until the samples are approved by the Engineer. All condemned material shall be removed from the site within 24 hours.

Frequency of tests and number of samples required shall be governed by the results of previous tests, the quality of materials revealed during the tests and the uniformity of that quality. Should it become evident that the quality of concrete is deteriorating, the Engineer may require additional samples to be taken and test cubes to be made and tested to determine the cause.

4.8 **CEMENT**

Cement unless otherwise specified shall be ordinary Portland Cement of a brand and source approved by the Engineer and shall comply with the requirements of B.S. 12. A manufacturer's certificate of test in accordance with B.S 12 shall be supplied for each consignment delivered to the Site.

Should the Contractor require to use cement of Rapid Hardening variety, he shall submit his proposals to the Engineer along with any cost implications on the project for his approval. Any additional cost that may be caused by the use of Rapid Hardening cement shall be borne by the Contractor.

Cement may de 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 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 in stacks more than 2.0 metres in height.

No cement which has been kept on site in bags for more than 3 months shall be used in works.

4.8 **CEMENT**

If delivered in bulk the cement shall be stored in a weather proof 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.

SPECIFICATIONS: CONCRETE

4.8A **SAND**

Sand used for concrete shall be clean, well graded siliceous sand of good sharp hard quality equal to samples which shall be deposited with and approved by the Engineer. The sand shall be free from lumps of stone, earth, loam, dust, salt organic matter and other deleterious substances, sieved and washed with clean water unless directed otherwise by the Engineer.

4.9 **AGGREGATE**

Aggregates shall conform with the requirement of B.S. 882 and all the proposed sources, types and grading test results of all aggregates are to be approved in all respects by the Engineer before work commences.

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

Coarse aggregate shall be good, hard, clean, approved blacktrap or similar stone, free from dust, decomposed stone, clay, weather 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 at the Contractor's expense.

Aggregate shall be delivered to the Site in their prescribed sizes or gradings and shall be stock-piled on paved areas to boarded platforms in separate units to avoid intermixing. On no account shall premixed coarse aggregates be brought to the batching plant. On no account shall aggregates be stock-piled 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 aggregates (including sand) showing that materials comply with the specification. Samples shall be subjected to such tests and at frequencies as determined by the Engineer. All such testing shall be carried out at the Contractor's expense

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4.10 **WATER**

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

4.11 **ADMIXTURES**

Before approval for the use of a proprietary admixture is given, the Contractor shall satisfy the Engineer as to its suitability for the work and its compatibility with the cement it is intended to complement.

4.12 **EXPANSION JOINT FILLERS**

Expansion joint filler shall be "Flexcell" as manufactured by Expandite Ltd. or "Rexilex" as manufactured by Evomastic Ltd, or equivalent and approved filler.

4.13 **JOINT SEALANT**

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

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

"Pli-astic" shall be applied hot. With the Engineer 's approval Polemastic fillers of the appropriate grade as manufactured by Evomastics Ltd., may be substituted for "Seelastic".

On no account shall soft board materials be used as joint fillers.

4.14 **CONCRETE MIXES**

All structural concrete shall consist of laboratory designed mixes. The wrights of cement, fine, coarse aggregates and water (and plasticiser where required) to be used in the designed concrete mixes shall be those giving one cubic metre of mixed concrete. Each design mix (for each class of structural concrete) shall be submitted to the Engineer along with at least 8 laboratory test results (4 No. 7 days and 4 No. 28 days) for his approval. The design mixes and the accompanying test results shall be sent in their original form directly to the Engineer with a copy to the Contractor. No photocopies shall be accepted. Once approved these design mixes shall be used in preliminary stage of works.

Only the 28 day test results shall form the basis of assessment for the preliminary and works cube results but the Engineer may use the 7 day test results to determine the quality of concreting at his discretion.

4.15 **STRUCTURAL CONCRETE STRENGTHS AT PRELIMINARY WORKS STAGE**

For the purpose of this Contract, Structural concrete shall mean concrete for which the specified characteristic cube strength is equal to or higher than 20N/mm².

SPECIFICATIONS: CONCRETE

The concrete mix shall be designed to attain a mean strength greater than the characteristic strength by at least the current margin. The current margin shall be taken as the smaller of the value resulting from (1) or (2) below.

1) For at least 40 separate batches of concrete of identical proportions of similar materials produced over a period of between 5 days and 60 days using the same plant under similar supervision and procedures.

Current Margin = 1.64 times the standard deviation but no less than 7.5N/mm².

2) For cube tests on at least 100 batches as described in (1) produced over a period not exceeding 12 months.

Current Margin = 1.64 times the standard deviation but not less than 3.75N/mm² for concrete grade 20 and above.

Where there is insufficient data to satisfy (1) and (2), the current margin for the initial mix design shall be taken as 10N/mm² until sufficient data is available.

Testing of concrete at preliminary stage shall continue until the Engineer is fully satisfied that the concrete mix has met all the requirements outlined in this section.

Structural concrete shall satisfy the above requirements for the characteristic strength at 28 days shown in the table below.

CONCRETE STRENGTHS IN (N/MM²)

Age	Grade 45	Grade 40	Grade 35	Grade 30	Grade 25	Grade 20
7 days	30.0	27.0	23.5	20.0	16.5	13.5
Characteristic strength at 28 days	45.0	40.0	35.0	30.0	25.0	20.0

The strength at 7 days shall only be indicative and unless the

Engineer otherwise agrees, it shall not form the basis of approval for design mixes.

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4.16 QUALITY CONTROL AT WORKS STAGE

Once the concrete mix is accepted from preliminary to works stage, the principal basis of control shall be analysis of the cube test results at 28 days.

Cube test results shall be examined individually in 10 consecutive sets of four. The standard deviation and mean strength of each set shall be calculated.

The concrete mix proportions shall only be acceptable if all of the following requirements are complied with:

i) Not more than two results in 40 are less than the characteristic crushing strength.

ii) No value of the average for any set of four results shall be less than the characteristic strength plus one-half of the current margin.

iii) When 40 No. have been obtained and the mean strength and standard deviation are calculated, the mean strength minus 1.64 times the standard deviation shall be greater than the characteristic strength.

Where the results do not conform to the above requirements the following action shall be taken:

- Adjustments to the mix to obtain strength required.

- In the case where any result is less than 85% of the characteristic strength the structural implications shall be determined and any necessary remedial action carried out shall be at the Contractor's costs.

4.17 **PROPORTIONS OF CONCRETE WORKS**

All structural concrete shall be proportioned in weight using weigh batching machines of an approved type (to B.S. 1305) and shall be properly maintained and checked for accuracy to the requirements of Factories Inspectorate and at such intervals as required by the law and/or as Engineer shall direct.

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4.18 **CEMENT**

The quantity of cement shall be measured by weight. Where

delivered in bags, each batch of concrete is to contain one or more bags of cement in accordance with the proportions specified.

For non-structural concrete, volume batching may be used as indicated below.

Class of Concrete	15	10
Nominal Mix by Volume	1:3:6	1:4:8
Cubic metres of fine aggregate per 50 kg. bag of cement	0.12	0.16
Cubic metres of coarse aggregate per 50 kg bag of cement	0.24	0.32
Maximum size of coarse aggregate	40 mm*	40 mm*

* or 20 mm for blinding concrete where described.

Where batching is by volume, approved gauge boxes of such a size as will give the correct proportions shall be used, and full account shall be taken of bulking due to high moisture content.

4.19 **READY-MIXED CONCRETE**

Where the Contractor desires to use ready-mixed concrete prepared outside the site, he shall submit a written request to the Engineer for his approval. In his request, the Contractor shall attach a detailed proposal showing the logistics of carrying out such an exercise.

The Engineer shall give his written consent only after satisfying himself with the adequacy of the Contractor's proposals as far as specifications and logistics are concerned.

The Engineer may demand particular conditions be fulfilled before granting the permission (A sample of "Delivery Ticket" for ready-mix concrete as attached at the back of this specification).

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4.20 **WATERPROOF CONCRETE**

Where waterproof concrete is specified, Sealocrete "Sealopruf Integral Waterproofing Compound" and "Sealoplaz Concrete Plasticizer" or similar approved are to be added to the mixing water strictly in accordance with the manufacturer's instructions and at the rate

of 500 cc and 125 cc respectively to each 50 kg bag of cement to which the aggregates have already been added and mixed. Not more than 22.5 to 24.75 litres of water per 50 kg bag of cement are to be used unless otherwise approved by the Engineer.

4.21 SURFACE TREATMENT FOR WATERPROOFING

Where specified treatment with "Vandex", "Sealocrete Supercoat Waterproofer" etc. 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. Surface so treated shall be protected from damage or staining as described elsewhere.

4.22 PHYSICAL BARRIER FOR WATERPROOFING

Where specified, physical barriers shall consist of the following:

Mastic Asphalt

This shall be laid inlayers of maximum thickness of 10 mm each. The Materials and workmanship shall comply to CP 102:1973.

Rubber-Membrane

This shall consist of preformed laminated membrane comprising an elastomeric self-adhesive rubber/bitumen compound and robust polythene sheet such as Bituthene 1000, as produced by SERVICISED LIMITED or other similar approved material. The membrane shall be stored, handled and laid onto the elements to be protected strictly in accordance with the manufacturers specifications and under the supervision of one of their approved representatives all to CP 102:1973. Special precautions shall be taken at the interface of this material and mastic asphalt. Only approved water bars shall be incorporated in the structural concrete works and these shall be provided in the positions indicated on the drawings or at other alternative positions approved by the Engineer.

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Waterbars

Joints shall be heat welded in accordance with the manufacturer's instructions and where the waterbar is to be fixed vertically, metal clips as manufactured by the supplier of the waterbar or of other approved design shall be provided to suspend the waterbar 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 waterbar so required will be at the Contractor's expense.

Formwork shall be designed with sufficient timber forms and blocking pieces to support the waterbar 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 concrete surrounding the lower half of the waterbar to be poured in the same operation as the slab or other concrete from which it springs. Formwork to walls or similar members where waterbar is positioned at the base of the lift shall have sufficient inspection openings not less than 300 mm square at approximately 15 mm to 300 mm above the level of the waterbar to permit checking that the waterbar is correctly positioned and not displaced during concreting.

Through-bolts or ties will not be permitted in liquid retaining structure or in retaining walls. The Contractor shall use only such bolts or ties as are capable of being removed in part so that the portion remaining embedded in the concrete shall be between the specified thickness of cover to the reinforcement.

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. No through holes shall be permitted in basement retaining walls.

The Contractor shall provide the following furniture and equipment for setting up his laboratory to be used in carrying out control tests on the site.

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4.23 **WORK CUBE TESTS**

Work cubes are to be made at intervals as required by the Engineer and the Contractor shall provide a continuous record of the concrete work. The cubes shall be made in approved 100 or 150 mm moulds as required by the Engineer in strict accordance with the Code of Practice.

At least four cubes shall be made on each occasion, from different batches, the concrete being taken from the point of deposit.

Frequency of the tests and the number of samples required will be governed by the results of the previous tests, the quality of the materials revealed during the tests, and the uniformity of the quality. Should it become evident that the quality of the concrete is deteriorating the Engineer may require additional samples to be taken and test cubes to be made and tested to determine the cause.

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 and time made

c) Temperature and weather conditions

d) Location in work

e) 7-day Test

Date: .....

Strength: .....

f) 28-day Test

Date: .....

Strength: .....

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Cubes shall be forwarded, carriage paid to an approved Testing Laboratory in time to be tested two at 7 days and two at 28 days. No cube shall be dispatched within 3 days of casting.

Authentic copies of all Work Test results shall be forwarded to the Engineer directly from the testing laboratory and one shall be retained on the site. The test certificate shall indicate all properties as required by B.S. 1881.

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 Test.

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

4.24 MIXING OF CONCRETE

The concrete shall be mixed only in approved power driven weigh batch mixers of a type and capacity suitable for the work. The batching plant shall have a reserve capacity of at least 30% over and above the expected maximum demand.

The weigh batch 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 shall be carried out in accordance with B.S. 1881. The Contractor shall provide the necessary apparatus and allow for the cost of such test.

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.

SPECIFICATIONS: CONCRETE

4.25 **TRANSPORTING CONCRETE**

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 to be 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 means which do not cause separation or otherwise impair the quality of the concrete. Approved mechanical means of handling will be encouraged, but the use of chutes for placing concrete is subject to the prior approval of the Engineer.

Where approval is obtained for concrete to be conveyed by chutes, these shall have a slope (not exceeding 1 vertical to 2 horizontal) such as to ensure a continuous flow of concrete.

Additional water shall not be introduced to assist the flow.

Where approval is obtained for pumping the concrete, the pump manufacturer's recommendations shall be followed. The pumps used shall be of adequate capacity and power to ensure delivery of a continuous supply. The Contractor shall provide adequate alternative arrangements for transporting concrete including standby pumps in case of breakdown of the pumping equipment.

No relaxation of these specification on pumped concrete will be permitted. In particular, attention shall be paid to the proper grading of aggregates to prevent bleeding and/or segregation during pumping operations.

The inclusion of mixtures to improve the flow characteristics of the concrete will only be permitted where it can be shown that they do not adversely affect the concrete.

Proper bridging arrangements for traffic over reinforcement shall be provided so that the reinforcement is not distorted, damaged or displaced.

SPECIFICATIONS: CONCRETE

4.26 **PLACING CONCRETE**

No concrete shall be placed before approval by the Engineer's representative.

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

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

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

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

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

Concrete in columns may be placed to a height of 4.0 m with careful placing and vibration and satisfactory results. Where the height of the column exceeds 4.0 m suitable openings must be left in the shutters so that this maximum lift is not exceeded. The bottom 500 mm must first be thoroughly compacted before more concrete is added as the vibrator is gradually withdrawn.

Tops of lifts in walls and columns shall be finished level and well compacted so that minimal preparation of the next lift is required.

Concrete shall be placed continuously until completion of the part of the work between construction joints as specified hereinafter.

If stopping of concreting is unavoidable elsewhere, a construction joint shall be made where the work is topped.A record of all such joints must be made by the contractor and a copy supplied to the Engineer.

SPECIFICATIONS: CONCRETE

4.27 WET WEATHER CONCRETING

Concreting during periods of constant rain shall not be permitted unless aggregate stockpiles, mixers and transporting equipment and the areas to be concreted are adequately covered.

4.28 HOT WEATHER CONCRETING

Concreting shall not be permitted if its temperature at placing is in excess of 38°C. In order to maintain the temperature of the concrete below this value the following precautions shall be taken wholly or in part as instructed by the Engineer:

i) All aggregate stockpiles, water lines and tanks as well as the mixer shall be protected from the direct rays of the sun.

ii) Coarse aggregate shall be cooled by constant watering where possible.

iii) Mixing water shall be cooled by the addition of ice to the storage tanks where necessary.

iv) Rapid-hardening cement shall not be used.

v) Where the above precautions are inadequate, concreting shall be carried out during the cooler parts of the day or night as may be directed by the Engineer.

When the air temperature is above 20°C loss of mixing water by evaporation shall be considered in arriving at the mount of water to be added to the mix. In order to maintain the water/cement ratio within permissible limits, an approved water-reducing agent shall be included in the mix.

The maximum water/cement ratio may be increased with the Engineer's permission during mixing, but on no account shall water be added to concrete directly or indirectly once it has left the mixer.

In order to reduce premature drying of the concrete during transporting and placing, all chutes, formwork and reinforcement shall be cooled by watering when possible, or shall otherwise be protected from the direct rays of the sun. Any water so used shall be removed by jetting with compressed air before placing the concrete in close contact.

SPECIFICATIONS: CONCRETE

As soon as possible after concreting, the formwork shall be stripped and the surface of the concrete shall be treated in accordance with the requirements stated elsewhere.

Where drying winds are encountered, wind shields shall be positioned as directed by the Engineer to protect exposed surfaces of the curing concrete.

4.29 CONTINUOUS POUR IN CONCRETE

Where the Contractor desires to use continuous concreting method in large sections (rafts and walls), he shall submit a written request to the Engineer for approval. In the request he shall attach details which shall include but not be limited to the following:

- Total amount of concrete to be placed in the shift
- Stock of approved concrete materials on site
- Capacity of the batching plant
- Number and type of truck mixers to be deployed for the exercise and movement logistics
- Number of skilled and other manpower to be deployed for exercise in shifts.
- Number and capacity of plant to be used in placing concrete (pumps, vibrators, buckets, etc.)
- Method(s) of monitor and dealing with the heat of hydration
- Details of protection against rain and floodwaters and how to cope with it.

The Engineer shall consider the above details and other parameters (e.g. weather, satisfactory records of cube test results, availability of adequate working section where reinforcement placement and the necessary formwork have been approved etc.) before making his decision. The Engineer may order that additional concrete cube moulds be made available as well as arrangements be made for cube crushing with an approved laboratory to cope with the increased demand.

The Engineer may order that the concreting works be stopped immediately if in his opinion the quality of the works is threatened for whatever reason.

SPECIFICATIONS: CONCRETE

4.30 SPECIAL NO-FINES CONCRETE

No-fines concrete for use in subsoil drainage shall consist of a 1:8 cement/aggregates mix by volume. Aggregate shall be 20 mm to 10 mm graded with no more than 5% passing the 10 mm sieve. Only sufficient water shall be added to ensure complete coating of the aggregate. One half of this water shall be placed into the mixer first, after which the aggregate and cement shall be admitted. After partial mixing, the balance of the water shall be added until a consistency of mix is achieved.

Preliminary tests shall be carried out on the site to prove the suitability of the finished concrete and adjustments made to the proportions and/or grading as may be required by the Engineer.

4.31 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.

The Contractor shall ensure that he has at least 30% backup/reserve capacity over and above the maximum expected demand.

Concrete shall not be placed at a rate greater than will permit satisfactory compaction nor to a depth greater than 450 mm before it is compacted.

During and immediately after placing, the concrete shall be thoroughly compacted by means of continuous vibration.

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

SPECIFICATIONS: CONCRETE

4.31 **COMPACTION**

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

Internal vibrators shall be inserted vertically into the concrete wherever possible at not more than 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 four cubic metres of concrete placed per hour and at least one spare vibrator for every three 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 1.200 M 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.

SPECIFICATIONS: CONCRETE

4.32 CONSTRUCTION JOINTS

Construction joints shall be permitted only at the positions predetermined on the drawings or as instructed on the Site by the Engineer. In general they shall be perpendicular to the lines of principal stresses and shall be located at points of minimum shear, viz. vertical at, or near, midspans of slabs, ribs and beams.

The position of construction joints, when not shown on the Drawings or otherwise required by this specification, shall be decided on site having regard to the plant and labour made available by the Contractor for the manufacture, placing and compaction of the concrete as well as its curing, the climatic conditions prevailing at the time of concreting, the nature and size of the formwork and conditions of operations of the work. The Contractor shall submit his proposals to the Engineer for his approval before commencing the work.

Suspended concrete slabs are generally to be cast using alternate bay construction in bays not exceeding 15 m 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 25 mm in thickness composed of cement and fine aggregate in the proportions used in the concrete.

4.33 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 at least three layers of Hessian sacking, white 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 white 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, clear or any other colour polythene sheets, hessian or other material in small pieces.

SPECIFICATIONS: CONCRETE

4.33 **CURING AND PROTECTION**

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

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

4.34 **FAULTY CONCRETE**

Any concrete which fails to comply with these Preambles, or which shows signs of setting before it is placed shall be taken out and removed from the Site. Where concrete is found to be defective after it has set, the concrete shall be cut out and replaced in accordance with the Engineer's instructions. On no account shall any faulty, honeycombed, or otherwise defective concrete be repaired or patched until the Engineer has made inspection and issued instructions for the repair.

On the Engineer's instruction, the contractor shall cut out and replace any concrete in any part of the structure if in the Engineer's opinion:-

a) The concrete does not conform to the specification, or

b) Deleterious materials or materials which are likely to produce harmful effects have been included in the concrete, or

c) The honeycombed or damaged surfaces are too extensive, or

d) The finished concrete sizes are not in accordance with the drawings within permissible tolerances, or

e) The setting-out is incorrect, or

f) The steel cover has not been maintained, or

g) The protection, including curing of the concrete during the construction was inadequate resulting in damage, or

h) Undue deformation of or damage to the works has taken place due to inadequate shuttering or to premature traffic or to excessive loading, or

i) Any combination of the above points has taken place resulting in unsatisfactory work.

The whole of the cost, whatsoever (including time lost) which may be occasioned by the need to remove faulty concrete shall be borne by the Contractor.

SPECIFICATIONS: CONCRETE

4.35 **LOADING TESTS**

The Engineer may direct that a loading test be made on the works or any part thereof if he deems such a test to be necessary for one or more of the following reasons:

a) Failure of "Site cubes" to attain the strength requirements.

b) Premature removal of formwork

c) Overloading of structure during construction

d) Improper compaction of concrete

e) Any other circumstances attributable to alleged negligence on the part of the Contractor which in the opinion of the Engineer may result in the structure being of less than the required strength.

The loading test ordered solely or in part for reasons (a) to (e) shall be made at the Contractor's own cost.

Loading tests shall be carried out in accordance with the requirements of B.S. 8110.

If the results of the test are not satisfactory, the Engineer will direct that the part of the work concerned be taken down or removed and reconstructed to comply with the Specification or that such other remedial measures as he may think fit be taken to make the work acceptable and the Contractor shall carry out such work at his own cost.

LOADING TESTS

The Engineer may also instruct the Contractor before a loading test takes place to take out cylindrical core specimens from the structures concerned and have them tested. The cutting equipment and the method of doing the work shall be to the Engineer's approval. The specimens shall be dealt with in accordance with B.S. 1881. Prior to testing, the specimens shall be available for examination by the Engineer. If the cores are ordered to be taken solely or in part for reasons (a) to (e) above, the work involved and the testing shall be made at the Contractor's own cost.

No extensions of time shall be granted for any delays or disruption of work caused by these tests.

4.36 **STEEL REINFORCEMENT**

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

Hot rolled M.S for the reinforcement of concrete	B.S. 4449
Hot rolled H.Y. steel for the reinforcement of concrete	B.S. 4449
Cold worked H.Y. steel for the reinforcement of concrete	B.S. 4461
Hard drawn steel wire	B.S. 4482

SPECIFICATIONS: CONCRETE

4.36 **STEEL REINFORCEMENT**

Generally high yield, hi-rib rebars (425 & 460 N/mm²) shall be used for main reinforcement and mild steel round bars, (250 N/mm²) for links and ductility for special elements where specified. In addition where so detailed, mild steel deformed bars shall also be used.

The Contractor shall submit a test certificate of the rollings. Reinforcement shall be stored on racks above ground level in covered waterproof sheds to keep away rain water. The sheds shall be well drained to prevent deterioration or contamination from any cause. 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.

4.37 **FABRIC REINFORCEMENT**

Fabric reinforcement shall be electrically cross-welded steel wire mesh reinforcement to B.S. 4483, and of the size and weight specified and made of wire to B.S. 4482.

4.38 **FIXING STEEL REINFORCEMENT**

Reinforcement shall be accurately bent to the shapes and dimensions shown on the Drawings and Schedules and in accordance with B.S. 4466 and B.S. 8110. Reinforcement must be cut and bent cold and no welded joints will be permitted unless so detailed or directed by the Engineer.

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 part of binding wire shall protrude into the specified nominal cover.

No concreting shall be commenced until the Engineer has inspected the reinforcement in position and until his approval has been obtained. The Contractor shall give two clear days notice of his intention to concrete to the Engineer. Approval forms shall be submitted in duplicates. (A sample of the format of the Approval form is attached at the back of this specification).

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 required to support and retain the reinforcement in its correct position, the Contractor shall provide templates, stools or other supports at his own cost.
Unless permitted by the Engineer, welding of bar reinforcement at intersections or for the joining of bars is prohibited. Where permission is granted, welding shall be carried out in accordance with the recommendations of the Institute of welding for the welding of reinforcement bars.

SPECIFICATIONS: CONCRETE

4.38 **FIXING STEEL REINFORCEMENT**

The Contractor shall provide on-site facilities for cutting and bending reinforcement whether he is ordering his reinforcement bent or not and shall ensure that a token amount of straight bar of each diameter is available on site for bending as and when directed by the Engineer in order that minor modifications may be implemented on site without prior notice.

Bar bending schedules shall be issued to the Contractor at least a month in advance of the actual physical requirement in site. The Contractor is responsible for verifying that he has in his possession the required schedules to meet his programme and shall give the Engineer at least 3 weeks notice for any schedules that he requires.

4.39 **SPLICES AND SCREWED COUPLERS**

Where specified in the works, splices and screwed couplers shall be CCI systems type or similar approved and shall be for reinforcement bar sizes 16, 20, 25 and 32. The relevant certificates of performance shall be submitted to the Engineer for approval. The Engineer may order additional relevant tests be carried out through the Contractor from time to time as a measure of continuous monitoring of qualify and performance.

4.40 **POSITION AND CORRECTNESS OF REINFORCEMENT**

The Contractor shall draw the Engineer's attention in good time if any discrepancies between details on drawings and bar bending schedules occur. Irrespective of whether any inspection and/or approval of the fixing of the reinforcement has been carried out as above, it shall be the Contractor's sole responsibility to ensure that the reinforcement complies with the details on the drawings or bending schedules and is fixed exactly in position shown therein and in position to give 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 bending schedules.

4.41 **SPACER 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 such 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 3 mm to tolerance and with single or double grooves (depending on the number of the reinforcement bars used per rib) in the top surface with wire ties at each groove.

SPECIFICATIONS: CONCRETE

FIXING STEEL REINFORCEMENT

The Engineer may direct that special types of spacers (e.g. preformed plastic types) be used in the whole or part of the works, if in his opinion the concrete spacers are not to the required standard.

4.42 **NOMINAL CONCRETE COVER TO REINFORCEMENT**

Unless otherwise directed the nominal concrete cover to steel reinforcing bars (including links and distribution) in any face shall be:

Foundations against earth face	75 mm
Foundation against blinding	50 mm
Columns (main bars)	40 mm
Beams (main bars)	30 mm or diameter of main bar
Slabs and stairs	20 mm
Wall (main bars)	40 mm

The tolerance on placing of bars achieve nominal cover is ±5mm

4.43 **FIXING FABRIC REINFORCEMENT**

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

4.44 **PROJECTING 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.

SPECIFICATIONS: CONCRETE

4.45 **SECURITY REINFORCEMENT**

Spiral

Spiral reinforcement where specified in the works shall be chubb spiral, Aegamesh or similar approved. It shall consist of steel bars of at least 15 mm diameter forming a mattress with pitches not exceeding 125 mm, and shall be delivered to the site in preformed 2 row mattress cages of exact and specified dimensions and incorporating appropriate spacer bars to maintain mattress rigidity. When assembled, the cages shall define the outline of the elements to be protected including allowance for openings. The assembling in the works shall be carried out under the supervision of the supplier's approved representative.

These shall be chubb tangbars, John Tann bars, Tord bars or similar approved. They shall be made from 3 mm thick mild steel plates cut into strips running off a central cord. They shall be transported to the site in flat condition where they shall be twisted into spirals. The twisting and laying of the units shall be carried out under the supervision of the supplier's approved representative.

4.47 **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 positions of all conduits 25 mm and over in diameter shall be submitted to the Engineer for his approval before being placed.

4.48 **CHASES, HOLES, ETC IN CONCRETE**

The Contractor shall be responsible for the co-ordination with the Electrical and other sub-contractors for incorporating electrical conduits, pipes, fixing blocks, chases, holes and the like in concrete members as required and must ensure that adequate notice is given to such sub-contractors informing them when concreting 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.

4.49 **POSITION OF ELECTRICAL CONDUIT**

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

The proposed position of all conduits 25 mm 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.

SPECIFICATIONS: CONCRETE

POSITION OF ELECTRICAL CONDUIT

4.50 **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, steel, plastic, 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.

4.51 **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 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 by consultation with the Engineer ensure that the supporting concrete structure is capable of carrying the load and/or sufficiently propped from lower floors or portions of the frame to permit the load to be temporarily carried during construction.

Soffits for beams and slabs of spans greater than 10 m shall be erected with an upward camber of 5 mm for each 3.0 m of horizontal span or as directed by the Engineer, without reducing the depth of the element.

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 caulded to the Engineer's approval before concreting.

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

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

SPECIFICATIONS: CONCRETE

CONSTRUCTION OF FORMWORK

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. Great care shall be taken to avoid oiling or greasing the reinforcement.

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 saw-dust, chips, nails and other debris shall be washed out or otherwise removed from within the formwork. The reinforcement shall then be inspected for accuracy of fixing. Immediately before placing the concrete the formwork shall be well wetted and inspection openings shall be closed. Cement slurry shall be applied to previously casted concrete as necessary to allow for adequate bonding. The erection, easing, striking and removing of all formwork must be done under the 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, made good to the requirements of the Engineer. Any voids or honeycombing shall be treated as described under "Faulty Concrete".

4.52 **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. The Contractor shall notify the Engineer of his intended removal of any formwork at least two days in advance. The minimum periods that shall elapse between the placing of the concrete and the striking of the formwork will be as follows:

Beam sides, wall and columns (unloaded)	2 days
Slab soffits (props left under)	3 days
Beam soffites (props left under)	7 days

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

Slabs	10 days

Beams	14 days
Cantilever beams and slabs	28 days

SPECIFICATIONS: CONCRETE

4.52 **STRIPPING FORMWORK**

In continuous spanning slabs or beams, no span shall be de-propped until the adjoining spans have been cast and cured for the specified periods.

Stripping and re-propping will not be permitted. The striking times indicated herein are for normal conditions and shall be adjusted if:

a) The span of the structural member under consideration exceeds 6.0 m for beam. An additional period of one day for each 500 mm of additional span shall then be allowe

b) The dead load of the structural member under consideration forms a large proportion of the total design load.

c) The setting of the concrete has been retarded for any reason.

d) Any combination of the above points and other consideration which would call for such a precaution to be taken.

In any case, props shall be left in place in the lower two consecutive floors over which construction loads are expected to be supported.

4.53 **SURFACE FINISHES**

Fair Face Finish

Where fair face finish is specified the concrete shall be brought to a perfectly true smooth and even surface by rubbing with carborundum stone dipped in cement grout. Such work must be commenced within one hour of removing the formwork and be actively and rapidly pursued 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.

Wrought Lined Formwork

The shuttering shall be constructed of wrought 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 Engineer subsequently rejects the work, the Contractor will at his own expense carry out all work necessary to attain the approval of the same.

SPECIFICATIONS: CONCRETE

4.53 **SURFACE FINISHES**

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.

Board Marked Finish

Where so directed or measured the finish shall be that of a board marked pattern panels, the boards shall be arranged vertically 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 that 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 on 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 an approved non-staining mould oil.

Vertical Ribbed Finish

Unless otherwise specified, vertical ribbed finish to walls shall comprise 50 x 50 mm concrete projections at 450 mm centres cast vertically on the face of wall. All surfaces are to be as described under "Wrought Formwork".

Diagonal Ribbed Finish

Unless otherwise specified, diagonal ribbed finish to walls shall comprise 50 x 25 mm deep concrete projections at 100 mm centres cast at 45 degree angle to the vertical on face of wall. All surfaces are to be as described under "Wrought Formwork".

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 12 mm (average 9 mm) of the surface to expose the aggregate without excessive cracking or breaking thereof.

Where the drawings show details of arises of columns, beams etc., these are to be preformed 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 requirement is not necessary.

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4.53 **SURFACE FINISHES**

All chisel dressed surfaces are to have the margins chisel dressed by hand for a minimum width of 75 mm commencing from the fillet edge. Thereafter mechanical chisel dressing may be used but the Contractor must ensure that a uniform texture and even

plain 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.

4.54 **PRECAST CONCRETE**

General

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

The maximum size of coarse aggregate in precast concrete shall not exceed 20 mm except for thickness less than 75 mm where it shall not exceed 10 mm.

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

Except where precast work is described as "fair face" or as having "exposed aggregate" or terrazzo finish the moulds shall be made of suitable strong sawn timber true in form to the

shapes required. Unless otherwise described faces are to be left rough from the sawn moulds.

Where precast work is described as "fair face" the moulds are to be made of metal or are to have metal or plywood linings or are to be other approved moulds which will produce…

SPECIFICATIONS: CONCRETE

4.54 **PRECAST CONCRETE**

General

…a smooth dense fair face to the finished concrete suitable to receive a painted finish direct and free from all shutter marks, holes, pittances, etc. In his prices for such precast work the Contractor shall include for all rubbing down to produce the finish required, to the satisfaction and approval of the Engineer. Where precast work is to have an "exposed aggregate" or terrazzo finish the moulds shall be constructed to the requirements given for moulds for "finished fair" work. The method of achieving the exposed aggregate finish shall be "aggregate transfer" or other approved method.

4.55 **PRECAST CONCRETE CLADDING UNITS**

These shall be cast to the general details shown on the drawings. The Contractor shall submit working/shop drawings for each type of the cladding panels to the Engineer for approval before he commences casting operations.

The panels shall be cast in special yards and shall be cured adequately before being hoisted into position in the structure, taking care that no parts are broken in the process. The units shall then be joined together with insitu concrete and flexibly connected to the top and bottom beams to allow for limited movement of the combined unit.

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

4.56 **HOLLOW BLOCK SUSPENDED CONSTRUCTION (COMPOSITE FLOOR SLAB)**

Concrete hollow blocks for use in the composite floor slabs shall be of the standard sizes required or as shown on the drawings 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. 6073 and to be of a mix not weaker that 1:4:8 cement: sand: stone using maximum 10 mm 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.

HOLLOW BLOCK SUSPENDED CONSTRUCTION (COMPOSITE FLOOR SLAB)

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

Hollow clay filler blocks for use in the composite floor slabs are to be of the sizes shown on the drawings and to be of adequate strength to support the concrete during placing and consolidation by vibration. They shall be obtained from an approved manufacturer. Before any orders are placed, at least 6 sample clay blocks shall be provided for the

approval of the Engineer. Any clay blocks subsequently delivered to site which in the opinion of the Engineer are not of equal standard to the approved samples shall be rejected.

Rejected blocks shall immediately be removed from the site and shall not be used in the works. Clay blocks are to be fully cured before delivery or use on site.

Clay blocks are to be well wetted before pouring of concrete.

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4.57 **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 Soffits 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 1.2 m Centres. Care must be taken during concreting that the reinforcement is not displaced.

Where holes or services 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 such holes through hollow block construction are to include the rearrangement or substitution of the hollow block with solid concrete in addition to the actual formation of the hole.

4.58 **CONCRETE SURFACE BEDS**

Before placing concrete and where specified or shown on the Drawings a layer of 1000 gauge polythene or diothene sheeting shall be laid on the blinding above the hard core filling. Minimum 300 mm 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 concreting 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 25 mm less than the finished thickness shall first be spread and struck off at the correct level to receive the top fabric reinforcement.

SPECIFICATIONS: CONCRETE

4.58 **CONCRETE SURFACE BEDS**

The top layer shall then be added. Not more than 30 minutes shall elapse between spreading the bottom layer and the start of compaction of the top layer. The Contractor shall be responsible for maintaining the reinforcement in its correct position during the placing and compaction of the concrete. The compaction and finishing of the concrete shall be effected by immersion vibrators and a hand or mechanical tamper weighing not less than 10 kg per meter run and having a tamping edge shored with a steel strip 75 mm wide fixed to a tamper by countersunk screws. Immersion vibrator with "spade" attachments will be permitted. Compaction shall be continued until a dense, scaled 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 tolerances:

- The level shall be within + or - 6 mm of the levels specified.
- The falls shall be within 10% of the falls specified.
- The smoothness shall be such that departures from a 3 m straight edge laid in any direction shall not exceed 3 mm.
- 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, white polythene sheeting or other approved means placed carefully on the surface and kept damp and in position for 7 days and the concrete shall be kept wet for a further 21 days. The most critical period is the first 48 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.

4.59 **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…

SPECIFICATIONS: CONCRETE

4.59 **EXPANSION JOINTS IN CONCRETE SURFACE BEDS**

…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.

4.60 **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 "Designed mixes" and "weigh batchers" for all structural concrete work.

Absolutely no deviation from the use of Design mixes and weigh batching machines shall be entertained on the basis of site topography expanse or any other reason whatsoever as the Contractor will have been deemed to have allowed for these in his pricing.

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 slab shall also include for levelling off the surfaces as described under "Compaction", and all temporary formwork to form construction joints at bay edges.

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

Prices for formwork shall include for extra materials at joints, extra labour and waste for narrow widths, small quantities, over laps, passing at angles, straight cutting and waste, splayed edges, notching, 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 boxing shall include for angles and ends.

Prices for steel rod reinforcement shall include for cutting to lengths and all labour in bending and cranking, forming hooked ends handling, hoisting and fixing in position and for providing all necessary tying wire and supports. Prices for fabric reinforcement shall include for all straight cutting and waste, handling, hoisting and fixing in position, providing all necessary tying wire and supports and all extra material in laps.

Prices for all precast concrete shall include for all moulds, finishing as described, handling reinforcement, hoisting and fixing at the required levels, bedding, jointing and pointing in

cement and sand (1:5) mortar also for casting or cutting to the exact lengths required and any waste resulting from such cutting.

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

SPECIFICATIONS: CONCRETE

4.60 **NOTES CONCERNING MEASUREMENT AND PRICING**

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

Concrete in main beams shall be separately measured to the full width thereof and for full depth to top of slab level and composite slabs are measured the nett area between same. No adjustment will be made in reinforcement, etc., into main beams or flanges, etc., to obtain bearings which are deemed to be covered in the Contractor's rates.

4.61 **SITE BOOKS AND STANDARDS**

Instructions to be Recorded

The Contractor shall provide and keep permanently on the site a numbered triplicate book wherein the Contractor shall record all instructions relating to concrete work issued by the Engineer or the Engineer's representative. One copy of every entry therein shall be sent to the Engineer on the same day as the entry is made.

Site Diary

The Contractor shall provide and keep permanently on the site a continuous entry diary wherein the Contractor shall record details of shuttering, placing of reinforcement, concreting and curing operations, striking of shuttering, making good and daily temperature and weather conditions. This diary shall always be available for inspection by the Engineer's representative.

STRUCTURAL CONCRETE APPROVAL FORM

(to be filled in duplicate before any pour)

Section: ..... Level: ..... Member: .....

Date and time of Request: .....

Date and time of Proposed Pour: .....

Concrete Grade: .....Site*/Ready Mix*

*Delete one

SPECIFICATIONS: CONCRETE

STRUCTURAL CONCRETE APPROVAL FORM

(to be filled in duplicate before any pour)

DESCRIPTION	CHECKED	REMARKS
Formwork Soundness		
Shutters/stop ends		
Formwork/shutter props		
Tie bolts, Cover Blocks		
Dimensions		
Plumbness/slope/level		
Re-bar cleanliness Chair/links, etc.		
Re-bar fixing		
Preparation or Hacking of joints		
Water stops		
Moulds for cubes		
Materials for curing		
Any other checks (specify)		
1.		
2.		
3.		

APPROVED: ..... SIGNATURE: ..... DATE: .....

NOT APPROVED: ....

(RESIDENT ENGINEER)

*Note: Approval by the Engineer or his Representative does not relieve the Contractor from any of his contractual obligations.

SPECIFICATIONS: CONCRETE

READY-MIX CONCRETE - DELIVERY FORM

Source: ..... Destination: ..... Distance: ..... (km)

Quantity Delivered: ..... m^3 Dispatched by: .....

Slump at source: ..... mm Slump on site: ..... mm

Mixer Reg. No. ..... Driver: .....

TIME DURATION DATE

Loading time: ..... Minutes

Time of Departure: .....

Time of Arrival on Site: .....

Off-loading time: ..... Minutes

Total time taken between loading at source
and off-loading on site: .....

Approved water added on site on request ..... Litres

Remarks: .....

.....

.....

Signed (R.E/C.O.W) ..... Date: .....

SPECIFICATIONS: WALLING

PART 5: WALLING

MATERIALS

5.1 **CEMENT**

Cement used for making mortar shall be as described in "Concrete work".

5.2 **LIME**

The lime for making mortar shall be obtained from an approved source and shall comply with B.S. 890 Class A for non-hydraulic lime. The lime to be run to putty in an approved lined pit or container. The water to be first run into the pit or container and the lime to be added until it is completely submerged, stirred vigorously until all lumps are disintegrated and shall be kept constantly covered with water and regularly stirred for at least four weeks. The resulting milk-lime then to be run through a fine sieve and run into a pit or other container and kept clean and moist for not less than two weeks before being used in the works.

5.3 **SAND**

Sand used for making mortar shall be clean, well graded siliceous sand of good sharp hard quality equal to samples which shall be deposited with and approved by the Architect. It shall be free from lumps of stone, earth, loam, dust, salt, organic matter and other deleterious substances, passed through a fine sieve and washed with clean water if so directed by the Architect.

5.4 **WATER**

Shall be as described in "Concrete Work".

5.5 **CONCRETE BLOCKS**

Concrete blocks shall comply with the requirements of B.S. 2028, 1384 except where amended or extended by the following clause. Blocks shall have square arrises and corners. For fair-faced work damage to arrises and corners shall not exceed the removal of 6 mm of the blocks depth or thickness.

Concrete blocks shall have a minimum crushing strength of 3.5 N/mm² except when below the damp course level or in contact with soil when they shall have a minimum crushing

strength of 7N/mm², unless noted otherwise on drawings. Hollow concrete blocks shall not be used below the damp course level or in contact with soil.

SPECIFICATIONS: WALLING

5.5 **CONCRETE BLOCKS**

Concrete blocks used for external walls shall be Class A and for internal load bearing walls they shall be at least Class B.

Class `C' blocks shall only be used for non-load bearing partitions.

No precast blocks shall be incorporated into the works unless approved by the Architect. The delivery of precast blocks from which samples tested do not comply with this specification shall be deemed defective. Any work constructed with blocks from which samples tested do no comply with this specification shall be deemed to be defective.

From every 1,000 precast concrete blocks delivered to site, ten block samples shall be provided for testing. The precast block samples shall be selected in accordance with B.S. 2028, 1364. Samples of precast concrete blocks for testing shall be tested for the following properties in accordance with the methods given in B.S. 2028, 1364 and the test results shall comply with the requirements of B.S. 2018, 1364 except where amended by this specification.

a) Drying shrinkage

b) Compressive strength or transverse breaking load (as applicable).

c) Wetting expansion*

d) Density

e) Dimensional Tolerance

f) Cavity size

*Test only applicable for concrete blocks made with clinker aggregate.

Blocks shall also be tested to determine the suction rate. The test shall consist of weighing the block, placing in a tray of water such that only 3 mm of the block side is immersed for a period of sixty seconds +/- 2 seconds; quickly wiping off excess water and reweighing. The suction rate is the increase in weight due to water absorbed and shall not exceed 2 kg/m²/minute. Blocks which have suction rate exceeding 2Kg/m²/minute may be used if the Contractor uses an approved water reactive additive in the mortar or can show that the blocks are wetted such that the blocks will have a suction rate not exceeding 2Kg/m²/ minute for a period of 24 hours from being laid and provided the blocks comply with all other requirements.

SPECIFICATIONS: WALLING

5.5 CONCRETE BLOCKS

Concrete blocks shall be stacked on prepared dry areas free of clinker, ashes and sulphate bearing strata. Blocks of different strengths shall be stacked separately and clearly marked to differentiate the strengths.

Blocks shall not be used for a minimum of 7 days after manufacture and shall not be loaded for at least 14 days after laying. For the first 7 days after manufacture, blocks shall be cured by maintaining in a damp condition, e.g. covering with polythene sheeting after wetting blocks.

5.6 HOLLOW CLAY BLOCKS

Hollow clay partition blocks shall comply with the provisions of B.S. 1190 Section 1 and are to be hard, well burnt true to size and shape and with sharp arises and keyed faces and joints and are to be obtained from an approved manufacturer and to be equal in every respect to a sample to be deposited with and approved by the Architect.

Blocks are to be 190 mm high (to give 200 mm course height including the joint) and of the thickness given herein. Cutting of blocks is to be avoided wherever possible and full use is to be made of quarter, half and three quarter blocks and blocks with conduit recesses.

5.7 LOUVRE BLOCK WALLING

i) To be precast concrete mix 1:1:5:3 or 25 N/mm² (12 mm aggregate) but with 10 mm finished fair on all exposed surfaces, built in cement and sand (1:5) mortar with straight horizontal and vertical joints to flush pointed both sides.

ii) Each block to be size 200 mm x 400 mm x 200 mm high and consisting of two ends each 200 mm x 200 mm x 50 mm thick joined with a 50 mm thick twice cranked louvre with top end of louvre projecting 40 mm above top of block.

5.8 STONE

All stone shall comply with the requirements of CP 121.202 for masonry and rubble walls respectively except where amended or extended by the following clauses.

Unless otherwise noted, all masonry walls shall be coursed squared rubble walling with mortar joints.

The size of stones for rubble walling shall be such that the length of stone does not exceed three times its height. For course squared rubble walls blocks shall not exceed 300 mm in height and shall be not less than 150 mm in height.

Where snecked rubble walls are specified, the snecks shall not be less than 100 mm square on the exposed face.

Stone for masonry shall have a minimum compressive strength of 10 N/mm². (Stone shall not be required to be tested to failure). The density of stone for masonry shall be not less than 230 kg/m^3

SPECIFICATIONS: WALLING

5.8 **STONE**

The drying shrinkage of stone shall not exceed 0.05%.

Samples of stone provided for testing shall be tested for the following in accordance with the methods given in B.S. 2028, 1364 and the test results shall comply with the requirements of this specification.

a) Compressive strength

b) Density

c) Drying shrinkage

The colour and texture of stone shall be uniform and consistent. Prior to delivering any stone to site, the Contractor shall supply the Architect with a sample of stone in order that he may approve the colour and texture. The Contractor shall ensure that sufficient suitable stone is available for the whole of the project prior to ordering the stone.

Where cast stone including stone described as artificial stone, reconstructed stone, etc is specified the stone shall comply with the requirements of B.S. 1217.

Masonry shall be of stone, having no irregular faces and only the back face if not visible shall be left as from the saw.

Prior to ordering dry stone the Contractor shall demonstrate that the stone is durable. This may be done by supplying details of buildings constructed with stone from the same quarry and which has been exposed to the same environmental condition for at least ten years.

The maximum projection from the face of stone for rubble walls shall be 20 mm beyond the specified face of the wall.

The Contractor shall provide six samples of stone measuring 150 mm x 150 mm for testing prior to delivering any stone to site. As work proceeds the Contractor shall provide six samples 150 mm x 150 mm x 150 mm for testing from every 300 m² of work.

All stone shall be stacked on prepared dry area free of clinker, ashes and sulphate bearing strata.

5.9 **MULTI-COLOURING STONE WALLING**

Stone for multi-coloured stone walling shall have at least three distinct colours but shall in any case be to the approval of the Architect. A sample panel of walling shall be built and on approval of the Architect will be the minimum standard for the works.

5.10 **FIRE BRICKS**

Clay fire bricks shall be obtained from an approved source and shall be hard, sound, square and clean, well burnt and in respect of size shall comply with B.S. 3921: 1974 Section 2.

SPECIFICATIONS: WALLING

5.11 **WALL REINFORCEMENT**

Where described walls and partitions shall be reinforced with a 25 mm wide strip of No. 20 S.W.G. hoop iron built into alternate horizontal joints in the wall centre. The reinforcement shall be lapped and hooked at running joints, angles and intersections and carried at least 115 mm into abutting walls at junctions.

5.12 **WALL TIES**

To be 3 mm diameter galvanized mild steel wire twisted butterfly wall ties.

5.13 **DAMP-PROOF COURSES**

The bituminous felt sheeting for damp-proof courses shall be hessian based bituminous felt complying with B.S. 743 type 4A weighing not less than 3.85 kgs per square metres. The sheeting is to be lapped 150 mm at running joints and the full width of walls at angles.

WORKMANSHIP

5.14 **CEMENT MORTAR**

Mortar described as cement mortar 1:4 shall be composed of 1 cubic metre (1498 kgs) of Portland Cement and 4 cubic metres of sand. Other mixes such as 1:3, 1:5 etc. shall be similarly construed.

5.15 **MIXING OF MORTAR**

The constituent materials shall be measured separately when dry in specially prepared gauge boxes of sizes to give the proportions specified without consolidation of the contents by ramming and shaking. The mortar shall be mixed in an approved power driven mixer for not less than two minutes per batch and using the minimum quantity of water necessary to obtain a working consistency. The mixer shall be used as close as practicable to the works and mortar and shall be used within 30 minutes of mixing. No partially or wholly set mortar will be allowed to be used or re-mixed.

5.16 **GENERAL CONSTRUCTION**

a) **Setting out**

The Contractor shall provide proper setting out rods and set out all work on some for course, openings, heights etc., and shall build the walls, piers etc., to the widths, depths and heights indicated on the Drawings and as directed by the Architect.

b) **Building in Wood Frames**

Openings for doors, ventilators etc., are to be set out and left unbuilt until the wooden frames have been fixed in position.

c) **Building in Metal Windows and Doors**

Openings for metal frames are to be wide enough for the frames to fit without being forced into position. Build the lugs into the joints of the walling and fill in the space between the walling and frame with cement mortar well tamped into the channel of the frames and point all round externally.

SPECIFICATIONS: WALLING

5.16 GENERAL CONSTRUCTION

c) **Building in Metal Windows and Doors**

All frames must be set plumb and level and free from twist.

d) **Walls to Receive Plaster & Similar Finishes**

All faces of walls to be plastered etc., to have all projections dressed off and joints raked out as key.

5.17 BUILDING WALLING

a) **Laying and Jointing**

All blocks shall be well wetted before being laid and the top of walling where left off shall be well wetted before commencing building. Walls to be kept wet three days after building. All walls throughout the works shall be carried up evenly in 200 mm courses except where courses of less depth are required to bring walling up to level of floors, windows and the like and where otherwise described, no part being allowed to be carried up more than one metre higher at one time than any other part and in such cases the joining shall be made in long steps so as to prevent cracks arising and all walls shall be levelled round at each stage. Not more than 3 metre height of wall shall be laid in any one day.

Blocks shall be bedded and jointed in cement mortar as described with beds and joints 10 mm thick, all flushed up and grouted solid as the work proceeds.

b) **Bonding**

The blocks shall be properly bonded together and in such manner that no vertical joint in any one course shall be within 115 mm of a similar joint in the courses immediately above and below. All walling of 300 mm thickness or less shall be built in single thickness of blocks. Walling exceeding 300 mm in thickness shall be built with through bonders not more than 1070 mm apart in each course as directed by the Architect. Alternate courses of walling at all angles and intersections shall be carried through the full thickness of the adjoining wall. All perpends, reveals and other angles of the walling shall be built strictly true and square.

c) **Tolerance**

All courses of walls shall be level with a maximum deviation of +/- 3 mm in any one metre length and a maximum overall deviation of 10 mm for length of wall exceeding 3 metres. Walls shall be plumb with a maximum deviation of +/- 3 mm in any metre height of wall with a maximum deviation of +/- 10 mm in the total height of the wall of any storey.

All corners of walls which are shown as being at right angles shall be square with a maximum deviation of 3 in 1000. All walls shall be straight with a maximum deviation of +/- 3 mm in any one metre length and a maximum overall deviation of 10 mm in any length exceeding 3 metres.

SPECIFICATIONS: WALLING

5.17 **BUILDING WALLING**

c) **Tolerance**

All bed and vertical joints shall be an average of 10 mm thick with a maximum deviation of +/- 3 mm of blockwork, and stone rubble walls, joints for stone masonry walls shall be 6 mm +/- 1 mm thick.

d) **Curing**

All walls shall be maintained in a damp condition for at least 24 hours after laying. Walls under construction shall be dampened by applying water with a brush and no hosing directly on to the wall shall be permitted. When work ceases on any section of wall polythene or hessian shall be draped over the wall for at least 24 hours. If hessian is used, it shall be maintained continuously wet.

e) **Cavities**

Cavity walls shall be of the overall thickness shown on the drawings.

Cavities above ground level between leaves of block or masonry shall be free of mortar droppings or other debris. The Contractor shall take proper precautions to prevent mortar or debris entering the cavity.

Cavities below ground level shall be filled with mortar for cavities up to 75 mm wide and for cavities over 75 mm wide filling shall be concrete mix 1:3:6. Cavities shall be filled such that there is maximum of three times the thickness of the thinner leaf of the wall filled with wet mortar or concrete unless the wall is continuously supported for the depth.

f) **Backfilling**

Earth backfilling against walls shall be carried out such that the level of the backfill is always equal on each side of the wall.

When a wall has filling material on one side only to a fill width of more than three times the wall thickness, the wall shall be continuously supported during backfilling.

Backfilling shall not be carried out until at least seven days have elapsed since the laying of the blocks or stone.

5.18 **REINFORCED WALLS**

Steel reinforcing bars in walls shall be carefully placed and spacers used to ensure that a minimum of 20 mm cover is given to the reinforcement unless otherwise specified.

Horizontal reinforcement in mortar joints shall be laid such that the reinforcement is not in contact with the blocks or stone.

SPECIFICATIONS: WALLING

5.19 WALL TIES

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

Wall ties shall be provided at 450 mm centres both vertically and 900 mm centres horizontally and shall be staggered when used to connect two leaves of unbonded wall. Wall ties shall be embedded into each material by a minimum of 50 mm.

5.20 FAIR FACE

All concrete and hollow blockwork described as finished with a fair face is to be built to a true and even face with the joints finished as specified hereinafter.

5.21 POINTING

Pointing of walls shall be prepared for painting by raking out all loose or friable material to a minimum depth of 15 mm to form a square recess. The joints shall then be wetted and new mortar shall be forced into the joints and finished as directed.

5.22 HOLES, CUTTING AND CHASING

a) All putlog holes shall be not 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 faced walls to match facing.

b) Where walling is cut, holed or chased for conduits, pipes and the like all such cuttings etc., shall be filled in with cement mortar (1:4) prior to the application of finishes.

SPECIFICATIONS: ROOFING

6.1 ASBESTOS CEMENT ROOF SHEETING

Galvanized mild steel corrugated sheeting (GCI) shall be in accordance with B.S 3083, not less than 0.56 mm (24swg) with sheets free from twist or buckle. Galvanizing must be clean, free from surface defects, and firmly bonded to the steel. Ridges, valleys, flushings and the like, of the same profile and quality with the roofing sheets shall be provided.

Galvanized mild steel ridges and valleys shall be not less than 0.56 mm (24swg) thick, of a profile to suit the specified construction, and not less than 300 mm wide.

Fixings must be of a size and pattern to suit the roof and the sheets being fixed and must be approved by the sheet manufacturer. Bolts, screws and nails must be supplied complete

with plastic washers. All fixing bolts and screws must be fitted with approved plastic washers for the profile of the sheeting in use. Steel hook bolts and nuts shall comply with B.S 1494. Cadmium or zinc plated steel roofing screws shall comply with B.S 1494, galvanized and gimlet pointed.

Roofing sheets and accessories shall be fixed in accordance with the manufacturer's recommendations to make the whole system sound and watertight.

Sheeting shall be laid with end laps of not less than 150 mm and one and a half corrugation side laps. Sheets shall be laid with open joint side laps to face away from the prevailing wind.

Eaves and end laps shall be fixed with two fixings per sheet width. Fixing at intermediate supports, where no lap occurs, shall be with one fixing per sheet width.

6.2 **SLATES**

Slates shall be "Thrutone Duracem" cement tiles to B.S 5534: Part 1 1978 by TAC Construction Materials (Turner and Newell PLC), or by other equal and approved. The slates shall be fixed with galvanized steel hooks to the manufacturer's specifications.

6.3 **SHINGLES**

Shingles shall be 400 mm long nominally and red Canadian cedar fixed with copper nails to timber battens with 125 mm laps.

6.4 **PROMENADE TILES**

Promenade tiling will be executed by an approve specialist sub-contractor. The tiles shall be manufactured by TAC Construction Materials (Turner and Newell PLC) or by other equal and approved. The tiles shall be fixed by galvanized steel hooks to the manufacturer's specifications.

6.5 **ASPHALT ROOFING**

Asphalt roofing will be executed by an approved specialist roofing sub-contractor. Before any application of roofing, the Contractor is to ensure all roof surfaces are thoroughly cleaned by sweeping.

SPECIFICATIONS: ROOFING

6.5 **ASPHALT ROOFING**

Roofing asphalt shall be to B.S 988/1966 Table 3 Column 111 Tropical Mastic asphalt laid in two coats to a total thickness of 20 mm on and including black sheathing felt and vertical surfaces local grey stone chippings or pre-cast concrete paving slabs as necessary.

The first layer of asphalt to be fully bonded to the Sheathing felt and the second layer to be laid with a 75 mm joint to the first layer.

At all junctions of covering with parapet walls, kerbs, eaves, gutters etc., the asphalt is to be turned up a minimum of 150 mm with an angle fillet at the junction with the roof and splayed at the top and tucked 25 mm into groove and pointed in cement and sand mortar.

Precast concrete tiles are to be 300 mm x 300 mm x 25 mm thick, interlocking, finished fair on exposed face and bedded in bitumen and pointed in cement mortar.

6.6 **ALUMINIUM FLUSHING**

Aluminium flushings shall be formed out of 22 gauge super purity aluminium with natural mill finish to B.S 1470. Where flushings are built into joints or rucked into grooves, the minimum depth is to be 25 mm and they are to be secured by folded aluminium wedges at 450 mm centres and pointed in cement mortar (1:3).

6.7 **ROOF SCREEDS GENERALLY**

Roof screeds are to be laid to a minimum fall and cross fall of 27 mm in 3.0 metres with a minimum thickness of 19 mm at rainwater outlets and are to be finished to the entire satisfaction of the sub-contractor executing the roofing.

6.8 **CEMENT AND SAND ROOF SCREEDS**

The roof screeds shall be formed of cement and sand (1:3). The screeds shall be laid in bays, square where possible, of maximum 10 square metres. Each bay shall be formed between stop boards of the correct height and cut on each side to indicate the slope required in the roofing. The screed shall be trowelled with a wood float to true and accurate falls or cross falls up to the stop boards. A 10 mm wide gap shall be left between each screed bay for the full depth of the screed.

The screeds shall be allowed to cure thoroughly to attain maximum shrinkage. Any cracks which will appear due to shrinkage shall be made good.

The gaps between the screed bays shall be filled as follows:

1. Brush or blow up joints to remove dirt, dust, etc. and prime the sides of the joints using a piece of sponge or similar dipped in a mixture of equal volumes of "Flinktone" Type 1 or Type 3 emulsion and water. Allow to dry.

2. Fill up joints slightly around the surface using a 1:2:3 mastic. This mastic shall be prepared by mixing one volume of cement with three volume of sand, adding a little water to dampen the mix, then adding two volume of "Flinktone" Type 1 or…

SPECIFICATIONS: ROOFING

6.8 **CEMENT AND SAND ROOF SCREEDS**

…Type 3 emulsion. The mastic is thoroughly mixed together adding further water as necessary until it is a uniform brown color, without being too sloppy. Allow to set and dry.

The screed joints shall then be covered with a 200 mm wide strip of building paper **not** bonded to the screed joint and well lapped at angles and junctions before the application of the roof covering.

6.9 **LIGHTWEIGHT ROOF SCREEDS**

Lightweight roof screeds shall be composed of bases of cement, sand and pumice (1:4:8) finished with a 12 mm cement and sand (1:5) topping laid whilst the base is still green and trowelled smooth to the satisfaction of the Architect.

The screeds are to be laid as described in cement and sand roof screeds.

6.10 P.V.C RAINWATER PIPES

P.V.C rainwater pipes and fittings are to comply with B.S 4576 with rubber ring seal joints.
Pipes are to be fixed to the structure with P.V.C holderbats or brackets built-in or plugged and screwed at maximum 2 metre centres.

Bends, swan necks, discharge chutes and fittings generally are to be fixed where necessary to facilitate the flow of water.

Rainwater outlets shall be PVC suitable for the roof finish in which they occur with domical PVC grating.

6.11 COMPLETION OF THE WORKS

On completion of the works, the Contractor shall clear away, ensure that rainwater outlets are clear and generally leave the roof area in a clean and watertight condition to the satisfaction of the Architect.

6.12 PROTECTION

The Contractor is to take all necessary precaution to protect the finished works and must ensure that no damage occurs to the footing until completion of the works.

SPECIFICATIONS: ROOFING

6.13 PRECAST CONCRETE INTERLOCKING TILES

Precast concrete tiles shall conform to the general standards of precast concrete units as before described in the specifications for concrete. The tiles shall be fixed in accordance with the manufacturer's specifications with a 90 mm end lap and 50 mm side lap. Ridge cappings and hip cappings shall be bedded and jointed in colored cement and sand (1:3) mortar to match the color of the tiles.

SPECIFICATIONS: CARPENTRY & JOINERY

PART 6: CARPENTRY AND JOINERY

6.1 GENERAL

All woodwork shall be carried out in accordance with the drawings and the principles of first class joinery construction. Unless specifically stated otherwise, sizes shown on drawings are finished sizes and the Contractor must allow for wrot faces.

MATERIALS

6.2 QUALITIES OF TIMBER

a) The qualities of timber stated hereinafter are in accordance with the latest KENYA Government Grading Rules.

b) All timber described as Prime Grade is to be First Grade (Grade II).

c) All timber described as Selected Grade is to be Second Grade (Grade II).

d) All hardwood is to be Prime Grade (Grade I).

e) All timber for permanent work in the building shall before use be approved by the Architect for quality in accordance with the foregoing specification for its

respective grade. Any timber not so approved by the Architect shall be removed from the site forthwith.

6.3 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 of 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.

6.4 SEASONING OF TIMBER

All carpentry timbers are to be seasoned to an average moisture content of not more than 20%. All joinery timbers are to be seasoned to an average moisture content of not more than 15%. The Contractor is to make available on site a meter for testing moisture content of all timber delivered.

SPECIFICATIONS: CARPENTRY & JOINERY

6.5 PREPARATION AND PROTECTION OF TIMBER

i) 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.

ii) 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.

6.6 SPECIES OF TIMBER

Only those timbers specified are to be used for the works, unless alternatives are authorized by the Architect in writing.

6.7 PRESSURE IMPREGNATED TIMBER

i) All timber described as "pressure impregnated" shall be impregnated under vacuum and pressure with "Celcure" or "Tanalith" wood preservative with an average absorption of not less than 6.7 kgs of dry salt per cubic metre. In case of resistant species where this retention cannot be obtained the timber shall be treated to refusal point. All treated timber shall not be exposed to wet conditions for at least 14 days after treatment has been carried out. All cut ends, drilling or fabrications on the site producing new surfaces shall be thoroughly brushed or soaked with "Celcure B" salts applied in accordance with the manufacturer's instructions.

ii) Any other method of timber impregnation will only be allowed at the Architect's approval.

6.8 **HARDWOOD**

All hardwood will comply with the requirements of B.S. 1186 Part 1 and B.S. 4047. It shall show a straight and regular grain throughout.

Hardwood shall be free from woolly texture, soft heart, sap wood, splits, shakes, all evidence of insect or fungi attack and rot and all faults caused by compression failure. There shall be no waney edges. Hardwood shall be free from knots on exposed faces. Any hardwood showing visible imperfections will be rejected.

Preservatives shall not be used without the Architect's permission. Where indicated on the drawings, internal hardwoods will be treated with clear sealants as specified elsewhere.

SPECIFICATIONS: CARPENTRY & JOINERY

6.9 **SOFTWOOD**

Softwood timber for carcassing work shall be either podocarpus or Cypress to the approval of the Architect and shall be to the dimensions specified on the drawings.

Timber shall be classified in accordance with the Groups listed in this Clause.

All softwood shall comply with the requirements of B.S. 1186 Part 1. Timber shall be free from woolly texture, soft heart, sap wood, splits, shakes pith showing on the surface, soping grain exceeding one in eight checks, knots exceeding 25 mm diameter, loose knot or knot holes and any evidence of insect or fungi attack. There shall be no waney edges.

Where indicated on the drawings, the softwood will be treated with clear sealer or painted with gloss paint.

All softwood is to be pressure impregnated against insect attack before delivery to site. Any ends cut after treatment shall be given two liberal coats of preservative.

6.10 **PLYWOOD**

All plywood shall comply with the requirements of B.S. 1455, be obtained from a manufacturer to be approved by the Architect and be of the thicknesses shown on the drawings.

Plywood shall be Exterior Grade except where otherwise stated. Plies shall be bonded together with adhesives complying with the requirements of B.S. 1203 grade WBP.

Plywood shall be free from end joints (including joints in veneers) overlaps in core veneers, dead knots, patches and plugs, open defects, depressions due to defects in cure, insect attack (except isolated pinwork holes through face veneers only), fungal attack and from discolouration differing from that normally associated with species.

PLYWOOD

Face veneers shall be hard and durable and shall be capable of being finished to a smooth surface. Face veneers shall closely match the general joinery timber supplied.

6.11 **CHIPBOARD**

Chipboard shall be medium density wood particle board complying with B.S. 2604 Part 2, produced in factories by an approved process.

6.12 **BLOCKBOARD**

Blockboard shall be of approved local or imported manufacture to B.S. 3444 glued throughout and softwood or hardwood faced as hereinafter specified and equal to a sample to be deposited with the Architect for approval and which when so approved shall form the standard for the works.

SPECIFICATIONS: CARPENTRY & JOINERY

6.13 **FIBREBOARD**

Shall be insulating board to comply with B.S. 1142 of the types specified and of approved manufacture.

6.16 **TIMBER DOORS**

Doors are to be designed, manufactured and fixed in accordance with the relevant British Standards summarized below:

B.S. 476 Part 8 1972 Fire tests etc

B.S. 4787 Part 1 1972 Door dimensions etc.

B.S. 1186 Part 1 1971 Quality of timber and workmanship

B.S. 1227 Part 1 A Hinges

B.S. 3827 Builder's hardware – glossary

6.17 FLUSH DOORS

Generally, the requirement for flush doors is that they have a minimum thickness of 40 mm. They shall be faced both sides and there will be hardwood lippings to all edges. Hollow core and semi-solid types shall contain adequate provision within the core for ironmongery (e.g. lock blocks etc).

All hollow and semi-solid door shall be faced with WEP bonded Exterior grade plywood.

Except where indicated, doors shall have hardwood veneered faces.

Vision panels where required shall be 150 mm wide x 900 mm deep.

Flush doors shall be obtained from a supplier to be approved by the Architect. Flush doors shall comply with the requirements of B.S. 459 Part 1, 2 and 3. All edges shall be lipped with hardwood tongued into the edge of the door.

The core of solid core flush doors shall be constructed of longitudinal laminations of precision planed timber, butt jointed and glued with resin based adhesive under hydraulic pressure, the whole forming a rigid fire-resistant raft.

Where doors are indicated as fire resistant they shall be constructed so as to exceed the requirements stated when tested in accordance with B.S. 476 Part 8 (1972) Section 7.

SPECIFICATIONS; CARPENTRY & JOINERY

6.18 HARDWOOD VENEERS

a) Veneer facings shall be selected to the approval of the Architect.

b) No glass or synthetic fibre stitching will be permitted for jointing veneer leaves together.

c) Veneers shall be free from splits, dote, glue, stains, insect or fungi attack and rot.

d) Filling or inlaying of any kind will not be accepted.

e) All wood veneers shall be bonded to the core material in such a way that no lifting and blistering shall occur.

6.19 LAMINATED PLASTIC VENEERS

Laminated plastic veneers shall be a decorative sheet 1.6 mm thick complying with B.S. 3794 Class 1. The pattern will be selected by the Architect. The laminate shall have decorative (pattern) finish on one face only. Patterns will be selected from the manufacturer's standard range.

6.20 MISCELLANEOUS MATERIALS

a) Tapered timber pellets for filling screw holes must be cut across the grain and shall be of the colour and grain being plugged.

b) Metal fixing devices must be fully rust-proofed. Cramps, brackets, plugs, bolts etc. must be of a type, make and pattern approved by the Architect.

c) Adhesives must be suitable for use in the local conditions and be compatible with the materials with which they are in contact.

6.21 NAILS AND SCREWS

Nails shall comply with B.S. 1201, screws shall comply with B.S. 1494 and bolts shall comply with B.S 916.

WORKMANSHIP

6.22 TOLERANCES

The method of construction must accommodate tolerances as shown on the drawings and allow for ensuring that repetitive units can be accurately located in relation to grid lines and that tolerances do not accumulate.

Reasonable tolerance shall be provided at all junctions between joinery and the building carcass, whether of masonry or frame construction, so that any irregularities or movement may be adequately compensated.

SPECIFICATIONS; CARPENTRY & JOINERY

6.23 JOINTING

d) Where the use of bolts and washers is specified the holes are to be bored from both sides of the timber and 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 cross-tongued 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, resin or organic glues may be used.

6.24 **FRAME WORK**

The word "framed" shall mean and include all the best known methods of jointing woodwork together by mortice, tenon, dovetail or other methods and for forming all necessary stops, mitres or mason's mitres in members which are moulded, rebated etc.

6.25 **PLUGGING**

Plugging and fixing to walls in all trades shall be executed by "Rawl plugging" or similar approved proprietary methods all in accordance with the manufacturer's printed instructions. Hacking of holes and filling with timber plugs will not be permitted under any circumstances.

6.26 **CARPENTRY WORK**

a) All carpentry shall be executed with workmanship of the best quality. Scantlings and boards shall be accurately sawn and shall be uniform in width and thickness throughout and shall be as long as possible and practicable in order to eliminate joints.

b) All work shall be left with a sawn surface except where specified to be wrot.

c) All work shall be accurately set out and in strict accordance with the drawings and shall be framed together and securely fixed in the best possible manner with properly made joints. Provide all braids, nails, screws etc. as necessary and as directed and approved.

(d) Actual dimensions of scantlings for carpentry shall not vary from the specified dimensions by more than +3 mm or -1 mm. Sizes and thicknesses of wrot carpentry timbers are nominal, that is to say a variation of 3 mm from the specified sizes will be allowed from each wrot surface unless the thickness or size is described as "finished" in which case no variation from the stated thickness or size will be permitted.

SPECIFICATIONS; CARPENTRY & JOINERY

6.27 **JOINERY WORK**

All joinery work shall be wrot unless otherwise described.

a) Sizes and thicknesses of joinery are nominal that is to say a variation of 3 mm from the specified sizes will be allowed from each wrot surface unless the thickness or size is described as "finished" in which case no variation from the stated thickness or size will be permitted.

b) No joinery to be put in hand until the details have been supplied or approved by the Architect and in all cases the details are to be worked to.

c) All joinery shall be executed with workmanship of the best quality in strict accordance with the detailed drawings, mouldings shall be accurately and truly run on the solid and all work planed, sand-papered and finished to the approval of the Architect. All arises to be slightly rounded. All framed work shall be cut out and framed together as soon after the commencement of the building as is practicable but should not be wedged up until the building is ready for fixing the same and any portions that warp, get in winding, develop shakes or other defects shall be replaced with new. In door frames etc. the heart face of the timber shall be fixed away from the wall. As soon as required for fixing in the building the framing shall be glued together with glue as described and properly wedged or pinned etc. as directed.

d) All beads, fillets and small members shall be fixed with round or oval braids or nails well punched in and stopped. All larger members shall be fixed with screws, the screws let in and pelleted over with wood pellets to match the grain.

e) Cups and screws for fixing beads and fillets shall be spaced 150 mm and 25 mm iron angles.

f) All joinery immediately upon delivery to the site is to be stored and protected from the weather.

g) All joinery is to be primed before fixing but no work is to be primed until it has been approved by the Architect.

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

i) When natural finish is specified, the timber in adjacent pieces shall be matched and uniform or symmetrical in colour and grain.

6.28 **SOFTWOOD**

Fixing shall be by means of non-rusting screws with counter sunk heads to proprietary plugs or grounds. Nailing will not be permitted.

Sections shall be neatly and accurately cut so as to avoid splitting of the wood.

SPECIFICATIONS: CARPENTRY & JOINERY

6.29 **HARDWOODS**

Hardwoods are as described.

In jointed panels each piece shall be of the same species. Joinery for oiling shall have all surfaces of the same species and same character or grain.

Fixing shall be by means of brass screws with countersunk heads to proprietary plugs or grounds. Where work is face screwed, heads of screws shall finish not less than 6 mm below the surface and be covered with round teak pellets of appropriate thickness. Pellets shall be chosen and fixed so as to match colour and pattern of grain so far as is practical. Nailing will not be permitted. Sections shall be neatly and accurately cut with fine toothed saws.

6.30 **PLYWOOD**

Plywood of the required thicknesses shall be used. The Contractor will not be allowed to make up thicknesses by gluing together sheets of thinner plywood.

Where cutting is required it shall be neatly and accurately performed with fine toothed saws so as to avoid splitting the face veneers and intermediate plies.

6.31 **CHIPBOARD**

Where cutting is necessary it shall be neatly and accurately performed with fine toothed saws so as to avoid splitting the face veneers. Where raw edges arise from cutting these shall be faced with a matching hardwood fillet cut pinned and glued to match factory produced edges.

7.32 **BLOCKBOARD**

Where cutting is necessary it shall be neatly and accurately performed with fine toothed saws so as to avoid splitting the face veneers. Where raw edges arise from cutting these shall be faced with a matching hardwood cut pinned and glued to match factory produced edges.

7.33 **LAMINATED PLASTIC VENEER**

Laminated plastic veneers are to be fixed with an approved adhesive, care being taken to eliminate all air from beneath the laminate on fixing. The laminate is to be free from chipped or cracked portions and work so disfigured is to be removed and replaced. When the adhesive is set, the laminate is to be neatly levelled off along all arises with a plane.

Where plastic laminate is fixed to doors or shelves etc. without a laminate to the outer edge, a raised lipping is to be provided and the laminate finished flush against the lipping.

SPECIFICATIONS: STRUCTURAL STEEL-WORK

PART 8: STRUCTURAL STEEL – WORK

8.1 **APPROVED SUB-CONTRACTOR**

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

8.2 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.

8.3 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 Standards and Codes of Practice, including all the amendments

8.4 BRITISH STANDARDS AND CODES OF PRACTICE

B.S 4360	Weld able Structural Steels
B.S 449	The use of Structural Steel in Building, (incorporating B.S Code of Practice C.P 113 including Addendum No. 1)
B.S 4 (Part 1)	Hot rolled sections
B.S 4 (Part 2)	Hot rolled hollow sections
B.S 938	General requirements for the metal arc welding of Structural Steel Tubes to B.S 1717, (B.S 938 will be considered to apply to the requirements for welding of hot rolled hollow sections to B.S 4 Part 2).
B.S 1775	Steel tubes for Mechanical, Structural and 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.
B.S 2008	Protection of Iron and Steel Structured from Corrosion.

SPECIFICATIONS: STRUCTURAL STEEL-WORK

8.5 TESTS

The Engineer may at any time require any materials to be tested in accordance with the requirements 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 of 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.

8.6 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 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 2 mm larger in diameter than the bolt size. Holes for high tensile friction grip bolts shall be drilled or sub punched and reamed to 2 mm larger in diameter than the specified bolt size. All drilled holes shall be parallel sides and shall be drilled by axle of holes perpendicular to the surfaces. Badly drilled holes shall either be reamed out to approval and larger bolts fitted or otherwise as directed. All rough arises shall be ground off. Holes for bolts in material thicker than 15 mm must be drilled. When holes are drilled in one operation through two or more thickness of material, the parts shall be separated after drilling and all burrs (rough edges) 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-filling.

c) **Bolting:** All bolts used shall be of such length that at least one 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 beveled washer of the correct shape shall be interposed between the two surfaces. Beveled 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.

SPECIFICATIONS: STRUCTURAL STEEL-WORK

8.6 FABRICATION

Bolting:

Beveled 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) or B.S 2708 (U.N.C. Threads) as appropriate.

ii. **Close Tolerance Bolts**
Close tolerance bolts shall conform to B.S 916 or B.S 2708

iii. **High Tensile Bolts**
High tensile bolts shall conform to B.S 1768.

iv. **High Strength Friction Grip Bolts**
a) General grade bolts to B.S 3139 Part 1

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

c) High tensile bolts to B.S 1768.

v. **Rawl Bolts**
Rawl bolts shall be those manufactured by Rawlplug Company Ltd. or any other approved manufacturer.

vi. **Washers**
Plain and tapered washers to B.S 3410.

Spring washers to B.S 1802.

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

vii. **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 so that they can be driven and the heads formed and the physical properties not impaired.

viii. **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 175 N/mm².

SPECIFICATIONS: STRUCTURAL STEEL-WORK

8.6 FABRICATION

viii. Pressed Steel Sections

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

ix. Electric Welding

All welding shall be carried out in strict accordance with the requirements of B.S 1856 and B.S 2624 as appropriate and electrodes shall comply with B.S 639.

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 results in minimum distortion of the welded parts.

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 and remade to approval.

Welds in material 25 mm 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 stated, the minimum size of fillet shall be 6 mm.
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 successful runs throughout the joint.

Defects shall be cut out and made good to approval in sound weld metal.

SPECIFICATIONS: STRUCTURAL STEEL-WORK

ix. **Electric Welding**

The external faces of butt welds are to be ground smooth on completion to the approval of the Engineer.

8.7 **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 12 mm diameter and no weld less than 40 mm 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 Clauses 53 and 54 and Appendix of B.S 449.
Butt welds in tension members shall 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.

8.8 **ASSEMBLY**

a) **Trusses and Portal Frames**

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

SPECIFICATIONS: STRUCTURAL STEEL-WORK

8.8 ASSEMBLY

a) **Trusses and Portal Frames**

Notwithstanding 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 the units in the shop prior to transporting to the Site must be inspected by the Engineer prior to painting. The assembled work shall be laid out in the shop or yard such that all parts are accessible for inspection or 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 site details and marking plans submitted to the Engineer for approval.

8.9 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 in 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 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.

SPECIFICATIONS: STRUCTURAL STEEL-WORK

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 effects 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 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 drawing, 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 that will preclude any possibility of damage from excessive stresses.

Packing plates, shims, washers or similar adjusting pieces found necessary to accommodate tolerance 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 the approval of the Engineer. Bracing shall be fixed in position as soon as dependent portion of the work is completed.

e) **Tightening and Testing High Tensile Friction Grip Bolt**

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 part have a slope of more than 1 in 20 with respect to a plane normal to the bolt axis, square smooth beveled washers shall be used to compensate for the lack of parallelism.

SPECIFICATIONS: STRUCTURAL STEEL-WORK

e) **Tightening and Testing High Tensile Friction Grip Bolt**

All bolts shall be tightened by the 'Turn of Nut' method. This method shall generally be specified in B.S 3259 and as approved by the Engineer to achieve a minimum tension equal to the roof load.

f) **Grouting**

Unless otherwise detailed on the drawing, a space of not less than 40 mm shall be provided between undersides of column base plates and footings and between 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 and pad and underside of 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 20 minutes of mixing. The caulking mixture shall be packed tightly into the space between base plate and foundation and protected from damage until it sets.

8.10 PAINTING

a) **Paints**

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 specifications.

Manufacturer's representatives are to be free to visit the site and inspect the 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.

SPECIFICATIONS: STRUCTURAL STEEL-WORK

8.10 **PAINTING**

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 before the 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 wet.

After erection, paint a second and finishing coat of 'Oil Company Aluminium Paint 360/36' 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 other approved primer.
2nd Coat – Robbialac 'Oil Company Aluminium Paint 360/36' or other equal and approved aluminium paint.
The interior of mild steel gutters shall be prepared as previously described and painted with two coats of Robbialac Epilac Coal Tar Epoxy Paint or other approved paint.

8.11 **PRICES, MEASUREMENTS AND PAYMENTS**

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.

SPECIFICATIONS: STRUCTURAL STEEL-WORK

8.11 PRICES, MEASUREMENTS AND PAYMENTS

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 weight of the structure as completed, shall result in appropriate additions to or deductions from 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 additional steel weights.

SPECIFICATIONS: METALWORK

PART 9: METALWORK

MATERIALS

9.1 GENERALLY

All materials shall be the best of their respective kinds free from defects and all work is to be carried out in the most workmanlike manner and strictly as directed by the Architect. The materials in all stages of transportation, handling and stacking shall be kept clean and prevented from injury by breaking, bending or distortion and weather action.

9.2 MILD STEEL

Mild steel shall comply with B.S 15

9.3 HOLLOW SECTION TUBING

Square and rectangular hollow section tubing shall be hot rolled mild steel in accordance with Grade 43 C of B.S 4360.

9.4 BOLTS, NUTS AND WASHERS

These shall be fabricated from materials which comply with B.S 15 and each manufactured item shall comply with the appropriate B.S.

9.5 GALVANIZED SHEET METAL

To be No. 24 SWG of approved manufacture to B.S 2989 of best quality mild steel sheets cold rolled close annealed patent, flattened and hot dipped galvanized.

9.6 ALUMINIUM

Aluminium shall be extruded sections with an anodized finish, either natural or coloured, to give a 25 micron minimum depth to European norm EWAA.

The Contractor shall submit with each item or batch of items delivered, test certificates or such other documentary evidence as the Architect shall require that the anodizing depth specified has been achieved.

9.7 **STAINLESS STEEL**

Stainless steel tube shall be Austenic steel to B.S 3014 comparable to B.S 1449 type 316 S16.

9.8 **METAL DOOR FRAMES**

Metal door frames are to be in steel to comply with B.S 1245 of profile to suit the wall thickness.

SPECIFICATIONS: METALWORK

PART 9: METALWORK

9.8 **METAL DOOR FRAMES**

Door frames are to be provided with the following:

a) Two priming coats of paint.

b) Fixing lugs for building into walls.

c) Three galvanized steel hinges per door.

d) Adjustable lock strike plate.

e) Two shock absorber buffers.

9.9 **STEEL WINDOWS**

Steel windows shall be manufactured from section conforming with B.S 990 of heavy duty sections of the metric W20 range of approved manufacture and design approved by the Architect.

After manufacture and before delivery to site, steel windows are to be hot galvanized by dipping in a bath of molten zinc or painted with one coat primer.

9.10 **ALUMINIUM WINDOWS**

Aluminium windows are to be designed, manufactured and fixed in accordance with the relevant British Standards summarised below:

B.S DD4	-	Grading of windows
B.S 1470	-	Wrought aluminium and aluminium alloys
B.S 1474	-	Wrought aluminium and aluminium alloys
B.S 4315	-	(Part I) window and structural gasket glazing systems

B.S 4842	-	Finishes to aluminium
B.S 4873	-	Aluminium alloy to windows
CP 3CH V	-	Loading
CP 153	-	Code for windows

Alternative standards may be adhered to but the Contractor must demonstrate that they are of an equal or better standard than the standards referred to in this specification.

SPECIFICATIONS: METALWORK

PART 9: METALWORK

9.10 ALUMINIUM WINDOWS

Members for aluminium windows shall be extruded aluminium and shall be fabricated from designated treated alloy HE9 TF, HE9 TE or HE9 TB to B.S 1474. Ancillary members such as sills and coupling mullions formed from sheet materials shall be fabricated from designated alloys SIC NS3 or NS4 in an appropriate temper.

Alternative alloys meeting the required physical properties of this specification shall be acceptable.

The main wet of aluminium solid section outer frame shall be not less than 1.2 mm thick at minimum tolerance.

For information on bi-metallic contacts see CP 153 appendix A.

The overall sizes of an assembled window frame shall be maintained with a permissible deviation of 1.5 mm. Maximum difference in length of frame diagonals shall be 4mm. Horizontally, the 1800 mm grid shall be used to centre the mullions and vertically allowance must be set for a large window tolerance at the window head.

Fasteners to be designed so that they cannot be released from the outside by the insertion of a thin blade or similar tools.

No opening light shall be openable or removable from the outside when it is fastened in the closed position except by use of special tools or breaking of part of the window.

The exposure factor shall be considered as moderate. Consideration should be given to both the height of the building and locations where exposure to solar radiations may result in high thermal stress.

Prevention of penetration of fine air borne dust is essential and of the utmost importance.

Finish to surface of aluminium alloy prior to anodising shall be 'Mechanical Satin' finish.

Where windows are described as "Black Anodised" then the final finish shall be black anodic oxidation coating to grade AA25 (or above) or B.S 1615.

Weather stripping and joint sealing materials shall be compatible with their adjacent materials and shall remain stable and not adversely affect the proper functioning of the window.

Replacement of weather stripping shall be possible from within the building and without requiring removal of the main frame.

SPECIFICATIONS: METALWORK

PART 9: METALWORK

WORKMANSHIP

9.11 **WELDING**

All welding is to be in accordance with the requirements of B.S 1856 and 938 and the electrodes shall comply with B.S 639.

Fusion faces shall be free from irregularities which could interfere with the welding material. These faces shall also be free from any deleterious material such as rust, grease and paint.

All welds shall be of the specified finish sizes and the sequence of the welding shall be carried out in a manner that will give minimum distortion to the welded parts.

Edges of all welding parts will be maintained in their correct position.

Welds shall be carried out with each run closely following the one prior with sufficient time between to allow for removal of slag.

Each run of weld is to be inspected and the sub-contractor shall ensure that unsatisfactory welds are cut out or remade to the required standard.

The minimum size of filled weld shall be 6 mm.

All completed welds shall have a regular and smooth surface. The weld material shall be solid with complete fusion throughout the weld and to the faircut metals.

Any defects shall be cut out or made good to approval.

External faces of butt welds to be ground smooth.

9.12 **PAINTING**

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

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

9.13 **FIXING OF STEEL WINDOWS**

Fixing of metal windows shall include for assembling and fixing, including screwing to sub-frames or cutting mortices for lugs in concrete or walling and running with cement mortar (1:4), bedding frames in similar mortar, pointing in mastic, bedding sills, transoms and mullions in mastic, making good finishes around both sides and fixing, oiling and adjusting all fittings and frames.

9.14 **ALUMINIUM WINDOWS**

Adjacent sashes in horizontal sliding windows shall be separated by a compatible spacer and the sashes shall be supported on bearing devices that facilitate movement. Joints in…

SPECIFICATIONS: METALWORK

PART 9: METALWORK

9.14 **ALUMINIUM WINDOWS**

…frames shall be made either by welding or by mechanical means. Where necessary joints shall be sealed with flexible material. Joints to be flush joints within one of the tolerances given in B.S 1474.

Hardware including its fixings shall be compatible with aluminium and shall be replaceable without removing the outer frame from its surround.

All screws, nuts, bolts, rivets, washers and other fastenings shall be of stainless steel or aluminium with the exception of those which are protected when the window is closed. Alternatively these may be made of steel which has been finished by one of the following methods:

a) Zinc plated and passivated according to B.S 1706 Classification Nr. Zn3

b) Hot – dip galvanized according to the requirements of B.S 729.

c) Sherardized according to the requirements of B.S 729 Part 2 or,

d) Sprayed with metal coating according to B.S 2569 Part 1.

Fixing devices not of aluminium may be made of steel finished by either method (a), (b) or (d) above.

The fixings shall be capable of withstanding the design wind load and any operating forces on the window.

Windows manufactured to standards set out in this specification shall each bear the name or trademark of the manufacturer and the number of the appropriate standard.

Fixing, assembling, bedding frames and painting shall be executed as described for 'Fixing of Steel Windows'.

SPECIFICATIONS: FINISHES

PART 7: FINISHES

GENERAL

10.1 **OTHER SPECIFICATIONS**

All other specifications of this contract where applicable are deemed to apply equally to the finishings specifications.

10.2 **SAMPLES**

The Contractor shall prepare at his own cost sample areas of the paving, plastering and rendering as directed until the quality, texture and finish required is obtained and approved by the Architect after which all work executed shall conform with the respective approved samples.

10.3 **FINISHED THICKNESSES**

The thicknesses of the floor finishes quoted in this section of the specification shall be the minimum requirements.

Suspended floors shall have a constant structural thickness and have level top surfaces. The finished floor surface will equally have a constant level and any adjustment needed to achieve this effect with the varying floor finish materials is to be made in the screeds beneath the same.

Slabs bearing on the ground may be cast to varying levels and be of constant thickness with varying formation levels, or have varying thicknesses at the option of the Contractor. This stipulation in no way relieves the Contractor of the requirements of the specification for structural works.

10.4 **MATERIALS GENERALLY**

All materials shall be of high quality, obtained from manufacturer's to be approved by the Architect.

Cement, sand and water shall be as described under Concrete Work and Blockwork.#

10.5 **BONDING**

Bonding compounds, etc. for use in applying plaster and similar finishes direct to surface without the use of backings or screeds are only to be used if approved by the Architect and are to be used strictly in accordance with the manufacturer's printed instructions.

10.7 **CHASES, OPENINGS AND HOLES**

All chases, holes and the like which were not formed in the concrete or walling shall be cut and all service pipes shall be and plaster work is commenced. In no circumstances will the fixed and all holes and chases filled with mortar before paving Contractor be permitted to cut chases, holes and the like in Finished paving or plasterwork.

SPECIFICATIONS: FINISHES

10.7 **GENERALLY**

The term plastering refers to the operation internally and rendering to the same operation externally but for ease of reference the term plastering has generally been used in this specification to describe both operations.

10.8 **MIXES**

The method of measuring and mixing plaster shall be as laid down under Concrete work and the proportions and minimum thickness of finished plaster shall be in accordance with the following:

Item of Work	Mix	Minimum Thickness and Finish
Internal Plaster	1 part cement ¼ part lime 4 parts sand	17 mm finish to walls ceilings. Wood float finish unless otherwise specified.
External Render	1 part cement 4 parts sand	12 mm finish in two coats
Tyrolean finish	Ditto	7 mm finished thickness in two coats on 10 mm Plastered backing

To obtain greater plasticity a small quantity of lime may be added to the mixes for external plastering at the Architect's discretion but in any case this is not to exceed ¼ part lime to 1 part cement.

With regard to the lime mortars gauged with cement, the addition just before use, of the cement to small quantities of the lime/sand mix shall preferably take place in a mechanical mixer and mixing shall continue for such time as will ensure uniform distribution of materials and uniform colour and consistency.

It is important to note that the quantity of water used shall be carefully controlled. Plaster may be mixed either in a mechanical mixing machine or by hand.

Hand mixed plaster shall first be mixed in the dry state being turned over at least three times. The required amount of water should then be added and the mix again turned over three times or until such time as the mass is uniform in colour and homogeneous.

The plaster shall be completely used within thirty minutes of mixing and hardened plaster shall not be remixed but removed from the site.

SPECIFICATIONS: FINISHES

10.9 PREPARATION OF SURFACES FOR PLASTER ETC.

Irregularities in the surfaces to be plastered or rendered shall be filled with mortar, without lime, twenty four hours before plastering is commenced. Joints in blockwork, etc. are to be well raked out before plastering to form a good key. Smooth concrete surfaces to be plastered shall be treated with an approved proprietary bonding agent or hacked to provide an adequate key for the plaster.

All surfaces to be plastered or rendered shall be clean and free from dust, loose mortar and all traces of salts.

All surfaces shall be thoroughly sprayed with water and all free water allowed to disappear before plaster is applied.

As far as practical, plastering shall not be commenced until all mechanical and electrical services, conduits, pipes and fixtures have been installed.

Before plastering is commenced all junctions between differing materials shall be reinforced. This shall apply where walls join columns and beams, particularly where flush and similar situations where cracks are likely to develop and as directed by the Architect. The reinforcement shall consist of a strip of galvanized wire mesh `Expamet' or equal approved 15 cm wide which shall be plugged, nailed or stapled as required at intervals not exceeding 45 mm at both edges. The surfaces to which such mesh shall be applied shall be painted with one coat bituminous paint prior to fixing the mesh.

10.10 APPLICATION OF PLASTER AND RENDER

After preparation of the surfaces a key coat of cement slurry shall be applied to the wetted surface to be plastered. When this coat is dry the plaster coat shall be applied, by means of a trowel, between screeds laid, ruled and plumbed as necessary. This coat which shall be to the required thickness shall be allowed to set hard and then cured as described.

Surfaces are to be finished with a wood or steel float to a smooth flat surface free from all marks.

Tyrolean finish shall be applied with an approved machine to give a finish of even texture and thickness. The sprayed finish shall be applied in two separate coats allowing time for drying between coats.

Application in one continuous operation to build up a thick layer will not be permitted. The total finished thickness of the two sprayed coats shall be not less than 7 mm. The sprayed finish shall not be applied until all repairs and making good to the undercoat are completed. Any plaster which adheres to pipes, doors, windows and the like shall be carefully removed before it has set. Curing shall take place after the application of the second coat. The finished surface shall be wither `rough textured' or `Pressed' finish as directed by the Architect. Where coloured tyrolean is required this shall be obtained by the addition to the mix of an approved colour pigment.

SPECIFICATIONS: FINISHES

10.10 **APPLICATION OF PLASTER AND RENDER**

All plastering and rendering shall be executed in a neat workmanlike manner. All faces except circular work shall be true and flat and angles shall be straight and level or plumb. Plastering shall be neatly made good around pipes or fittings. Angles shall be rounded to 7 mm radius.

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

10.11 **CURING OF PLASTER**

Each coat of plaster is to be maintained in a moist condition for at least three days after it has developed enough strength not to be damaged by water.

10.12 **ANGLE BEADS**

Where required by the Architect, salient external angles of plastered walls shall be protected with galvanized mild steel angle beads complying with B.S. 1247 profile C3.

They shall be securely plugged, nailed or stapled as required at intervals not exceeding 450 mm at both edges.

10.13 **PLASTER STOPS**

Where shown on details, plasterwork shall be stopped against "Expamet" galvanized steel plaster stop, reference 575 which shall be securely nailed to walls in the positions indicated on the drawings.

Stops shall be neatly and closely fitted together at corners and it is important that they are secured to walls through all holes provided.

10.14 **CEMENT AND SAND SCREEDS**

Screeds shall be mixed and formed as described.

10.15 **SURFACE HARDENERS**

Floor hardeners shall comprise an approved type guaranteed by the makers to produce a hard dense concrete with high abrasive resistance, impervious to the penetration of heavy oils, acid or alkali solutions and to be used strictly in accordance with the maker's instructions.

The first dressing of sodium silicate for granolithic flooring shall be one part of sodium silicate to six parts of water by volume.

Subsequent dressings shall be composed of one part of sodium silicate to four parts of water by volume, for all surface. The two liquids shall be well mixed together, sprayed over the flooring and spread evenly with a mop or soft brush, any excess being wiped off and the flooring allowed to dry for at least 24 hours after each dressing. After final drying floors shall be washed with clean water.

SPECIFICATIONS: FINISHES

10.17 **RATES OF IN-SITU WORK**

The rates for in-situ work shall include for raking out joints of blockwork or bonding coat or spraying cement slurry on new concrete surfaces to form key, for work in narrow widths, small and isolated areas , rounded arises, fair and chamfered edges, for making good and working around pipes, brackets etc. and for all other incidental labours.

Rates shall also include for masking before the application of spray finishes work executed overhead, temporary rules, supports, screeds and templates.

10.17 **TILE, SLAB AND BLOCK FINISHING**

Vinyl asbestos floor tiles shall comply with B.S. 3270 of an approved manufacturer to patterns as directed by the Architect. Adhesives are to be as recommended by the manufacturer in writing and approved by the Architect.

The tiles are to be laid and bedded direct in adhesive on to a cement and sand bed to make up the total paving thickness.

The cement and sand screed is to be finished with a steel trowel to a perfectly smooth surface before the application of the mastic and tiling.

On completion the vinyl asbestos tiles are to be sealed and polished with wax all in accordance with the manufacturer's printed instructions.

10.18 **RUBBER STUDDED FLOOR TILES**

Rubber studded floor tiles are to be of approved manufacture and shall have the following specifications:

a) Tile size 500 x 500 mm

b) Thickness 4 mm

c) Weight 5.84 kg. per M3

d) Hardness IRHD80 + or - 5

e) Breaking load 70 kg. Per mm^3

f) Extension of break 200 g

g) Effect of burning to be slight localised change of colour only.

h) Brasion under load of 0.5 kg. 300 mm^3

i) Colour black or brown

Adhesives are to be polychloroprene as approved by the manufacturer and the Architect.

SPECIFICATIONS: FINISHES

10.19 **LINOLEUM**

Linoleum sheets shall be:

a) Manufactured by Krommenie Linoleum, N.V. Nederlandsche Linoleum Fabriek, krommenie, Holland or equal and approved.

b) 3.2 mm thick

c) In accordance with B.S. 810

d) Smooth, uniform and free from indentations or protrusions.

10.20 **CLAY TILE PAVING**

Clay tile pavings are to be in 150 mm x 150 mm tiles obtained from an approved manufacturer and are to be laid on prepared screeds. The tiles are to be bedded in cement and sand (1:4) with straight joints in each direction. Upon completion grout in cement and wash and clean down. Tiles are to be cut with an electric tile cutting saw.

10.21 **GLAZED WALL TILES**

Glazed wall tiles shall be in accordance with B.S. 1281 and shall be 150 x 150 x 7 mm tiles from the standard colour range with cushion edges. Wall tiling shall be carried out in accordance with C.P. 212.

10.22 **THERMOPLASTIC TILES**

Thermoplastic tiles shall be:

a) In conformity to B.S. 2592

b) Size 300 x 300 x 3 mm thick

SPECIFICATIONS: FINISHES

10.23 **CERAMIC TILES**

Ceramic tiles shall be:

a) Manufactured by Daniel Platt & Sons Limited, Brownhills Tileries, Tunstall, Stroke-on-Trent, ST7 4NY, England or equal approved.

b) Weigh 1000 kgs. per 29 square metres

c) 10 mm Thick

d) Fixed in accordance with Code of Practice CP 202: 1972 and AMD 3271 June 1980.

10.24 **PRECAST TERRAZZO TILE PAVING**.

Terrazzo tile pavings are to be in sizes as specified x 25 mm thick bedded on cement mortar screeds and jointed and pointed in white cement. The tiles are to be laid with straight joints in both directions and cleaned down on completion. Tiles are to be cut with an electric cutting saw.

The mix of the terrazzo for tiles is to be as described under "Insitu Terrazzo Pavings".

10.25 **PRECAST CONCRETE PAVING SLABS**

To be all in accordance with B.S. 378. The slabs are to be of the sizes given herein and bedded, jointed and pointed in cement lime mortar (1:2:9).

10.27 **RATES**

The rates for tile, slab and block finishings shall include for rounded edge tiles and angles, cutting and fitting up to boundaries and around pipes, brackets, etc. and waste for work in narrow widths, small and isolated areas and for all other incidental labours.

SUSPENDED CEILINGS

10.28 **GENERALLY**

The Contractor shall provide shop drawings to show the final layout and sizes of members of all suspended ceilings with other trades to provide for the reception and installation of outlets, fixtures etc. pertaining to mechanical or electrical work, all for the Architect's approval before any work is commenced.

Ceilings shall be erected by workmen skilled in this work in a rigid and secure manner so that the final surface is free from any waves, buckles or sags.

SPECIFICATIONS: FINISHES

10.29 **EXPENDED METAL LATHING CEILINGS**

Framework for expanded metal lath ceilings shall be as specified. Straps shall be bolted either to steelwork or to steel angle cleats rawl bolted to concrete.

Covering shall be galvanized expanded metal lathing Ref>264 fixed to underside of suspension grid with 16 gauge soft galvanized tying wire or to underside of timber framing at maximum 356 mm centres.

The whole to form a suspension grid ready and of adequate strength to receive plaster or other applied finish and with supports for lighting fittings where required.

The Contractor shall submit to the Architect for approval prior to erection, shop drawings showing the precise layout of suspended ceiling systems.

10.30 **ACOUSTIC CEILINGS**

Acoustic tile ceilings shall be of approved manufacture. The ceilings shall include a proprietary suspension system as recommended by the manufacturer. The suspension system shall be suspended from wire hangers fixed to the concrete soffit by an approved method. All to be fixed strictly in accordance with the manufacturer's instructions.

10.31 **RATES FOR SUSPENDED CEILINGS**

Rates shall include for shop drawings as specified, all hangers and supports as required including fixing same to concrete or ductwork, for angles at edges, for corner angles at upstands, for cutting and fixing around grilles and registers and light fixtures and for leaving in a perfect condition to the entire satisfaction of the Architect.

Rates shall also be deemed to include the use of plaster stops and angle beads around the edges and at all corners.

Rates shall include for all edge details, angle runners and light fittings frames as required.

SPECIFICATIONS: GLAZING

PART 11: GLAZING

MATERIALS

11.1 **GENERAL**

Glass used for glazing and for mirrors shall be best quality clear glass free from visible defects so as to afford uninterrupted vision and deflection as appropriate and without obvious distortion.

11.2 **STANDARDS**

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

11.3 **CLEAR SHEET GLASS ETC.**

The clear sheet glass shall be ordinary glazing (OG) quality.

11.4 **PLATE GLASS**

Polished plate and Georgian wired polished plate glass to be selected glazing (SG) quality.

11.5 **OBSCURED GLASS**

To be of type described and approved by the Architect.

11.6 **SOLAR GLASS**

Solar control glass is to be obtained from a manufacturer approved by the Architect. Details of the characteristic and properties of the glass are to be provided to the Architect before ordering.

Solar glass is to be of the spectrafloat type incorporating metallic irons in the glass with a bronze tinted colour. Unless otherwise specified, thickness of the glass is to be 6mm.

11.7 **SAFETY GLASS**

Where safety glass is required, this shall be triplex.

11.8 **GLAZING GASKETS**

Glazing to metal frames shall be secured with clip in gaskets of butyl rubber. The gaskets shall be of size and section to suit the frame and glazing so as to provide a weather and airtight seal. The mechanical properties of the gasket shall be such as to resist the climatic conditions experienced in Kenya.

11.9 **WASH LEATHER**

Wash leather shall be best quality chamois oil curved natural colour. Where wash leather is called for, an approved substitute may be employed.

SPECIFICATIONS: GLAZING

PART 11: GLAZING

MATERIALS

11.10 **PUTTY**

a) The putty for glazing to wood sashes is to be linseed oil putty all as B.S 544.

b) The putty for glazing to metal windows is to be gold size metal window putty specially designed for tropical use, or patent mastic putty if approved by the Architect.

c) All putty shall be delivered on site in the original manufacturer's sealed cans or drums and used direct therefrom with the addition only of pure linseed oil

necessary. No mineral or other oils may be used in the putty except genuine linseed oil.

11.11 **MIRRORS**

Mirrors shall be polished float glass silvering quality protected at back with electro – copper backing coated with Shellac varnish and paint. The mirrors are to be fixed with chromium plated dome headed mirror screws with plastic or rubber distance pieces and washers unless otherwise stated and rates shall include for this.

WORKMANSHIP

11.12 **GENERAL**

Glazing of all types and in all locations shall be carefully executed by artisans skilled in this type of work and in conformance with the recommendations of CP 152. Glazing shall be carefully fitted so that it is not subject pressure and stresses imposed by being an oversized fit within the framing.

11.13 **MEASUREMENTS**

Each element (door, window, etc.) to receive glass shall be accurately measured to ensure a perfect fit subsequently.

11.14 **SINGLE GLAZING**

Single glazing shall be executed with glass of the various types described herein. Ordinary (non-safety) glass may be pre-cut or cut on site.

11.15 **WIRED GLASS**

Wired glass shall be cut so that the wires embedded are truly vertical and horizontal (i.e. at right angles to the cut edges).

11.16 **SAFETY GLASS**

Safety glass shall be factory cut before delivery to site. Site cutting will not be permitted.

SPECIFICATIONS: GLAZING

PART 11: GLAZING

MATERIALS

11.17 **STORAGE AND HANDLING**

Glass shall be delivered to site in stout containers and clearly marked. The containers shall incorporate sling attachment points for lifting bridles. Glass shall be stored under cover so that the panes are truly vertical.

11.18 **PROTECTION**

After fixing, glass shall be boldly marked with paper or whitewash so that it is clearly visible. In positions where damage sue to construction traffic or activity is

likely to occur, stout screens composed of hardboard or fibreboard on battens shall be arranged to protect the glass.

11.19 **DAMAGE**

Should any glass delivered to site be found to be damaged, it shall not be incorporated into the works without the express permission of the Architect. Should glazing installed be damaged for any reason, it shall be removed and replaced free of charge to the satisfaction of the Architect. Should any adjacent works be damaged, this shall equally be reinstated free of charge to the satisfaction of the Architect.

11.20 **DEFECTIVE WORK**

All glass shall be checked before installation to ensure that defective glass is not installed. Notwithstanding that, if in the opinion of the Architect any installed glazing is defective, it shall be removed and replaced free of charge to the satisfaction of the Architect.

11.21 **GLAZING TO WOOD**

Glazing shall be secured to wood framing with hardwood beads. Edges shall be wrapped in wash leather so that the wash leather finishes just below the surface of the bead. No adhesives shall be used.

11.22 **GLAZING TO METAL**

Glazing shall be secured to metal framing with clip-in butyl rubber gaskets.

11.23 **GLASS THICKNESS**

Glass thickness shall conform to the recommendations of CP 152 and the manufacturer's recommendations for sizes of panes relative to the position in the building and the effects of wind pressure (both positive and negative)

11.24 **CLEANING**

All window glazed panels and mirrors shall be cleaned both inside and outside immediately prior to handing over of the building to the satisfaction of the Architect.

SPECIFICATIONS: PAINTING AND DECORATING

PART I2: PAINTING AND DECORATING

MATERIALS

12.1 **MANUFACTURERS**

Except where stated all materials shall be obtained from approved manufacturers. The Contractor shall state the name and address of the manufacturer whose materials he proposes to use. Once approval has been given the Contractor shall not obtain materials from other sources without the prior written agreement of the Architect.

12.2 **GENERAL**

Each succeeding coat of priming, undercoating and finishing (pigment) or clear coating shall be sufficiently different in colour as to be ready distinguishable.

All primers and paint in one system upon a particular surface shall be obtained from the same manufacturer.

The mixing of paints, etc. of different brands before or during application will not be permitted.

12.3 **EMULSION PAINTS**

Emulsion paints shall be matt or satin finish vinyl emulsion paint.

The first (mist) coat shall be thinned in accordance with the manufacturer's instructions.

12.4 **GLOSS PAINT**

Gloss paints shall be hard gloss finish oil paint.

12.5 **LEAD BASED PAINTS**

The use of lead based paints will not be permitted.

12.6 **CLEAR FINISHES**

Clear finishes internally shall be clear polyurethane varnish (one pack)

12.7 **PRIMERS AND UNDERCOATS**

Unless otherwise specified, primers and undercoats shall be of the type recommended by the manufacturer of the finishing coats specified for a particular surface. Primer for external bare metalwork surfaces shall comply with B.S 2523.

12.8 **KNOTTING**

Shellac knotting shall comply with B.S 1336

12.9 **WHITE SPIRIT**

The white spirit shall comply with B.S 245.

SPECIFICATIONS: PAINTING AND DECORATING

PART I2: PAINTING AND DECORATING

12.10 **TIMBER STAIN**

Timber stain shall be oil based pigmented stain. The application of this material shall be strictly in accordance with the manufacturers written instructions. Tint and degree of application shall be to the approval of the Architect.

12.11 **STOPPING**

The stopping shall be as follows:

a) Plaster work shall be plaster based filler.

b) Concrete and brickwork shall be similar material to the background and finished in a similar texture.

c) Internal woodwork, plywood and blockboard shall be putty complying with B.S 544.

d) External woodwork shall be white lead paste complying with B.S 2029.

e) Internal clear wood finishes: the stopping shall be that recommended by the lacquer manufacturer.

12.12 **FILLERS**

The fillers for internal joinery shall be the type recommended by the paint manufacturer for use with this type of paint or lacquer.

Stoppers and fillers shall be tinted to match the undercoat, and shall be compatible with both undercoats and primers.

All materials shall be used strictly in accordance with the manufacturer's instructions.

12.13 **TEXTURED COATING**

Textured coating is to be of proprietary manufacture approved by the Architect, of an approved colour.

Technical information concerning the coating is to be submitted to the Architect before ordering but the minimum qualities of the coating are to be as follows:

a) Suitable for application internally and externally to plastered, rendered, concrete, block, stone, brick, asbestos and timber surfaces.

b) Minimum durability of 10 years even in exposed surfaces.

c) Maintenance fee.

d) Built-in mould resistant fungicide.

SPECIFICATIONS: PAINTING AND DECORATING

PART I2: PAINTING AND DECORATING

WORKMANSHIP

12.14 **GENERAL**

Workmanship generally shall be carried out in accordance with CP 231, unless otherwise specified.

Before painting is commenced, floors shall be swept and washed over, surfaces to be painted shall be cleaned before applying paint as specified and all precautions taken to keep down dust whilst work is in progress.

No paint shall be applied to surfaces structurally or superficially damp, and all surfaces must be ascertained to be free from condensation, efflorescence, etc. before the application of each coat.

No painting shall be carried out externally during humid, rainy, damp, foggy or freezing conditions where surfaces have attained excessively high temperatures or during dust storms.

No new, primed or undercoated woodwork and metalwork shall be left in an exposed or unsuitable situation for an undue period before completing the process.

No dilution of paint materials shall be allowed except strictly as detailed by the manufacturer's own direction, either on the containers or their literature, with the special permission of the Architect. For external work, dilution of paints will not be allowed whatsoever. For internal work, where permitted by the Architect, undercoats may be thinned by the addition of not more than 5% thinners. Gloss finish shall not be thinned at all.

Metal fittings such as ironmongery etc. not required to be painted shall first be fitted and then removed before the preparatory processes are commenced. When all painting is completed, the fittings shall be cleaned as necessary and re-fixed in position.

12.15 **BRUSHWORK**

Unless otherwise specified, all primers and paints shall be brush applied. Written permission must be obtained from the Architect if an alternative method of application is to be used.

12.16 **STOPPING AND FILLING**

Unless otherwise specified by the manufacturer, all primers and undercoats shall be stopped flush and rubbed down to a smooth surface with an abrasive paper and all dust removed before each succeeding coat is applied. Care shall be taken to avoid burnishing (make shine) of the surface.

SPECIFICATIONS: PAINTING AND DECORATING

PART I2: PAINTING AND DECORATING

12.17 **STIRRING**

Unless otherwise stated by the paint manufacturer, all paint materials shall be thoroughly mixed and/or stirred before and during use and suitably strained as and when necessary.

12.18 **INSPECTION**

No priming coats shall be applied until the surfaces have been inspected and the preparatory work has been approved by the Architect. No undercoats or finishing coats shall be applied until the previous coat has been similarly inspected and approved.

12.19 **PAINT APPLICATION**

Each coat of paint shall be so applied as to produce a film of uniform thickness. All paint shall be applied in accordance with the manufacturer's instructions. Special attention shall be given to ensure that all surfaces including edges, corners, crevices, welds and rivets receive a film thickness equivalent to that of adjacent painted surfaces.

12.20 **DRYING**

All coats shall be thoroughly dried before succeeding coats are applied. Allow a minimum of 24 hours between applications on any one surface, unless otherwise stated by the manufacturer.

12.21 **UNPRIMED WOODWORK**

Unprimed woodwork scheduled to be painted shall be rubbed down with abrasive paper and dusted off. Care shall be taken to prevent burnishing of the surface. All knots and resinous areas shall be coated with two coats of knotting. Pitch on large, open unseasoned knots and all other beads or steaks of pitch shall be scraped off, or if still soft, shall be removed with white spirit before applying the knotting. Apply one coat of priming to all surface, two coats to all end grain, to be subsequently painted. Backs of all wood frames in contact with concrete, brickwork, blockwork and metalwork or similar material shall be primed before fixing. After priming all joints, holes, cracks shall be stopped and filled, rubbed down and dusted off.

12.22 **PRIMED WOODWORK**

Woodwork delivered primed shall be lightly rubbed down with abrasive paper and dusted off. Touch up bare areas with a similar priming including open grained ends. After touch priming all joints, holes, cracks and open grained ends shall be stopped and filled, rubbed and dusted off.

12.23 **PLYWOOD AND BLOCKBOARD**

Edges of exterior plywood and blockboard shall be sealed with two coats of aluminium primer and the backs treated with a lead primer.

SPECIFICATIONS: PAINTING AND DECORATING

PART I2: PAINTING AND DECORATING

12.24 **CLEAR FINISHED WOODWORK**

All woodwork scheduled to receive a clear finish shall be well sanded with the grain removing all dirt etc. to give as smooth a surface as possible. Resinous timber shall be swabbed (mopped) down with white spirit and dried thoroughly. Split or end grain shall be filled with suitable filler recommended by the lacquer manufacturer, in accordance with their instructions and of the appropriate shade.

12.25 **BARE METALWORK**

Bare metalwork shall be thoroughly cleaned of all dirt, grease, rust and scale by means of chipping, scraping and wire brushing, particular attention should be given to the cleaning of welded, brazed and soldered joints. Wash down with white spirit and dry with clean rags. Apply a coat of metal primer immediately the cleaned surfaces have been approved by the Architect.

12.26 **GALVANIZED METALWORK**

Galvanized metalwork scheduled for painting shall be thoroughly cleaned of dirt, grease dusted and washed down with white spirit and wiped dry with clean rags. Any minor areas of rust shall be removed by wire brushing and spot primed with a zinc rich primer. Apply at least one coat of calcium plumbate primer to all surfaces subsequently to be painted.

12.27 **PRIMED METALWORK**

If the priming coat of pre-primed metalwork has suffered damage in transit, or during erection on site, the affected areas shall be cleaned off by wire brushing, abrading and dusting off, the bared patches touched up with a primer of a similar type to that already applied.

12.28 **COPPER**

Copper scheduled for painting shall be lightly abraded with emery cloth, washed with white spirit and wiped dry with clean rags. Apply a coat of the primer immediately the cleaned surfaces have been approved.

12.29 **BRICKWORK, CONCRETE ETC.**

All brickwork, blockwork, concrete, rendered and plaster surfaces scheduled to be painted shall be brushed down, all holes and cracks filled, all projections such as plaster or mortar splashes etc. removed to leave a suitable dust free surface. All traces of mould oil shall be removed from concrete surfaces by scrubbing with water, detergent and rinsing with clean water. All these surfaces shall be thoroughly dry before any primer and paints are applied. Apply a coat of alkali resisting primer where surfaces are to be finished with oil paints or alkalyd resin type emulsion.

Asbestos cement surfaces scheduled for painting shall be brushed down to remove powdery deposits and a coat of alkali resisting primer applied where such surfaces are to be finished with oil paints or alkalyd resin type emulsion.

SPECIFICATIONS: PAINTING AND DECORATING

PART I2: PAINTING AND DECORATING

12.30 **COLOURS**

The colours will be selected by the Architect from the paint manufacturer's standard colour range.

12.31 **TOXIC WASH**

Concrete, blockwork, plaster and timber surfaces which are to be painted shall be washed down prior to painting with a toxic wash applied by brush or spray. A second wash shall be applied two days after the first wash. The surfaces shall be allowed to dry out completely before application of paint.

12.32 **PROTECTION**

Proper care must be taken to protect surfaces while still wet by use of screens and wet paint signs where necessary.

12.33 **DAMAGE**

Care must be taken when preparing surfaces, or painting etc. not to stain or damage other work. Dust sheets and covers to the satisfaction of the Architect shall be used to protect adjacent work. Any such stains or damage shall be removed and made good at the Contractor's expense.

12.34 **CLEANLINESS**

All brushes, tools, pails, kettles and equipment shall be clean and free from foreign matter. They shall be thoroughly cleaned after use and before being used for different colours, types or classes of material. Painting shall not be carried out in the vicinity of other operations that may cause dust. Waste liquids, oil soaked rags etc. shall be removed from the building each day. Waste liquids shall not be thrown down in any sanitary fittings or drains.

12.35 **PERFORMANCE**

If, while the work is in progress, the paint appears to be faulty, such as consistency of colour, drying time, or quality of finish, the work shall be stopped at once and the manufacturer consulted.

The manufacturers of the materials shall be given every facility for inspecting the work during progress in order to ascertain that the materials are being used in accordance with their directions, and to take samples of their products from the site if they so desire for tests.

The finishing coats of the various paints or surface finishings shall be free from sags, brush marks, runs, wrinkling, dust, bare or starved patches, variations in colour and texture, and other blemishes.

When the work has been completed, the finished surfaces shall not be inferior in quality. Colour and finish to the samples approved by the Architect and imperfections in manufacture shall not be apparent through these finished surfaces.

SPECIFICATIONS: PAINTING AND DECORATING

PART I2: PAINTING AND DECORATING

12.35 **PERFORMANCE**

In the event that the Architect is not satisfied that the quality of finish does not comply with the required standards and/or the sample panel, the Contractor will be required to repaint at his own expense, such work to the satisfaction of the Architect. If in the opinion of the Architect it is necessary to remove completely the unsatisfactory paintwork, this shall also be done under the direction of the Architect and at the expense of the Contractor.

12.36 **PACKAGING, DELIVERY AND STORAGE**

All paints and surface coatings shall be delivered in sound, sealed containers, labelled clearly by the manufacturers, the label or decorated container must state the following:

a) The type of product.
b) The brand name and colour
c) The use for which it is intended
d) The manufacturer's batch number
e) The B.S number if applicable
f) All labels shall be printed - containers bearing type written labels will not be acceptable.

Materials shall be stored under cover in accordance with the manufacturer's instructions and with local fire and safety regulations. The store itself must be maintained at a temperature of not less than 50 degrees F (10degrees C) and must not be subjected to extreme changes of temperature.

The batch deliveries are to be dated and used strictly in order of delivery.

12.37 **VINYL EMULSION PAINT**

Surfaces to be painted shall receive one mist coat followed by two final coats of vinyl emulsion paint.

12.38 **GLOSS FINISH PAINT**

Surfaces to be painted shall be primed then painted with two undercoats followed by one coat gloss finish paint.

12.39 **CLEAR POLYURETHANE VARNISH**

Surfaces to be clear varnished shall be treated with two coats polyurethane varnish.

12.40 **TEXTURED COATING**

The manufacturer's instructions concerning application of the coating are to be strictly followed under the direction of the Architect.

All surfaces to receive textured coatings are to be clean and dry with surfaces scraped and brushed before application of the coating. Application of the coating is to be with textured roller fibre brush as directed by the Architect with a minimum spreading capacity of 1 kilogramme per square metre. Under no circumstances is the coating to be thinned.

SPECIFICATIONS: ELECTRICAL INSTALLATIONS

PART 13: GENERAL ELECTRICAL SPECIFICATIONS

13.0 GENERAL

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

13.0.1 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.

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

Materials and apparatus supplied by others for installation and connection by the Sub-contractor shall be carefully examined on receipt. 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.

13.0.2 Regulations and Standards

The Sub-contract Works shall comply with the current editions of the following:

a) The Kenya Government Regulations.

b) The United Kingdom Institution of Electrical Engineers (IEE) Regulations for the Electrical Equipment of Buildings.

a) The United Kingdom Chartered Institute of Building Services Engineers (CIBSE) Guides.

d) British Standard and Codes of Practice as published by the British Standards Institution (BSI)

e) The Local Council By-laws.

f) The Electricity Supply Authority By-laws.

g) Local Authority By-laws.

h) The Kenya Building Code Regulations.

i) The Kenya Bureau of Standards

13.0.3 Power Supply on Site

The supply voltage will be 240 volts single phase of 415 volts 3 phase 50 Hz. TN-S system, viz. separate neutral and protective conductor throughout the system.

13.1 INSTALLATION OF CABLES

13.1.1 General

Bending of cables shall be in accordance with table 52c of the IEE Regulations and no cable shall be bent to radius less than that specified by the cable manufacturers.

Cables shall be rated for the maximum connected load with due consideration to the following factors:-

(i) Voltage drop not in excess of 4% of the nominal voltage.

(ii) Ambient temperature.

(iii) Degree of excess-current protection.

(iv) Grouping.

(v) Cables run under defined conditions.

13.1.2 Cables in conduits and Trunking

All cables shall be polyvinyl chloride (PVC) insulated to BS 6604, "PVC-insulated cables (non-armoured) for electric power lighting", 450/750 volt grade, unless an alternative is specified elsewhere in the contract documents. The quality and size of cables contained in any one conduit shall comply with IEE Regulation 529-7 and Appendix 12.

No cable with a cross-section area of less than 1.5mm^2 shall be used. All cables installed in a conduit or trunking system shall be PVC single insulated conductors and shall be colour coded in accordance with the IEE Regulation 524-3 and Table 52A.

Final sub-circuits shall be run in conduits separate from main or sub-main cables. All cables in conduit shall be drawn in simultaneously. All cables shall be drawn in without the use of excessive force, without the use of lubricants and the wiring shall be easily withdrawable.

13.1.3 PVC/SWA/PVC Cable

These cables shall comprise copper conductors unless specifically detailed otherwise, laid up with PVC fillers bedded with an extruded inner PVC sheath, armoured with a single layer of galvanized steel wires, aluminium or strip as specified, and covered overall with PVC sheath.

Cables shall be manufactured to BS 6346 "PVC insulated cables for electrical supply" with conductor dimensions and resistances in accordance with BS 6360 1969, "copper conductors in insulated cables and cords", Armouring shall be galvanised steel to BS 1442.

Attention is drawn to Chapter 52 of the IEE Regulations and Appendix 9. Where the armour wires of cables are used to provide protective conductor they shall comply with the requirements of Chapter 54 of the IEE Regulations, particularly section 543; alternatively, additional cables with copper conductors shall be installed to reduce the impedance to a level which ensures compliance with Section 543 of the IEE Regulations.

Unless permission is given by the Engineer, no joints will be allowed. In the event of joints being authorized, they shall be made using plastic boxes of approved design filled with an approved cold pouring plastic or resin compound. The cable box shall incorporate suitable copper tapes and clamps to bond the armouring of the jointed cables.

The PVC/SWA/PVC cables should be terminated in the cable manufacture's approved glands. These shall be of the compression type providing controlled radial compression of the sheath seal. The gland shall incorporate an armour clamping ring and earthing ring and, where used outdoors, a lead washer shall be used to ensure a watertight joint between the gland and the unit to which it is fitted. The earthing ring shall be rigidly fixed to the item of equipment and terminated using brass nuts, bolts and washers. All gland terminations shall be protected by a PVC shroud which shall fit tightly over the cables.

The electrical Sub-Sub-Contractor is responsible for determining the true nature and extent of cable routes. No claim on the grounds of lack of knowledge will be entertained. All cable routes shall be agreed with the Engineer. After the cables have been installed and terminated, but prior to putting into service, they shall be subjected to an insulation test of 500 volts and the results of these tests (recorded on test sheets) forwarded to the Engineer.

13.2 CONDUIT AND CONDUIT FACILITIES - MILD STEEL CONDUIT SYSTEM

13.2.1 Conduits

Conduits shall be installed as required by the IEE Regulations and as detailed in this specification.

All metal conduits must be heavy gauge, seam welded, steel tube screwed conduits manufactured to BS 31, "steel tube screwed conduits and fittings for electrical wiring", Class B, BS 4568, "Steel conduit and fittings with thread of ISO form for electrical installation", for metric conduit, unless specified otherwise. Conduits shall be finished black stove enamelled, except in positions exposed to water (other than water used in construction), steam condensation or the action of weather, where hot galvanised conduits shall be used.

Any conduits work rejected by the Engineer shall be replaced at no extra cost. No conduit smaller than 20 mm in diameter or longer than 50mm diameter shall be used.

All bends in conduit shall be in accordance with the IEE Regulation 529-5, and made in a conduit bending machine fitted with a former of the correct radius for each conduit size.

Conduits shall be secured in an efficient pipe vice whilst being screwed. Conduit system shall be installed so as to ensure compliance with requirements of IEE Regulations 529-7. Attention is drawn to Appendix 12 of the IEE Regulations.

13.2.2 Conduit Fittings

Conduit fittings shall have same finish as the conduits being used and shall comply with BS 31 or BS 4586. All conduit fittings shall be screwed or loop-in malleable iron circular type, fitted with covers secured by brass screws. Rectangular adaptable steel boxes may be used on multi-conduit runs.

All circular type boxes must be fitted with long screwed spout conduit entries with the screwed thread terminating within the spout and the edges of the internal orifice of the box rounded and smoothed to act as a bush except for the adaptable steel rectangular

boxes and loop-in conduit boxes, in which case male bush and coupling must be used for conduit connections. In concealed installation, boxes shall be fixed with the rims flush with the finished surface, but when, for any reason whatsoever, the rims are below the surface, suitable extension rings of the required depth shall be provided and installed to finish flash with the surrounding surfaces and with the lids of sufficient

oversize (7.5 mm minimum all round) to cover the junction between box and plaster. In no case will the use of site-manufactured bends, sets, elbows, inspection elbows or tees be permitted.

13.3.3 **Fixing of Conduits**

All conduits must be firmly and rigidly fixed to be entirely without whip or movement. Space-bar saddles, or strap saddles, must be used on the timbers in roof spaces and will be allowed when the conduits are run on the underside of exposed unsealed floor or ceiling joints. Pipe hooks or crumpets will not be allowed except for security conduits in chases, or screeds, when the top of the hook must at least be 10 mm below the finished surface of the wall, or 25 mm below the floor finish. Pipe hooks shall be galvanised.

The finish of the saddles must in all cases conform to the finish of the supported conduits. Galvanised, sherardised or cadmium plated screws shall be used in all cases where galvanised conduits are installed.

The standard cast iron distance saddle, (single fixing base and two-screw fixing top), must be used for all conduits run on the surface of walls and ceilings etc., fixed at intervals of not more than 1.2 metres.

13.3.4 **Conduit Runs and Concealment**

The routes of the conduit installation shall be agreed with the Engineer prior to commencing the installation. Conduits shall be installed atleast 150 mm from, and preferably under, any hot water pipes and atleast 50 mm from other surface pipes and cables. Conduits shall be bonded to other surfaces in accordance with the requirements of IEE Regulations 413-2 and 547-4 to 547-7 inclusive.

Each continuity test shall be applied to the system before plastering, screeding, or casting of concrete is commenced. Surface work will be allowed where certain pre-fabricated methods of construction preclude the concealment of the runs, and or fair-faced brickwork or block work or other unplastered walls.

Conduit runs shall be planned to obviate the need for draw-in boxes, but where the use of such boxes is unavoidable they shall be accessible at all times and be fitted with covers. When Conduits are specified as being installed on the surface the runs must be arranged to render the whole system as neat and inconspicuous as possible, having regard to the existing architectural features. All vertical and horizontal runs must be taken where conduits converge and run together near distribution centres to obtain a symmetrical layout. The distance between the conduits shall be maintained through bends and sets and shall not vary noticeably.

13.3.5 Flexible Metallic Conduit

Flexible Conduit shall comply with the BS 731 part 1. "Flexible steel conduit and adaptors for the protection of electrical cables." It shall be used for the final connection from a rigid conduit installation to the terminal boxes of all the equipment provided with a means of positional adjustment and /or where vibration may reasonably be expected to occur.

Flexible conduits shall be PVC sheathed and shall be terminated using approved glands. In all instances a separate PVC insulated green and yellow coloured protective conductor complying with table 41A1 or 41A2 and section 543 of the IEE Regulations shall be installed, terminating at each end into purpose-made earthing terminals.

Under no circumstances will flexible conduits be accepted in lieu of sets and bends in a rigid conduit installation.

In normal circumstances flexible conduits shall have a minimum length of 300 mm and a maximum unstretched length of 800mm. It shall permit a full range of withdrawal, adjustment or movement of the equipment.

13.3.6 Locking, Bushing and Coupling

All conduit ends must be filed square and rearmed before erection to ensure freedom from internal burrs and roughness.

Running couplings shall only be used on black enamelled steel conduit installations, and the use of this shall be kept to the minimum. All running couplings shall be secured by means of the lock nuts or lock rings, and the exposed thread painted after installation.

Every conduit connection to the equipment, boxes, distribution boards, loop-in boxes, cable trunking etc, shall be made by means of a screw coupling and a male hexagonal headed smooth bore brass bush. The smooth bore shall be fitted to secure the conduit to the item connected via a purpose-made clear hole to be closed by the bush and coupling when fitted. Paint must be removed from the surface of the item connected to allow it to be covered by the end of the coupling which shall be filed, clean and square, to ensure a good mechanical and electrical metal to metal joint. Any exposed

area of metal from which paint has been removed must be made good in a matching paint. Bushes shall be fitted and tightened by means of correctly fitting spanners. Mutilated bushes damaged whilst being fitted must be removed and replaced.

Conduits connecting via couplings shall be connected by a means of 15 mm long threaded section and shall have a gap of approximately 2 mm between them. No thread shall be exposed except running couplings.

13.3.7 Continuity and Earthing

The whole of the conduit installations shall be mechanically and electrically sound and continuous throughout their length in accordance with the IEE Regulations.

Where the conduit system is used to provide a protective conductor it shall comply with the requirements of Chapter 54 of the IEE Regulations particularly Section 543; alternatively, a separate protective conductor shall be installed in the conduit to comply with Section 543 of the IEE regulations.

13.4 CABLE TRUNKING-SHEET STEEL

Trunking shall only be installed in situations which will remain readily accessible throughout the life of the buildings. No cable trunking shall be installed behind a plastered ceiling or in other inaccessible situations.

All cable trunking shall comply with BS 4678, part 1 "Steel surface trunking" and part 2 for "Steel underfloor (duct) trunking".

Sheet steel cable trunking may be used on installations employing steel conduits, for connecting two or more switchboards together or where several conduits would otherwise have to run alongside each other. Proper allowance should be made for the derating of cables installed together in a container system. The cables must be capable of carrying the current imposed by the equipment connected. Attention is drawn to Chapter 52 of the IEE Regulations, particularly Section 522, and Appendix 9: the current carrying capabilities of cables indicated shall not be exceeded. The Engineer must be consulted as to precise details concerning trunking routes and applications.

All lengths of trunking shall be heavy gauge zinc coated steel connected together by internally fitted rectangular couplings of sufficient width to provide a minimum bearing face of 25mm, to which the lengths shall be bolted on site or welded at the factory.

Adequate provision shall be made to allow for expansion.

All Tee pieces and bends shall be formed with similar means of connection and the inner radii area shall be such that cables will not be bent through a radius less than that prescribed in the IEE Regulations. Only bends and tees of approved pattern will be accepted.

All fixing screws within the trunking shall be of the round head type. The trunking shall have an over-lapping well-fitted lid securely fixed to the trunking by approved means that will avoid damage to the cables. Self-tapping screws shall not be used.

All necessary accessories including long sleeve couplings, end piece, bends, sets, tees, reducers, branches, fillets, pinracks, cable retainers etc., shall be purpose-made units rather than being fabricated on site.

Where a change in direction of trunking run occurs, the deviation should be effected by a purpose-made unit manufactured on similar lines to the bends and tee pieces described above. Where this is not practical, changes in direction shall be fabricated in a neat workmanlike manner. All joints shall fit closely and gaps will not be permitted. All burrs and sharp edges shall be removed and no screw shall protrude into the trunking.

Trunking shall be firmly attached to its associated equipment either by bolted flanges or by male bushes and couplings.

Where trunking is connected to equipment by means of flange connectors, the entry into the equipment shall be of the same cross-section as the trunking.

Where trunking does not terminate in equipment, the otherwise open end shall be capped with a cover suitable bolted in position.

Where communications, extra low voltage circuits (category 1) etc., are contained in a trunking, the requisite number of separate compartments shall be provided to segregate the wiring. Where conduits are taken off such trunking they shall not pass through other compartments unless prior permission is obtained from the Engineer.

The entire trunking is required to be recessed in the structure of the building, the finished edge of the trunking is to be installed flush with the plasterwork.

Trunking runs shall be so arranged that the lid or cover plate is always on the top or side and not underneath, unless this cannot be avoided, in which case the Engineer's permission shall be obtained.

Wherever trunking passes through walls, vertical partitions etc., a fixed piece of trunking lid shall be fitted to the trunking extended 25 mm either side of the wall or other barrier, this is to allow removal of the adjacent lid without disturbing the building fabric. Care shall be taken to ensure that no opening is left between the trunking and the building structure through which fire might spread. In addition a suitable barrier of incombustible material shall be provide and fitted inside the trunking, in accordance with the IEE Regulations 528-1. On vertical runs of trunking internal incombustible barriers shall be fitted at the distance between floors or 5m, whichever is the less, in accordance with IEE Regulations 523-6.

All necessary trunking support work, hangers, brackets and fixing requirements shall be provided by the electrical Sub-Sub-Contractor.

Earth links of the appropriate size and type shall be installed at every jointing coupling, manufactured bend, etc., throughout the entire trunking system. Where trunking is used to provide a protective conductor it shall comply with the requirements of Chapter 54 of the IEE Regulations, particularly Section 543; alternatively, a separate protective conductor shall be installed in the trunking to comply with section 543 of the IEE Regulations.

In cases where sheet steel trunking is installed and there is danger of movement, a flexible earth conductor shall be installed bonding all joints in the trunking. This shall be fitted in addition to the standard earth links. Cable retaining strips shall be fitted at 1 m intervals. Insulated cable support pins shall be fitted at intervals of 4 m in vertical runs of trunking and at the top of the
vertical trunking.

13.5 CABLE TRAYS

Cable trays shall be formed from perforated steel of not less than 0.9 mm thickness up to and including 100 mm width - 1.25 mm thickness from 150 mm up to and including 300 mm width - and 2.00 mm thickness above 300 mm width. They shall be galvanised unless otherwise specified. Tray shall be adequately sized to support the cable without bunching.

Support shall be by means of steel brackets installed at intervals necessary to provide a rigid fixing and ensure that no undue deflection occurs in the complete installation. The brackets shall be galvanised prior to fixing. Dome-headed bolts, nuts and washers of finish suitable to the tray shall be used between tray and brackets.

Fixing to the surfaces of walls, ceilings, etc. shall be by means of expansion-type masonry plugs or bolts. Fixings shall be galvanised unless otherwise stated. Cable trays shall be installed using factory-formed bends, elbows, tees, couplers and risers etc. Site fabrication of elbows etc., will only be permitted with prior approval of the Engineer and where it is not possible to obtain the necessary factory-made item.

Where cuts have been made, the try shall be painted with zinc rich paint.

Holes which have been cut to allow cables to pass through shall be suitably bushed.

Suspension sets shall comprise threaded M12 cadmium plated hanger roads together with nuts and locking washers, verticle hanger brackets, support channel, tray hold-down clips etc., all of which shall have a galvanised finish.

All cables shall be securely fixed to traywork and the complete installation must be carries out in a neat and workmanlike manner without crossovers. A 25% reserve margin in size and weight shall be allowed for all cable tray works.

Cables of 30 mm diameter and above shall be fixed using the appropriate size cable straps of approved manufacture.

On light duty multi-cable runs, cable straps of plastic coated metal shall be used to secure cables.

Bunching of cables will not be permitted.

Cables shall be clipped by means of copper or brass saddles and clips where high temperature or humid conditions are likely to be experiences. In all cases, saddles, clips, straps, etc., shall be fixed to the tray by means of brass screws or bolts and nuts.

13.6 PROTECTION OF PVC/SWA/PVC CABLES

13.6.1 General

Cable routing shall be such that the maximum degree of protection against accidental damage is obtained by running cables along the inside of channels and beams, etc.

Cables shall be laid in performed trenches or duct throughout all paved areas. Ducts shall be installed for underground cables before the paving is constructed.

Cable ducts shall be sealed at both ends using materials which are resistant to any likely corrosive and insect attack in the area concerned.

All cables rising through floors and trench covers, except in switch rooms, shall be protected by a length of steel pipe which shall project at least 150 mm above the finished surface level.

The open end of the pipe shall be sealed with a suitable compound. Care must be taken that all phases of single core cables pass through the same protective steel duct.

13.6.2 Cables Direct in Ground

All excavation and backfilling of cable trenches will be carried out by the main Sub-Contractor unless otherwise specified, but the electrical Sub-Sub-Contractor shall in any case make sure that trenches are made to a depth as specified.

The electrical Sub-Sub-Contractor shall lay cables direct in the ground in the following manner:-

75 mm (3 inches) of dry fine sand shall be placed to form a bed for the cables. After cables have been laid they shall be covered with additional dry fine sand well punned over and around the cables to a level of 75 mm above the top of the uppermost cable. Mechanical punners shall not be used for this work. The electrical Sub-Sub-Contractor shall supply and install concrete cable tiles which shall be carefully placed over the cable forming each circuit.

Until all the cables have been laid in the trench and have been covered with their protective tiles, no sharp metal tools such as spades or fencing stakes, shall be used in the trench. Rollers used during laying of cables shall have no sharp projecting parts liable to damage the cables.

13.6.3 Cables above Ground

For main cable runs the cable shall be run on approved tray or ladder rack, and secured to it at intervals of not more than 400 mm horizontally and 600 mm vertically.

Cables shall be dressed together and fixed with a common saddle. If the number of cables is such as to require the tiering of cables, the number of tiers shall generally be two.

13.7 TERMINATION OF CABLES

Cables shall be terminated in accordance with Chapter 52 of the IEE Regulations, particularly Section 527.

Cables shall be terminated by one of the following methods:-

(i) The cable conductors shall be sweated into lugs of the appropriate size for the cable and equipment terminal.
(ii) The cable conductors shall be secured by compression type lugs of the correct size for the cable and equipment terminal.
(iii) The cable conductors shall be secured in pinch screw terminals.
(iv) The cable shall be secured by means of clamps.

Where cables are required to terminate at connectors, as at lighting points, such connectors shall secure all the strands of stranded cables. Care shall be taken to ensure that cables are not damaged during preparation for termination.

Cables terminating at pinch screw terminals shall be twisted together and single cables shall have the conductor doubled back to ensure adequate purchase for pinching screws.

Cables connected to lamp holders or other components at which heat is produced shall be insulated with heat resisting material capable of withstanding, without detriment, the temperature encountered.

All terminations on PVC/SWA/PVC insulated cables shall be by compression type glands of an approved design and manufacture with facilities for clamping the armouring the outer sheath of the cable.

Glands mounted outdoors shall incorporate a seal to prevent ingress of moisture into the gland, and all glands shall be fitted with a thermoplastic shroud.

Where circular terminations are to be made, these shall be completed using Ross Counterney terminals.

Where cables are terminated in "Klippon" type terminals with parallel faced jaws, the individual cores shall be terminated using the appropriate flat or hook blade crimped lugs. Where the terminal faces are concaved, the cores shall be terminated in wires pin crimped lugs.

The electrical Sub-Sub-Contractor shall avoid multiple connections under one screw or one pin. Where more than two wires are required, a common termination jumper bar shall be used.

Terminals shall be mounted on rails or supports. All internal wiring is to be clearly marked by markers.

13.8 SEGREGATION OF SERVICES

Cables of differing voltages shall be segregated so that there is no possibility of a fault in a power cable damaging any adjacent cables or imposing a different voltage upon them.

13.9 IDENTIFICATION OF CABLES

All cables shall be fitted with non-corrosive cable identification bands at each end, and at all changes of direction where they leave a group of cables. All cables cores connected to equipment having marked terminals shall be fitted with non-corrosive identification bands bearing markings corresponding to those of the terminals at both ends.

13.10 EARTHING

The whole of the metallic portion of the installation, other than current carrying parts, shall be electrically and mechanically bonded to the consumer's main earth terminal and also if applicable, to the lighting protection system or other points specified.

The installation shall be earthed in accordance with the Sixteenth Edition of the Regulations for Electrical Installation issued by the IEE, BS CP1013, "Earthing" and BS 6651' "The protection of structures against Lightning". The electrical Sub-Sub-Contractor's attention is drawn to Chapter 54 of the IEE Regulations.

A main earth terminal shall be supplied and installed adjacent to the electricity supply cable termination. The terminal shall be of ample size and capacity to suit the installation. All items of equipment, switchgear, etc., shall be bonded to this earth terminal using PVC insulated PVC sheathed cables, coloured green and yellow and sized in accordance with Tables 41A1 of the IEE Regulations. An invorine label reading **"SAFETY ELECTRICAL CONNECTION - DO NOT REMOVE"** in

engraved upper case characters not less than 4.75mm high, shall be permanently fixed immediately adjacent to or on the earth terminal.

A heavy duty copper clamp complying with BS. 951 shall be used to bond the main protective conductor to the electricity supply cable armouring or metallic sheath (where applicable the armouring and sheath shall be bonded together).

All protective conductors shall, where possible, be enclosed within metal trunking or conduit serving switchgear, distribution board etc., so as to provide mechanical protection. Where protective conductors are run on building surfaces they shall be properly fixed and supported by means of PVC coated metal saddles along selected routes.

Earth continuity between separate items of switchgear, distribution boards etc., mounted adjacent to one another shall be affected by means of high conductivity continuous copper tape, or PVC sheathed cable, coloured green and yellow, and sized in accordance with the Table 41A1 or 41A2 and Section 543 of the IEE Regulations, connecting all items to the earth terminal.

All items of switchgear, accessories, luminaries, conduits, and the outer sheaths of MICS cables, the armouring of all PVC/SWA/PVC cables together with all other items of electrical plant and equipment shall be effectively earthed by means of a protective conductor in accordance with Table 41A1 and 41A2 and section 543 of the IEE Regulations.

At every terminal point on the fixed wiring an integral earth terminal shall be provide e.g. BESA boxes, accessory boxes etc. A protective conductor shall be provided and installed between this terminal and the earth terminal on the associated switch, socket outlet, luminaire etc.

Each circuit protective conductor shall be connected to a multi-way earth terminal provided and fixed within each distribution board. The earth terminal shall be provided with an adequate number of ways such that not more than one conductor per terminal shall be installed and the earthing conductors shall be connected in the same sequence as the current carrying conductors.

All metal piped services, e.g., Heating, Water and Gas Services, metal wastes and piped services at sinks, baths and showers etc., shall be bonded to the earth terminal in accordance with the IEE Regulations 413-2.

A 50mm section of each gas and water pipe, at position close to their entry into the relevant building, shall be cleaned and made smooth. A copper earthing clamp designed to permit the connection of protective conductors shall be provided and sized in accordance with Table 41A1 and 41A2 and Section 543 of the IEE Regulations.

The clamp shall be a proprietary type or shall be fabricated from high conductivity copper strip, minimum size 40 mm x 4 mm which shall encircle the cleaned sections of the pipe. A permanent label indelibly marked with the words, **"SAFETY ELECTRICAL CONNECTION - DO NOT REMOVE"** in legible type not less than 4.75 mm high, shall be permanently fixed at the points of connections.

The final connection of bonding conductors from gas, water pipes and other services to the earthing terminal shall not be completed until earth electrode and earth impedance tests have been satisfactorily completed.

Bonding connections to pipework shall be as unobstructive as possible where practicable shall be made in service ducts or accessible voids and shall be readily on the Record Drawings. All materials and sundry item shall be provided whether or not specifically mentioned, necessary to completely and effectively earth the installation. The installation shall be fully protected against dampness and corrosion and the effect of electrolytic action between dissimilar materials. A completely permanent installation shall be provided which shall be fully accessible for regular testing and inspection.

The value of earth resistance from any point of an installation to the general mass of earth shall be low enough to ensure operation of circuit protective devices and shall in any case not exceed four(4) ohms for electrical equipment, seven (7) ohms for lighting protection. Each earthing cable shall terminate in an approved design of cable lug.

Where earth conductors are run upon structures or walls they shall be fastened by means of heavy gauge non-ferrous fasteners not more than 0.75 m apart on horizontal runs and not more than 1.2 m apart on vertical runs and to give a minimum clearance of 4 mm from the fixing face.

In the event of the electrical sub-Sub-Contractor not being able to establish a suitable earth connection to the electricity supply cable, earth electrodes shall be installed which shall be galvanised or copper clad steel extendable rods not less than 16 mm diameter and not less than 1.2 m in length. Connections to electrodes shall be made by means of solderless mechanical clamps.

To avoid corrosion, all earth system connections shall be cleaned bright and immediately covered with silicon MS4 compound or approved equal.

Earth pits, where required, shall be in accordance with the Sub-Contractor's relevant drawings, with the facility to disconnect the earth ring while measuring the electrode earth resistance.

13.11 LIGHTNING PROTECTION

Lighting protection shall be provided on high buildings/structures more than 10 m in height. such protection shall be effected by bonding each individual building/structures direct to the earthing system, in accordance with the BS CP 326, by a minimum size of 170mm^2 conductor.

13.12 FUSED-SWITCH UNITS, SWITCHFUSES AND ISOLATORS

The above units comply with BS 5419 and shall be 500 volt type and installed where specified and indicated on the relevant drawings.

All switchgear shall be provided with suitable locks for padlocking the switches in the 'OFF' position. The cover shall be interlocked with the operating mechanism to prevent it from being opened in the 'ON' position. This interlocking shall also prevent the switch from being closed with the cover open unless for maintenance purposes. The cover shall be gasketted to prevent ingress of dust.

The switch action mechanism shall be of the parallel operation (double break type having cartridge fuses mounted switches) and shall be ASTA certified to meet adequately all the duties specified.

The end plates shall be removable for drilling for conduit or cable entry and shall be fitted with additional distance pieces where necessary. Switchgear boards shall be fixed to the wall/floor by Rawl bolts or other approved fixings.

No building alteration shall be allowed when moving the switchboard into position, the switchboard being supplied in sections to be built in position, if so required.

Switchgear shall be delivered to site when required to suit the progress of the works. Care shall be taken to preserve the manufacturer's paint finish. Any refurbishing etc. shall be carried out, using paint obtained from the switchboard manufacturer, to the original standard of finish.

All fuses in switchgear shall be HRC fuses sized for the fused-switch units or switch-fuses etc., in which they are incorporated. They shall be ASTA certified for compliance with BS 88, Category of Duty 440 A.C 5 Class 01 and in all cases fuse links shall be selected to provide circuits discrimination.

13.13 CONTROL PANELS AND CUBICLES

The details specified in clause 4.11 shall apply as far as fused switches, bus-bars and rating etc are concerned. The panels shall be constructed from rolled steel channel minimum size 60 mm x 30 mm deep x 5 mm or equivalent angle section clad with sheet steel of 3 mm gauge. 2 mm gauge may be used for covers and doors of not more than 1 m square.

Terminals shall be of the "Klippon" standards rail-mounted feed-through type or approved equal. All terminals shall be identified by means of numbered or lettered marking tags, which shall be identical to the number of letter applied to the cables. Cables shall be identified as terminations by means of cable markers as manufactured by "Klippon" or approved equal. 25% spare terminals capacity within wiring duct shall be provided. All components motors, starters, relays, timbers, etc. shall be labelled showing their reference and function and these shall relate to the panels' schematic wiring diagram provided with the "As-built" drawing and manuals.

All control panels shall be fitted with multi-pole isolating switches through which all electricity supplies shall pass. The door(s) of the control panel shall not open unless the isolating switch is in the "off" position. A facility to lock the control panel-isolating switch in the "off" position shall be included.

13.14 DISTRIBUTION BOARDS

13.14.1 General

All distribution boards, unless stated otherwise, shall be miniature Circuit Breaker Distribution Boards and shall be of surface or flush type, as specified. Facilities for local isolation of the distribution boards shall be provided by either a local fused-switch unit or an integral isolating switch, whichever is specified.

Where surface mounted on a flush installation, all conductors shall terminate behind the board in an adequate box. For surface mounting, trunking shall be fixed between the board and ceiling level, or conduits run directly into the board. Adequate earth continuity connection shall be made between the various components.

13.14.2 Fused Distribution Boards

All fuse boards shall be of 500 volt rating to BS. 5486 part 11 "Particular requirements for Fuse boards". The details specified in clause 4.12 shall apply as far as cabinet and construction, cabling arrangements, bus bars, neutral bars, earthing and isolating switches are connected.

Fuse banks shall be spaced so as to obviate the necessity for insulating barriers, but protection shall be provided by means of insulating shields to prevent accidental contact with the main bus bars and connections.

All fuses lighting and heating circuits shall be of the HRC cartridge type, ASTA certified, for compliance with BS. 88, category of Duty 440 A.C 5 class 01.

13.14.3 Miniature Circuit-Beaker Distribution Boards

MCB distribution boards shall comply with BS. 5486 part 12 'Particular requirements for miniature circuits-breaker boards'. The cases shall be constructed of heavy gauge

sheet steel, in such a manner as to afford rigidity and maximum ease of wiring for full size circuit and main cables.

The cover shall be provided with an efficient gasket or alternatively designed with generous overlapping edges to prevent the ingress of dust. Components shall not be manufactured from zinc alloy in conjunction with sheet steel where they are relied upon for earth continuity.

Where the cover is required to be lockable, cylinder type locks shall be provided, having two keys per lock. All locked distribution boards shall be handed to the Engineering Supervisor on completion of the works. The cases shall be provided with detachable cable/conduit terminating plates, which shall be reversible and interchangeable from top to bottom.

All screws and nuts used in the construction of the case shall be fitted with shake proof washers and care taken to ensure efficient earth continuity. An external earthing terminal with cable socket shall be fitted.

All MCB banks shall be fitted to frames, with robust locking plates provided to ensure the frames rigidly in the fixed position.

The banks shall be so spaced to obviate the necessity for insulating barriers, but protection shall be provided by means of insulating shields to prevent accidental contact with main bus bars and incoming mains cable.

Bus-bars shall be of high conductivity, hard drawn copper conductors connected to the MCB contacts by means of spring washered screws or bolts, unless plug-in type MCBs are specified.

Neutral bars shall be similar to the main bus bars and shall have two screw terminals per way for rating of 30 amps or over. Single screw connections will be allowed for capacities up to 30 amps. The neutral bars shall have one terminal for each MCB within the board, and connection of conductors to the neutral bar shall be in the same order as the MCB ways.

Where installations are carried out with cables with a protective conductor, all distribution boards shall also contain internal earthing bars similar to the neutral bars detailed above, with one terminal for each MCB within the board. Earthing conductors shall be connected in the manner described for neutral conductors to neutral bars.

Where a main integral isolating switch is provided in an MCB case it shall be arranged to isolate incoming live and neutral main cables from the bus-bars. The isolator switch shall be rated at 500 volts and of the quick make-and break pattern with positive action. Incoming and outgoing terminals shall be fitted with two clamping screws and outgoing conductors to the bus-bars shall be high conductivity hard drawn copper rods.

Isolating switches shall comply with IEE Regulations, Part 537, and shall be capable of carrying their full rated load continuously and shall 'make' or 'break' their full rated load without undue burning of the contacts.

13.14.4 Miniature Circuits Breaker (MCB)

All MCBs shall have movements which are positive in both directions (make and break) so as to enable units to be closed decisively by the operation of the handle, and to be able to assume the 'OFF' position unless the contacts are definitely separated, to safeguard against false indications.

The hand shall be trip free to make it impossible for the operator to hold the breaker in the closed position under faulty conditions. The operating mechanism and arc chambers of the circuit breaker shall be separated from the terminals and fixing screws.

Terminal identification shall be readily discernable as viewed from the front of the board with automatic and clear signal identification for both 'ON' and 'OFF' position.

All terminals shall be readily accessible from the front and each wiring chamber shall be closed by a screw fixed cover which protects the terminals and prevents dust from settling on the insulation.`

Where the full capacity of a distribution board is not required the electrical Sub-Sub-Contractor shall fix blanking plates in the vacant MCB housings. All MCBs shall be rated at 500 volts minimum, and comply with BS 3871. "Miniature and moulded case circuits breakers" and 4752 part 1, "Circuit breakers".

13.14.5 Moulded Case Circuit Breakers (MCCB)

Where specified, MCCBs shall be of the thermal/magnetic type, having a quick make, quick break, trip free mechanism which prevents the MCCB from being closed or held against short circuits or overloads. Tripping of every multi-pole MCCB shall be such that operation ensures simultaneous action in all phases.

Clear indication shall be provide for the three positions of operation of the mechanism - 'ON', 'OFF' and 'TRIPPED'. The operation shall be such that the MCCB shall trip automatically under fault conditions and, to reset, the dolly shall require first moving through the 'off' position. All MCCBs shall be provided with facilities for locking the breaker in 'OFF' position.

All MCCBs shall be rated at 500 volts minimum, be ASTA certified for this operational duty, and comply with BS. 3871 and BS. 4752 Part 1.

13.15 LABELLING AND ENGRAVING

13.15.1 Labelling

All fused-switch units, switch-fuses, switches, bus-bars chambers, distribution boards etc., and all items of equipment on the main panel shall be identified in accordance with section 514 of the IEE Regulations and shall have securely fitted externally a white 'Traffolyte', 'Formica' or other approved plastic laminate label engraved with 6 mm high black letters detailing the function of the equipment and any reference number.

Red, yellow, blue, plastic laminate phase discs shall be fixed inside all switchgear and distribution boards to indicate to which phase of the supply the various circuits are connected. The colourings shall comply with Part 524 of the IEE Regulations.

Each TP or TP & N item of switchgear shall have fitted on the cover a white plastic laminate label having 'CAUTION' - 415 VOLTS' engraved in 10 mm high red lettering.

13.15.2 Engraving

The electrical Sub-Sub-Contractor shall allow for engraving of all switched fused spurs, double pole switch accessories and any other accessories, which are customarily required.

The accessory plate shall be engraved in either black or red, capital letters 5 mm high, detailing and appliance or equipment being supplied by the accessory e.g., 'WATER PUMP' etc.

13.16 MOUNTING HEIGHTS

The approximate position of main switchgear, control equipment distribution boards, fittings and accessories shall be as indicated on the Drawings. Actual positions shall be determined on site by the Engineer.

Unless otherwise stated on the relevant drawings or directed by the Engineer the following mounting heights of all accessories above finished floor level shall be adhered to: -

Lighting Switches **1400 mm to centre**

Socket Outlet and Spur **300 mm to centre (or 150 mm above work top level to centre)**

Distribution Boards **1800 mm to lower edges.**

All groups of accessories shall be in line either vertically or horizontally or as specified.

13.17 LUMINAIRES

All Luminaires shall be of the manufacture, size and type specified and shall comply in all respects to BS 4533 "Electric Luminaires".

The electrical Sub-Sub-Contractor shall supply and install all luminaires including lamps, lamp-holders, control gear, capacitors, glassware, diffusers or other attachments, heat resistant internal cables, fuses and terminals and all necessary suspension gear. In case where Luminaires are supplied by the client the Sub-Sub-Contractor shall deliver to site store, install, commission and set to work.

Unless otherwise stated, Luminaires shall be suitable for Class 1 normal indoor environments, giving a degree of protection against ingress of moisture or dust.

All Luminaires shall be assembled and installed in accordance with the respective manufacturer's instructions/recommendations, in the position and mounting heights specified.

Luminaires shall not be installed under dirty and hazardous site conditions, and any damage or deterioration to luminaires installed under these conditions shall be made good by the electrical Sub-Sub-Contractor.

The Luminaires shall be cleaned free of dust and dirt after completion of the installation. Where dirt, dust, corrosion or other conditions cause imperfections in the luminaires, they shall be replaced.

Luminaires, diffusers, attachments or glassware etc., shall be properly stored to final erection, in such a manner as to avoid damage of any kind.

Luminaires fixings shall generally be suitable for direct connection to conduit boxes or as otherwise specified. Luminaires not provided with suitable BESA box shall be modified as necessary.

Where a flexible cord supports, or partly supports, a luminaire the maximum mass supported by the cord shall not exceed the values set out in IEE Regulations 523-32.

The minimum cross-section area flexible core to the employed shall be 0.75mm^2.

Specified attention shall be given to Chapter 52 of the IEE Regulations, particularly Regulation 521-5 and 521-6, Appendices 9 and 10.

Pendant tungsten luminaires shall be fitted with heat resistant flexible cord complying with BS 6500, capable of continuous operation with a conductor temperature of 150 degrees C. The cable shall be of the circular multicore type, finished white, if not otherwise specified.

Ceiling mounted tungsten luminaires, spotlights and other luminaires of the category 'hot' luminaires shall be wired internally with cable suitable for continuous operation at 185 degree C. Where cable tails are provided they shall be of the heat resistant type capable of operation at 185 degree C.

Exterior luminaires, fixed to the walls of buildings etc., shall be wired such that final circuit wiring terminates within the luminaire. All final circuit cables so installed shall be provided with heat resistant sleaves from the connection point within the luminaire for a distance of 300 mm.

All flourescent and other discharge luminaires shall be provided with an integral fused connector block. The rating of the fuse shall be in accordance with the manufacturer's instructions to protect the internal wiring of the luminaire and to provide discrimination between final circuit protection and luminaire protection.

All recessed and semi-recessed luminaires in ceilings shall be connected by three core 0.75 mm^2 high temperature flexible cord from the terminals of the luminaires to a plug-in ceiling rose fixed and connected to an accessible outlet box in the wiring system, within the suspended ceiling immediately above the luminaire. The ceiling rose shall be accessible via the opening provided in the ceiling.

The electrical Sub-Sub-Contractor shall ensure that the methods of suspension for luminaires are electrically and mechanically sound.

Luminaires suspended by means of tubes shall be fitted to ball joints allowing a swing of at least 20 degrees all round. Reliable earthing between the fixed and moving parts shall be provided by means of a flexible braided copper tape.

Fluorescent luminaires shall be provided with a minimum of two fixings, except in the case of recessed modular luminaires or surface-mounted luminaires exceeding 300 mm in width, where four number fixings (one from each corner) shall be provided by means of conduit drops or threaded rods.

Normally visible luminaires support shall be conduit. All fluorescent luminaires shall be solidly mounted with all assembly nuts, bolts and accessories made tight to prevent vibrations and noise. Anti-vibration packing shall be fitted where necessary. luminaires mounted direct to trunking shall be fixed by means of the manufacturer's recommended fixing assemblies.

Unless stated otherwise, all luminaire supports shall be fixed to the building primary structure. Luminaires shall not be supported from suspended ceiling unless otherwise specified. The electrical Sub-Sub-Contractor shall be responsible for mounting and fixing arrangements.

Break joint rings of approved colour shall be provided for all suspended luminaires and fluorescent battery luminaires where the batten is of insufficient width to cover completely the conduit box and its associated clearance hole in the ceiling.

The metalwork of all luminaires shall be effectively bonded to the earthing system in accordance with Chapter 54 of the IEE Regulations.

Care shall be taken to ensure that the internal wiring of luminaires and the cable of any fixed wiring shall not be in contact with high temperature areas in luminaires.

Lighting track shall be of the type, size, finish, number of circuits and manufacture specified and shall comply with the requirements of the relevant section of BS. 4533. The positions of luminaires as shown on the Drawings are approximate only and exact position shall be determined after reference to the Engineering supervisor.

13.18 CEILING ROSES

Surface mounted ceiling roses shall be of all insulated, high impact moulded plastic construction complying with BS. 67 and shall be suitable for direct attachment to conduit outlet boxes. Recessed or semi-recessed ceiling roses shall be manufactured from porcelain. Break joint rings shall be provided when used on flush conduit outlet boxes.

Ceiling roses shall not be connected to fixed wiring in such a manner that one of the terminals remains 'live' when the associated switch is in the 'off' position, unless that

terminal is inaccessible to touch when the ceiling rose cover is removed, e.g. for replacement flexible cord.

Terminals shall be provided for switched live, neutral and protective conductors. Loop-in facilities shall also be provided.

13.19 LAMPS

Lamps shall be compatible with the luminaire for which they are intended and shall be of the wattage, type and colour specified. Lamps shall be of the correct voltage rating for the particular electricity supply concerned.

Tungsten filament lamps, unless otherwise specified, shall be of the 'PEARL' type and of the long-life type giving 2000 hours average life.

Luminaires designed to accommodate lamps with reduced physical dimensions shall be fitted with lamps of the mushroom type of approved equal.

13.20 EXTERNAL LIGHTING

External lighting system shall comprise the lighting points at the position shown on the Drawings and shall include the provision, erection and connection of all lighting columns, bollards, wall and ceiling luminaires and the provision and connection of all control gear together with the laying, jointing and connection of all necessary cables.

All excavation, trenching, backfilling etc., will be undertaken by the main Sub-Contractor.

All lighting columns shall be of the type specified, suitable for looping in and out three No.2 Core PVC/SWA/PVC cables of the specified size.

Where discharge lamps are specified the associated controlgear shall be mounted in the base of the column above the fused 'cut out', all on a timber board housed within the base of the column.

Each lighting column/bollard shall be completed with all adaptors, spigots, mounting brackets, luminaires, controlgear and lamps and shall be provided with a base compartment and locking door.

All column/bollards shall be fixed in the position specified.

Cable routes are shown on the relevant drawings and the electric Sub-Sub-Contractor shall lay the lighting cables in the trenches.

All connections shall be made in an approved manner, and the installations shall be finished complete and handed over in working order to the full satisfaction of the Engineer.

13.21 LIGHTING SWITCHES

Lighting switches shall be of the type, size and manufacture as specified.

Wall and ceiling switches shall comply with BS 3676. Wall and ceiling switches controlling A.C lighting circuits shall be rated 20 amp and be of the slow break quick make, type unless stated otherwise.

Where several switches on one phase are shown at one position, a ganged box shall be used.

13.21 LIGHTING SWITCHES

Where switches at any location are connected to different phases, purpose-make phase barrier switches shall be installed. The phases shall be separated by means of rigidly fixed barriers and the cable for each phase shall be confined to the area enclosed by the barriers for that phase.

Switches connected to a particular phase shall have separate cover or covers fitted over each phase. The covers shall be engraved "CAUTION 415 VOLTS".

The switch plate of the specified finish shall be fitted over phase covers to render the switch unit indistinguishable from the switches that are not phase barrier switches.

Alternatively, each gang shall have its own piping and box for each phase, physically separated from other phases with similar arrangements.

For flush position on a plastered or equivalent finish wall, the switches shall have overlapping plates.

In any places where the finish is fair-faced brickwork, the wiring shall be installed on the back of the wall and make a back entry into the accessories. Each switch in these areas shall be neatly recessed and incorporate an overlapping plate.

For surface-mounted positions and such Plant Rooms, Electrical Switch room etc., employing a surface-mounted system or wiring, switches shall be surface-mounted, having metal front plates of an aluminium finish, mounted in matching metal boxes.

13.22 SOCKETS OUTLETS

All socket outlets and plugs shall be supplied and installed in accordance with the manufacture, type, sizes and finish specified.

All round pin 2A ,5A, 15A,and 30A socket outlets shall comply with the requirements of BS 546.

All sockets outlets shall be switched, unless otherwise specified.

All switched sockets outlets shall be complete with steel boxes of the same manufacture, complete with earth terminal.

Assemblies shall comply fully with the requirements of the IEE Regulations concerning the bonding of protective conductor terminals and each such terminal shall be connected by a conductor, having a minimum cross-sectional area of 2.5 mm^2, to a permanent earthing terminal incorporated in the associated box providing an effective, solid connection to the earth continuity conductor of the installation.

Where the assembly does not provide a reliable electrical contact between the cover plate and box with effective connection of metal operating bars and toggles, then an insulated earthing lead shall be provided, solidly connected to the metal plate and operating bar or toggle and terminating at the fixed earthing terminal incorporated in the associated box. 13 amp sockets will generally be installed using ring circuits in accordance with Appendix 5, Table 5A of the IEE Regulations.

All plugs shall be of mounded rubber or other resilient material complying with BS 1363 or BS 546. The plug shall have internal cord grip. 13 amp plugs shall be fitted with cartridge fuse links to BS 1362. The fuse rating shall be selected to give protection to the flexible cord or cable connected.

All fuses installed within 13 amp plug top, fused spurs, clock connections etc., shall be cartridge fuse links rated at 240 volts, ASTA certified for compliance with BS 1362 'General purpose fuse links for domestic and similar purposes', or BS 464 'Cartridge fuse links (rated at up to 5 amperes) for AC and DC service', or BS 2950 'Cartridge fuse-link for telecommunications and light electrical apparatus'.

All equipment, which is locally fused, shall have fitted fuses with characteristics, which are recommended by the manufacturer of the equipment.

If any appliance or equipment suffers due to incorrect fusing of the appliances, such appliances or equipment shall be repaired or replaced at the electrical Sub-Sub-Contractor's cost, to the satisfaction of the Engineer.

13.23 INSPECTION AND TESTING

A visual inspection shall be made in accordance with IEE Regulations 612-1. References shall be made to appendix 14 of the IEE Regulations, which is a checklist for initial inspection of installations.

The electrical installation shall be inspected and tested by the electrical Sub-Sub-Contractor in accordance with part 6 of the IEE Regulations.

Where any part of installation is to be concealed within a building, fabric tests shall be made to ensure that the installation is satisfactory prior to concealment.

Upon completion of the works the whole installation shall be subjected to the tests detailed hereafter and every defect shall be noted, corrected and brought to the notice of the Engineer.

All tests shall be witnessed by the Engineer to his full satisfaction and he shall be given at least one week's notice in writing of the proposed tests.

All labour and test instruments shall be provided by the electrical Sub-Sub-Contractor and the instruments shall be correctly calibrated and certified for the limits of accuracy required and shall be operated by competent person. If, in the Engineer's opinion, a particular instrument is not suitable, then an acceptable alternative shall be provided. The Engineer shall be at liberty to demand the use of any testing instrument or apparatus that he may reasonably consider to be necessary in the execution of the testing.

In the event of the installation failing to pass the test, the Engineer has the full authority of the Employer to deduct from the Contract Price all reasonable expenses incurred, due to him being required to attend a repetition of the test.

The following items, where relevant, shall be tested in the sequence indicated. Standard methods of testing, in respect of some of the following regulations of this section, are given in Appendix 15 of the IEE Regulations.

i) Continuity of ring final circuit conductors.

ii) Continuity of protective conductors, including main supplementary equipotential bonding.

iii) Earth electrode resistance.

13.23 INSPECTION AND TESTING

iv) Insulation resistance.

v) Insulation of site-built assemblies.

vi) Protection of barriers or enclosures provided during erection.

vii) Insulation of non-conducting floors and walls.

viii) Polarity.

ix) Earth fault loop impedance.

x) Operation of residual current devices and fault voltage operated protected devices.

Upon completion of all tests and commissioning, two copies of detailed certificates shall be provided by the electrical Sub-Contractor to show that the equipment, materials, installation etc., have been tested and commissioned. One copy of each, duly completed and signed shall be submitted to the Engineer within 154 days of the results being obtained. The second copy of the certificates shall be retained to be included with operator and maintenance manuals.

The results of the test and details of completion for the electrical test shall be detailed on the Test and Completion Certificates respectively; issued by the National Inspection council for Electrical Installation Contracting or other approved authority.

13.24 AS BUILT DRAWINGS, AND DOCUMENTATION

Within one month of the date of completion the electrical Sub-Contractor shall provide 3 prints of all electrical drawings showing the electrical installations "As built". In case the electrical Sub-Contractor fails to provide "As Built" drawings as required, these will be prepared by others at the expense of the electrical Sub-Contractor.

APPENDIX 1

SUPPLEMENTARY SPECIFICATION FOR PVC INSULATED CABLES

AND NON-METALLIC CONDUITS WIRING SYSTEM.

1. PVC 1 CABLE

The wiring shall be carried out in 250-volt grade or 440 volt grade for 3-phase PVC Insulated cable, as specified elsewhere run in non-metallic conduit. The cable shall be of the sizes specified on the drawing.

2. INSTALLATION OF WIRING

Cable shall be drawn into accessories, distribution boards and switchgear after the erection of the conduit system. Under no circumstances shall it be permitted to draw cable into an incomplete section of the conduit installation.

3. JOINTS IN CABLES

The wiring shall be carried out on the looping-in principle. All joints shall be made at the terminals of main switches, distribution boards, ceiling roses, switches and socket outlets, etc. and fixed apparatus only. No joints shall be made in boxes unless approved.

4. CAPACITY OF CONDUITS

The cable shall run in the conduit so as not to exceed the capacities as set out in Table 10 of the IEE Regulations (13^{th} Edition with current amendments).

Conduits shall be best quality new super high impact grade heavy gauge 'A' riding PVC unplasticised conduits as manufactured by Egetude limited suitable for plain connections.

Conduit of sizes less than 20 mm shall not be used without the written authority of the D.R.

5. BENDING

The conduit shall be bent and formed strictly in accordance with the manufacturer's instructions: -

i) Small size, i.e. 20 and 25 mm shall be bent cold by inserting the correct size bending spring. It is essential for right angle bends that the conduit is bent past 90 degrees to allow for "spring back".

ii) Large size of conduit shall be pre-heated before inserting rubber cord to prevent kinking. Conduit badly formed or bent or damaged in any way, shall not be used.

6. JOINTING

Joints shall be made water-tight by the use of 'Egaweld' cement applied with a brush or rug. 'Egaweld' shall be applied to the complete circumference of conduit. Conduit shall be thoroughly cleaned at the ends to ensure a good adhesion of the fittings. 'Egaweld' shall not be permitted to enter into the conduit.

7. CONDUIT FITTINGS
8.

All conduit fittings and accessories, including couplers, ordinary clips, saddles, pipe hooks, reducers, stopping plugs, lockouts and male and female bushes shall be manufactured dimensionally, similar to B.S.S. 31/1940. Solid tees shall not be used . Solid inspection elbows or bends or inspection tees shall be used only in exceptional circumstances and then only with D.R.'s approval.

Where it eases the installation of cast-in-situ back entry boxes on the loop-in system, purpose made bends manufactured by Egatube and comprising a tight bend with a push socket at one end and a threaded socket at the other end may be used with the D.R.'s approval.

8. FIXING OF CONDUITS

Conduit shall be installed on the loop-in system and shall either be cast-in-situ in the main concrete structure, concealed in chases cast in concrete walls, or chases cut in solid partition walls, run in ceiling spaces or in hollow partitions of floors, or concealed below the floor screed, whichever shall prove to be the most suitable method of installation for use in the building under construction. Unless it is clearly specified or shown on the drawing, the method of installing conduit shall be subjected to the approval of the D.R.

Sunken conduit run in chases in walls shall be fixed by means of mild steel pipe hooks or non-metallic saddles spaced not more than 1 m apart. Where conduit is concealed behind plaster it shall be sunk to a depth of either 10 mm below finished plaster level, or installed flush with the structural wall level before application of plaster, whichever is the lesser depth.

8. FIXING OF CONDUITS

Conduit fixed on the surface of walls or ceiling shall be fixed by spacer bar saddles fixed not more than 1 m apart.

Surface conduit shall also be fixed 230 mm on both sides of all boxes, the box itself securely fixed. Where such an arrangement of boxes and saddles would prove to be both unsightly and unnecessary, short lengths of conduit not exceeding 1 m in length between boxes need not be secured further than by connection to the adjacent boxes. In such cases the D.R. reserves the right to insist upon additional fixing being provided, should he for any reason whatsoever consider such additional fixing necessary.

Where two or more lines of conduit run parallel to each other, on the surface of walls, etc., the distance between them shall not be less than 15mm and conduits shall not cross.

Conduit shall be installed in such a manner as to prevent interference with other services and shall be kept at least 180 mm clear of gas or water pipes, and heat in excess of 68 degrees C.

A means of expansion shall be provided in conduit runs in excess of 6 m without any bend or set, by use of 'Egetude' expansion couplings, which shall also be used at building expansion joints.

Conduit cast-in-situ shall be frequently secured to the steel reinforcement work, with heavy binding wire to prevent movement of the conduit and conduit boxes during the pouring and vibrating of the concrete. Outlet boxes shall be securely fixed to the shuttering with nails, or by means, which shall be visible as a marker on removal of the shuttering only where marks can be concealed. Conduit shall be installed after the first grid of steel reinforcement work is securely fixed and all open ends of conduits shall be protected by couplings plugged with a suitable non-metallic stopping plug. The number of right angle bends in conduit cast-in-situ shall not exceed two between boxes.

Immediately prior to installation the wiring all conduit and fittings shall be dried and cleaned out by drawing through a cloth swab. Rawl plugs shall be used for fixing to brickwork, self-tapping screws for fixing to aluminium section, raw nuts, raw-anchors spring toggles, gravity toggles or rawlbolts, shall be used for fixing to other materials as approved by the D.R.

Corners shall be turned by easy bends or sets made in accordance with the manufacturer's instructions without altering the section or splitting conduit.

9. CIRCULAR INSPECTION

Boxes will not be permitted in floors unless approved. Boxes cast-in-situ must face downwards from the ceiling/floor section. Small standard circular non-metallic conduit boxes, conforming dimensionally with B.S. 31/1940 with standard circular non-metallic (4mm) lids and nylon fixing screws, shall be provided and fixed at all junctions.

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

Where ceiling roses occur and the ceiling box is recessed below the finished level of the ceiling, suitable extensive rings to accommodate the ceiling rose must be provided. Where ceiling boxes, including extension rings, are flush with the ceiling surface, break joints rings shall be provided to hide the joints.

Where a non-metallic outlet box of thermoplastic material is used for the suspension of a lighting fitting, care shall be taken to ensure that the temperature of the box does not exceed 60 degrees c. The weight suspended from the box shall not exceed 3 kg.

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

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

Conduit and trunking shall be mechanically and electrically continuous. Conduit shall be tightly screwed between the various lengths so that they butt at the socketed joints. The internal edges of conduit and all fittings shall be smooth, free from burrs and other defects. Oil and other insulating substance shall be removed from the screw threads. Where conduits terminate in fuse-gear, distribution board, adaptable boxes, non-spouted switchboxes, etc., they shall, unless otherwise stated, be connected thereto by means of smooth bore male brass brushes, compression washers and sockets. All exposed threads and abrasions shall be painted (using an oil point for black enamelled tubing and galvanised tubing immediately after the conduits are erected. All bends and sets shall be made cold without altering the section of the conduit. The inner radius of the bend shall not be less than four (4) times the outside diameter of the conduit. Not more than two right angle bends will be permitted without the inter-position of a draw-in box. Where straight runs of conduit are installed, draw-in boxes shall be provided at distances not exceeding 15 m. No tees, elbows, sleeves, either of inspection or solid type, will be permitted.

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

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

9. CIRCULAR INSPECTION

Conduits and trunking shall be run at least 150 mm clear of hot water and stem pipes, and at least 75 mm clear of cold water and other services unless otherwise approved by the D.R.

Conduits installed and buried in walls shall allow a minimum of 15 mm cover. These conduits and those cast-in-situ concrete slabs shall be given one coat of rust prevention paint before installation of conduit and before concrete is placed. Sunk

circular conduit boxes shall be provided with break joint rings of white moulded material or metal.

Surface conduit shall be run in square symmetrical lines and shall be marked on site for approval before installation. Conduits shall be fixed by means of distance saddles spaced at not more than 1.2 m for 20mm and 50mm conduit and 1.5 m for larger sizes. Conduits shall be fixed each side of conduit boxes at a distance not exceeding 250 mm, and the saddles shall be equally spaced.

Where conduit runs enter specified areas requiring flameproof equipment, barrier boxes shall be inserted immediately before the conduit enters the flameproof area.

All conduit installed within this area shall be solid drawn galvanised, as shall be conduit fittings and accessories and Buxton Certified as suitable for Group 11 Hazards. Equipment shall comply with B.S 229, B.S.S. 889, and Code of Practice C.P. 1003. In no case shall conduits from different distribution boards be connected at one box, likewise cables from different distribution boards shall not be housed in the same conduit specified.

All conduit boxes, except loop-in pattern concrete floor shall be fixed direct to the structure apart from the support provided by the conduits. Box lids where required shall be heavy gauge metal, secured by means of zinc plated or cadmium steel screws. All adaptable boxes and lids of the same size shall be interchangeable.

9. CIRCULAR INSPECTION

Boxes used in conjunction with mineral insulated copper sheathed cable boxes shall be galvanised and painted after erection.

Draw-in boxes in the floor are generally to be avoided but where they are essential they must be grouped in positions approved by the D.R. and covered by suitable floor straps, with non-ferrous tray and covers.

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

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

Where it is intended to fix enclosed lighting fittings directly to a box to suspend a fitting of weight in excess of 3 kg., Egetude steel insert clips shall be used.

10. SWITCH AND SOCKET OUTLET BOXES

All boxes intended for switches, socket outlet or other outlets shall be fitted with brass ferrules to accommodate fixing screws.

11. STOPPING PLUGS

All spare ways in junction boxes, etc., left for possible future extensions shall be fitted with the stopping plugs.

12. EARTHING

Where fittings and accessories require earthing, an earth continuity conductor be run through the conduit. The earth continuity conductor shall be a green coloured PVC insulated copper wire of

minimum size 2.5 sq. mm and shall be continuous between terminals. Where the earth terminal is formed by a brass screw and washer, "Ross Courtney" type terminations shall be used. All switch, socket outlet, ceiling boxes etc., shall be supplied with an earth terminal.

13. EARTH CONTINUITY

Each final sub-circuit that is required to be earthed shall be provided with its own individual earth continuity conductor which shall be run from a terminal on the earth

bar in the distribution board or consumer's control unit protecting any particular final sub-circuit.

SPECIFICATIONS: ELECTRICAL INSTALLATIONS

PART 14: PARTICULAR ELECTRICAL SPECIFICATIONS

14.1: GENERAL

14.1.1 The electrical Sub-Contractor shall supply labour and supply, deliver, install, fix, connect, test, label, and commission the electrical works, clean, complete and working to every detail as described in the specification and by related specifications to the satisfaction of the Consulting Engineer/Architect.

14.1.2 **Exclusions**

Excluded from this Sub-contract is:-

i) Control panels for motor-starters and internal wiring between control-panels, motor thermostat etc.

14.2 SUPPLY AND DISTRIBUTION

14.2.1 Supply and Distribution system

The power supply shall be from a ground mounted transformer located in the transformer room. The external distribution shall be effected through underground cables to run in a ducted distribution system

14.2.2 Main Switch Board

Mains power distribution is through ducts a and mainly cable trays

The schematic for main switchboard are shown on drawings, together with Transformer room details, including trenching.

All switch fuses, fuse switches, MCB's including meters shall be of reputable manufacture meeting current British and Kenya Standards as stipulated in the general specifications. Any other quality that does not strictly meet these standards shall not be acceptable.

Unless specifically stated otherwise, vertical power distribution shall be via riser (bus-bar) trunking. All incoming circuit breakers in the Main Switchboard to be motorized and set at different timings to allow for sequential loading of the standby generator. Exact trunking details to be given at the time of approving shop drawings for the main switchboard.

14.3 LIGHTING AND SMALL POWER INSTALLATIONS

14.3.1 INSTALLATION SYSTEM

With the exception of where otherwise noted on the drawings, the installation shall throughout be carried out in PVC insulated copper cables of not less than 1.5 mm^2 copper drawn in high grade PVC conduit.

14.3.2 LIGHTING CONTROL SYSTEM

Indoor Lighting

Types of accessories and fixed apparatus to be used shall be as manufacture MK or Crabtree. Subject to the approval of the Engineer equivalent makes may be used. All light fittings to be of manufacture shown on the detailed descriptions, or approved equivalent.

14.3.4 CONNECTIONS TO FIXED APPLIANCES

The Sub-contractor shall supply and interconnect flexible cords between spur units/outlets boxes and the appliances where the symbols for flex connections are shown.

All connections shall be made by white heat-resisting PVC flexible cords having fuse rating in accordance with the respective circuits subjected to a minimum of 0.75mm^2.

14.3.5 MOUNTING HEIGHTS AND LOCATIONS

All mounting heights stated shall mean the heights from finished floor level to underside of the accessory.

Each mounting heights for wall fixtures shall, however, be re-confirmed on site.

14.3.5 MOUNTING HEIGHTS AND LOCATIONS

Lighting control Switches

1400 mm above floor level and 100 mm away from architrave. If mounted in a column they shall be located in the centre.

Sockets Outlets

300 mm above finished floor except for areas that are otherwise stated.

Connection Units and Outlets

Connection units having cord outlets shall be located as to limit the length of the flex cord to approx. 600 mm and be located slightly higher than the inlet on the appliances. The same applies to outlet boxes.

Conduit Boxes (General)

Where one fitting is shown in a room the box shall be in the centre (unless otherwise stated). Where two or more fittings are to be installed they shall be half of the between two fittings. Where one row of fittings is to be installed they shall be located in the centre. Where installed between beams they shall be in between two beams. All boxes shall be with covers.

14.3.6 WALL AND CEILING FINISHINGS

The Sub-Contractor is to obtain information regarding the ceiling claddings before any installation is commenced as he will be held responsible if the conduit boxes as well as boxes for switches and socket outlets, telephone, etc are not installed at the right depth.

14.3.7 LIGHTING FITTINGS

The sub-Contractor shall supply, deliver to site, install and commission all the fittings.

The tenderer may submit an alternative schedule of equal makes of fittings with the tender where applicable.

Where appliances fittings shall be supplied complete with bulbs or tubes, the tubes shall be as Thorn Manufactures. The bulbs shall also be Thorn make. Equivalent makes may be substituted subject to due approval of the Engineers, and the sub-contractor proving that what is specified is not available.

14.3.8 FIXING AND LOCATION

Details of fixing and location of various fittings are as shown on relevant drawings.

Fluorescent and incandescent fittings shall, in addition to being fixed to the conduit boxes, also be fixed by means of PVC covered rawplugs (no wooden plugs) at the fixing centres.

A rubber gasket shall be fitted on the conduit boxes for the outdoor fittings in order to provide a waterproof seal.

14.3.9 All switch panels shall be as MK manufacture or equivalent subject to the Engineer's approval. Each panel shall be fed from a particular phase as NOT more than one shall be allowed inside one panel. Separate conduits shall be installed to each panel.

14.3.10 POWER INSTALLATIONS

The sub-Contractor shall include for all installations shown on the drawings.

The sub-contractor shall satisfy himself that there is a continuous conduit, trunking and /or duct system to facilitate installation of the entire power installation and shall be held responsible where continuity does not exist.

14.3.11 INSTALLATION SYSTEM

The installation system for the indoor installation shall be carried out in concealed PVC conduits, PVC ducts and surface mounting trunking. The size of the cables shall not be less than 2.5 mm^2 for ring main circuits.

14.4 FIRE ALARM SYSTEMS

14.4.1 INSTALLATION

The installation for the above shall be carried out using PVC 1.5mm^2 copper cables in high impact grade PVC conduit. All cables for fire alarm installations to be fire-resistant. Tests for fire resistance will be performed as part of this sub-contract.

The sub-contractor shall ensure continuous link-up between individual break-glass call units, detectors, bells and panels.

14.5 INSTALLATION FOR COMMUNICATION AND SECURITY SERVICES

14.5.1 INSTALLATION SYSTEM

In the tender for electrical installations supports for all cables in the communications and security services shall be included. The electrical tender shall include for trunking, conduits etc. to ensure a continuous supply system from the telephone switchroom to any individual outlet.

Holes in structures shall be provided by the main-contractor.

The conduits shall at each point terminate in deep switch-boxes as specified for lighting control switches.

14.5.2 MOUNTING HEIGHTS AND LOCATIONS

Mounting heights shall be as for socket outlets.

14.5.3 BLANK-OFF PLATES

As MK list No. 3827 white.

SPECIFICATIONS: ELECTRICAL INSTALLATIONS

PART 15: STRUCTURAL LIGHTNING PROTECTION SPECIFICATIONS

15.0 DESIGN CONSIDERATIONS

This consideration is based on the provisions of BS 6651.

If it has been established that a structure requires lightning protection, certain general design considerations need to be made.

Could, for instance, any of the metallic components in or on the structure be incorporated into the lightning protection scheme? Could the metal in and on the roof be used? Should window cleaning rails, window frames, handrails surrounding the structure be incorporated in the protection network? The reinforcing bars or the steel frame of a structure may well provide a conductive path within the lightning protection system.

If metallic components in a building are not used, then the structure will require externally fitted conductors. A Lightning Protection System can incorporate all natural conductors, all externally fitted conductors, or a combination of both. BS 6651 does not, however recommend the routing of conductors inside the structure.

15.1 MAJOR COMPONENTS

The principle components of a lightning protection system should comprise the following:

- Air termination networks
- Down conductors
- Earth termination networks
- Bonding to prevent side flashing

15.1.1 **Air Termination Networks**

It is now accepted that lightning can strike the upper part of tall structures. BS 6651 now introduces the concept of air termination networks on all sides of tall buildings (ie, vertical air termination networks). No part of the roof within the air termination network should be more than 5m from a conductor. For large flat roofs, this will be achieved typically by a network mesh of 10m x 20m. For high risk structures, ie, explosive factories, etc. the air termination mesh is reduced to 5m x 10m.

If a building's metal reinforcing bars are to be used as down conductors, these should be connected to the air termination network in the correct number of positions.

BS 6651 advises the use of a rolling sphere to determine zones of protection. To minimize the likelihood of a lightning strike damaging the side of the buildings, it is suggested that the rolling sphere method be applied to identify those areas where an extension of the air termination network should be considered. This recommendation could be summarized as follows:-

Where there is a risk that a lightning strike to the sides of a structure may cause masonry to be dislodged, then an extension of the air termination network should be considered.

To ensure complete continuity of the lightning protection system BS 6651 recommends that:

Where structures vary in height and have more than one roof termination network, the lower roof network should not only be joined to its down conductors, but also joined to the down conductors of the taller portions of the structure. This will ensure that a lightning strike to a lower portion of the structure will not lead to side-flashing to other 'remote' down conductors and will provide a multi down conductor path for the lightning current to disperse.

The protective systems of churches and similar non-conducting structures should include air termination networks, down conductors and earth termination networks. It is, however, very difficult to design protective systems for these structures collectively. BS 6651, therefore, advises that such structures should be treated as special cases: that the presence of a tower or spire should be disregarded when designing the protection of the lower parts of the structure.

For less complex tall structures of varying heights, the 'rolling sphere method' as described should be employed. The rolling sphere method is a simple means of determining where the zones of protection should be located. Wherever the sphere touches the structure determines the extent of the air termination network.

There is a reference in BS 6651 to the use of covered conductors for air termination networks. Although it advocates that, wherever possible, bare conductors should be used, it permits the use of PVC covered or painted conductors.

15.1.2 **Down Conductors**

The function of a down conductor is to provide a low impedance path from the air termination network to the earth termination network, to0 allow the lightning current to be safely conducted to earth.

BS6651 advocates the use of various types of down conductors. A combination of strip and rod conductors, reinforcing bars, structural steel stanchions, etc. can be used as all or part of the down conductor system-providing they are appropriately connected to the air and earth termination networks, and are known to offer good electrical conductivity.

The code suggests there is no advantage in using 'shielded' coaxial cables as down conductors. In fact there is thought to be the disadvantage that potentials up to hundreds of kilo-volts can occur between the inner and outer conductor (shield) at the top of the down conductors so triggering a side flash.

Down conductor systems should, where possible, take the most direct route from the air termination network to the earth termination network. Ideally they should be symmetrically installed around the outside walls of the structure starting from the corners. Routing to avoid side-flashing should always be given particular attention in designing any installation.

Down conductors should be positioned no more than 20m apart around the perimeter at roof or ground level, whichever is the greater. If the structure is over 20m in height, then the spacing is reduced to every 10m or part thereof.

Sharp bends in down conductors at the edge of the roofs are unavoidable and are permitted in BS 6651; however, re-entrant loops in a conductor can produce high inductive voltage drops which could lead to the lightning discharge jumping across the side of the loop. To minimize this problem BS 6651 recommends that the length of the conductor forming the loop should not exceed eight times the width of the open side of the loop.

15.1.3 **Earthing – General**

Earthing plays a vital role in all electrical systems. The main reasons for earthing are:-

- To protect people and livestock
- To protect equipment
- To permit the equipment to function correctly
- To ensure the reliability of electrical services.

A good earth connection should possess the following characteristics:-

- Low electrical resistance between the electrode and the earth. The lower the earth electrode resistance the more likely the lightning or fault current will choose to flow down that path in preference to any other, allowing the current to be conducted safely to and dissipated in the earth.

- Good corrosion resistance. The choice of material for the earth electrode and its connections is of vital importance. It will be buried in soil for many years so has to be totally dependable.

- Ability to carry high currents repeatedly.

- Ability to perform the above functions for a minimum of 30 years.

15.1.4 **Soil Conditions**

Achieving a good earth will depend on local soil conditions. A low soil resistivity is the main aim, and factors that affect this are:

- Moisture content of the soil.
- Chemical composition of the soil, eg. Salt content.
- Temperature of the soil.

Note: It is now deemed bad practice to use salt as a chemical means of reducing soil resistivity, because of its very corrosive nature. Salt along with other chemicals, has the disadvantage of leaching out of the surrounding soil after a period of time, thus returning the soil to its original resistivity.

Once the soil resistivity has been calculated from the local soil measurements, the appropriate earth electrode system can be chosen by using typical formulae listed below:

15.1.4 **Soil Conditions**

Horizontal Strips (Rectangular Section)

$R = \rho/275L \text{ Log}_{10} 200L^2/wD$

Horizontal Strips (Circular Section)

$R = \rho/275L \text{ Log}_{10} 100L^2/dD$

Vertical Strips (Rectangular Section)

$R = \rho/275L \text{ Log}_{10} 800L/w$

Vertical Strips (Circular Section)

$R = \rho/275L \text{ Log}_{10} 400L/d$

Where:

R= Apparent earth electrode resistance in ohms.

ρ= Soil resistivity in ohm.cm

D= Depth of electrode in metres.

d= Diameter of electrode in centimeters.

L= Length of electrode in metres.

W= Width of electrode in centimeters.

Assume we use a standard 5/8" diameter rod (nominal diameter 14mm) Actual shank diameter 14.2mm

Thus d = 1.42cm

L = ?

If we let L = 6m and substitute to see what value of R is obtained

$R = 10{,}000/275 \times 6 \times \text{Log}_{10} 400 \times 6/1.42$

$= 6.0606 \times 3.228$

= 19.56 ohms

Thus 6m of extensible rods (5x1.2m) can be used to obtain the desired resistance value of 20 ohms.

The above example illustrates the importance of the accuracy of the soil resistivity figure. If the survey is inaccurate, then the calculated apparent elecvtrode resistance R will be inaccurate and misleading.

15.1.5 **Solid Plates or Mats**

Earth plates or mats can be buried instead of driving rod electrodes but installation is expensive and time consuming.

15.1.6 **Reinforcing bars in foundations as natural earths**

This is an economical method of using the mass of metal already underground in the form of the re-inforcing bars, within the structure's foundations. Precautions should be taken to ensure there is electrical continuity between these re-inforcing bars and the earth/lightning protection connections above ground.

15.1.7 **Underground Pipe Work System**

Buried water pipes were previously considered to be a reliable method of earthing but he increasing use of plastic pipes or replacing metal joints with plastic ones now makes this method unreliable.

Other forms of earth electrode can be used, including ring conductors or radial strips emanating from a particular point, or a combination of conductors with earth rods.

15.1.8 **Voltage Gradient**

A further factor affecting the choice of an electrode system is the electrical considerations.

Step and touch voltages on the surface of the ground in the vicinity of earth electrodes must be restricted to safe values.

This can be achieved by using electrodes to form a ring around the area to be protected. The electrodes must be buried sufficiently deep to reduce surface potential.

An effective method of reducing the voltage gradient of rod electrodes is to install them with the top of the electrode some distance beneath the surface of the soil. The connection between the electrode and down conductor being made with insulated conductor.

An example of how effective this can be is illustrated by tests which gave the following results.

The maximum voltage gradient over a two metre span adjacent to a 25mm diameter earth electrode was 85% of the total electrode potential when the top of the assembly was at ground

level. This electrode potential was reduced to 20% when the electrode was buried 0.3 m below ground level and 5% when buried 1.0 m below ground level.

One of the biggest problems for the installation contractor is of obtaining an earth resistance of, say, one ohm or less in an area of high soil resistivity. Unfortunately, there is no magical solution. However, several options are available to the contractor in the form of soil conditioning agents.

15.1.9 **Soil-Conditioning Agents**

Introducing a soil conditioning agent into the ground can reduce the soil resistivity and hence reduce the earth resistance.

There are various agents available, the choice of any particular one will depend on the type of earth required – temporary or permanent; the locality; the condition of the soil, etc.

As previously mentioned moisture forms an important part in obtaining a low soil resistivity value and it is the impurities in the water that produce this. One way of reducing the soil resistivity is to pour chemical solutions i.e.: copper sulphate; sodium carbonate; calcium sulphate, over the local area and allow it to migrate through the soil. The disadvantage of this is the large volume of solutions required, which makes it a cumbersome and time-consuming exercise. Also chemicals will eventually leach out of the local soil, returning it to its original high resistivity. Dissolving chemicals into the soil is also likely to encourage corrosion of the earth electrode. Hence the reason for the British Standard Code of Practice 7430 on Earthing and BS6651 Protection of Structures against Lightning – not recommending the use of a salt as a means of reducing the soil resistivity.

Other soil-conditioning are available including Bentonite and Marconite.

Bentonite is used as an earth-electrode back-fill to reduce soil resistivity by retaining moisture. The clay consists largely of sodium montmorillonite, which when mixed with water sells to many times its dry volume. It has the ability to hold its moisture content for a considerable period of time and to absorb moisture from the surrounding soil (e.g. from rainfall).

Marconite is a conductive carbonaceous aggregate which when mixed with conventional cement, effectively increases the surface area of the earth-electrode, thus lowering its earth resistance. Ideal for use on sub-stations and transmission/distribution networks or in hot, dry climates, and also has electromagnetic screening and anti-static flooring applications.

Both products have applications with deep-driven electrodes. The ground/soil in question can be drilled using a portable drill rig, transported to the site. Significant depths can be reached depending on the type of ground.

The electrode assembly can then be inserted into the pre-drilled hole and back-filled with Bentonite or Marconite, or any other appropriate conditioning agent.

It is vital with any earthing system that regular inspection is carried out for possible damage. Regular checks on earth electrode resistance to ensure optimum protection are advised.

The key to arriving at a successful earthing electrode system is not to sacrifice quality for cost. Many products currently on the market fall far short of the recommended standards. BS 7430: 1991 Code or Practice for Earthing contains recommendations for material specification to ensure components are corrosion-resistant and provide adequate mechanical strength.

15.1.9 **Soil-Conditioning Agents**

The correct choice of material and installation should ensure a life span of 30 years for the earth electrode.

15.1.10 **Earthing – Lightning Protection Systems**

There are two stages in testing an earth network for satisfactory resistance.

1) An earth electrode should be connected to each down conductor with a test link incorporate into every down conductor path.

   With the test link removed and without any bonding to other services, etc, the earth resistance of each individual earth electrode should be measured. The resistance, in ohms, should not exceed ten times the number of down conductors on the structure. For example, if there are fifteen down conductors equally spaced around a building, then the resistance of each electrode with the test link removed should not exceed 10 x 15 = 150 ohms.

2) With the test links replaced the resistance to earth of the complete lightning protection system is measured at any point on the system. The reading from this test should not exceed ten ohms. This is still without any bonding to other services.

BS 6651 provides a guide to the minimum dimensional requirements of various electrode systems. For example, where earth rods are chosen, the minimum combined rod length to complete an earth electrode system should be 9 metres – therefore a small structure with only two down conductors would have a minimum requirement of 4.5 metres for each electrode. Each local earth rod electrode should be a minimum length of 1.5 metres.

It must be remembered that this dimensional requirement does not effect, in any way, the need to obtain the satisfactory earth resistance values mentioned in (1) and (2) above.

15.2 **BONDING**

All metal work on or around a structure must be bonded to the lightning protection system if side-flashing is to be avoided. When a lightning protection system is struck, its electrical potential with respect to earth is significantly raised and, unless suitable precautions are taken, the discharge may seek alternative paths to earth by side-flashing to other metal-work in or on the structure.

Typically, water pipes, gas pipes, metal sheaths and electrical installations which are in contact with earth, remain at earth potential during a lightning discharge. Even metal parts that are not in contact with earth will see a potential difference between them and the lightning protection system during a discharge, even if this potential is smaller in magnitude to the metal parts in direct contact with earth.

It is vital that all exposed metal work is bonded into the lightning protection installation.

There are two ways of preventing side-flashing. The first is to isolate nearby metal from the lightning protection system. So, even if a strike occurs, the clearance distance between the metalwork and the lightning protection system would be so great that the strike would prefer to follow the lightning protection path rather than jump across to the metal work. Obviously, this will not be practical for certain fixed metal installations, for example central heating systems or metal windows. In these cases, the second method of preventing side-flashing has to be considered, that of connecting the metal work to the lightning protection system with an appropriate bond.

To determine whether the distance between the suspect metal work and the lightning protection system is large enough for the metal work to be considered ‘isolated’ or close enough to be ‘bonded’ BS 6651 provides a mathematical means of determining the minimum isolation distance for a given set of parameters.

Simple formulae are used in conjunction with two curves to evaluate the minimum isolation distance required between the suspect metalwork and the lightning protection system. If the figure obtained, with the given set of parameters, results in, say, a separation distance, of 2m, then if the actual gap is less than 2m, bonding is required. If the gap is greater than 2m, then isolation is sufficient, and no bonding is required.

BS6651 also provides specific recommendations for protecting buildings which contain explosives or highly flammable contents, dwelling houses/domestic properties, fences, trees and structures near trees, structures with radio and television aerials and a whole range of other miscellaneous structures including tents, sports stadiums, bridges, etc.

The code also mentions that internal bonds can be half the cross sectional area of external bonds as they are, at most, only likely to carry a proportion of the total lightning current.

15.2.1 **Corrosion**

As mentioned earlier the correct choice of materials for a lightning protection system is vital. Metal fittings must be compatible with the metal or metals used externally on the structure over which the system passes or with which it may be in contact.

Aluminium and copper, the two metals most commonly used in lightning, protection systems, are not compatible, so great care must be taken when both are used in a system – particularly where they come into contact with each other.

If aluminium is selected as the material for air termination networks and down conductors, it has to be connected to copper at or around the test clamp. This connection should be positioned at he beginning of the earth termination network. This is because both BS 6651 and the Earthing Code BS 7430 do not permit aluminium to be buried underground.

Simple and effective means of joining aluminium and copper conductors in one connector do exist. Ingots of high purity copper and aluminium are friction welded together forming an effective electrical and mechanically robust joint. This termination, if used in conjunction with contax inhibitor grease minimises the effect of corrosion.

The contact surfaces of dissimilar metals should be kept completely dry and protected against the ingress of moisture, otherwise corrosion will occur. A particularly effective means of

excluding moisture is to use inhibitor pastes, bitumastic paint, or approved protective wrappings.

As aluminium is prone to corrosion when in contact with Portland cement and mortar mixes, aluminium conductors need to be fixed away from the offending surface with an appropriate fixing.

Earth conductors between the test clamp(s) and earth electrodes should be protected against corrosion where they enter the ground for a distance of 0.3m above and below ground level. This can be achieved by using PVC protective sleeving.

15.3 LIGHTNING PROTECTION DESIGN

For a well-designed lightning protection system, the following information will be required:

1. Drawings of the structure requiring protection, showing the roof plan and at least two elevations. These drawings should be clear, precise and have the scale shown.

2. The materials used in the construction of the structure should be stated along with information on the type of fixings permissible (e.g. can the roof be drilled to take screw plugs).

3. For what purpose is the structure being used? (i.e. its use will determine the risk category of the structure).

4. The proximity of other structures, trees and its general locality.

5. Information regarding any unusual features such as aerial masts on the roof of buildings, which may not be shown on the drawings.

6. At what stage of construction is the structure (i.e. complete, partly built, etc).

7. Notification of code that the scheme is to be designed to e.g. BS 6651 (1992).

8. Is there any soil resistivity data available?

15.4 EARTHING SYSTEM DESIGN

General statements regarding earthing have been made earlier. This Section however is specifically aimed at assisting with earth electrode calculations – whether they be for a simple power earth, or for a more complex design, say a high voltage sub-station.

15.4.1 Why do we require an Earth?

The function of an earth system for an electrical installation can be split into three broad bands:

i) To limit the potential of any part of the installation to a pre-determined value with respect to the general mass of earth.

ii) To permit the flow of current in the event of a fault to earth so that the protective equipment has time to operate and thus isolate the faulty circuit.

iii) To ensure that, if a fault occurs, non-current carrying metalwork associated with the equipment does not attain a dangerous potential respect to the general mass of earth.

Points (i) and (ii) are normally essential to the security of the system, and are generally known as system earthing.

Point (iii) is aimed at ensuring safety of humans, animals and property and is sometimes known as equipment earthing.

15.4.2 How do we choose our Earth Electrode System?

Having determined that there is an earthing requirement, how do we go about deciding what type of earth electrode we should use? The previous chapter elaborated the various types of earth termination networks available, and their differing properties are a major consideration. However, the most significant factor that will govern our choice is the ground itself. A borehole survey of the ground where the earthing is to be installed will indicate whether rock is present and at what depth, a factor that will not only affect the electrical consideration but will also have a direct bearing on installation costs. The information required by the earth electrode designer, however, is the resistivity of the soil: that value of "rho" that will enable him to calculate the earth resistance – i.e. the resistance of the soil to the passage of electric current.

15.4.2 **How do we choose our Earth Electrode System?**

Compared to a length of copper conductor the soil or earth could be regarded as a relatively poor conductor of electricity; for example, the resistivity of copper is 1.72×10^{-8} ohm metres, whereas chalk in Norfolk might register a value of 100 ohm metres. In reality, however, the earth's enormous mass, and, hence, its large cross-sectional area for the current path, gives it quite a low resistance, i.e. – the earth is, in fact, a good conductor. Since soil strata differs significantly from country to country, or even from site to site, it is not possible to be specific about the correct choice of earth electrode system without carrying out a detailed soil resistivity survey.

15.4.3 **Soil Resistivity Measurements**

A technique for measuring the earth's resistivity was proposed by the American, Dr. Frank Wenner, in a scientific paper published in 1915. Since that time it has been universally accepted as the most popular method to employ.

The Wenner method gives the average resistivity of the soil between ground level and a given depth. Using this method, Furse site surveys measure the soil resistivity of various depths up to a minimum of 20 metres. This enables the plotting of a soil resistivity v. depth graph to reveal the optimum earth electrode system and where in the soil-strata it should be located.

15.4.4 **Earthing Design**

If the objective is to achieve a desired resistance to earth for a particular installation, e.g. one ohm, then formulae given in BS 7430 (1991) can be used to calculate the required amount of electrodes. If the earthing requirements are more comprehensive, for instance achieving a stipulated resistance to earth and also addressing the problems associated with step and touch voltages, then an internationally accepted standard such as IEEE standard 80 (1986) – Guide for Safety in AC Substation Grounding, should be employed. Other nationally recognised standards on earthing may be used to calculate the earth electrode requirements, but most design efforts concentration BS7430 and IEEE80.

For BS 7430 systems the resistance values are calculated to allow the Designer simply to select the 'bill of quantities' which gives his required resistance. IEEE80 designs include a schematic drawings representing the earth grid layout; from this, accurate site installation drawings can then be produced.

SPECIFICATIONS: ELECTRICAL INSTALLATIONS

PART 16: FIRE ALARM SPECIFICATIONS

16.0 SYSTEM DESIGN

16.0.1 The Code of Practice for design, installation and servicing

This specification is for the design and installation of fire detector alarm systems for general applications and is based on BS5839 Part 1: 1988.

16.0.2 Property Protection

A satisfactory fire alarm system for he protection of property will automatically detect a fire at an early stage, indicate its location and raise an effective in time to summon the fire fighting forces (both resident staff and fire brigade).

The general attendance time of the fire brigade should be less than 10 minutes. Therefore an automatic direct link to the fire brigade is essential.

16.0.3 Life Protection

A satisfactory fire alarm system for the protection of life can be relied upon to sound a fire alarm while sufficient time remains for the occupants to escape.

16.1 ZONE DETAILS

16.1.1 Zoning of the system

To ensure a fast and unambiguous identification of the fire source, the protected area should be divided into zones.

When determining the area to be covered by a zone, consideration should be given to accessibility, size, the fire routine determined for the premises, and particularly in occupied premises, that each zone is accessible from the main circulation routes leading from the where the control panel is sited.

16.1.1 Zoning of the system

In general the following guide lines for the size of a zone should be observed:

1. **If the total area** (i.e. the total of the floor areas of each storey)of the building **is not greater than 300m^2** then the building need only be one zone, no matter how many floors it has.

2. **The total floor area** for a zone should not exceed **2000m$^{2.}$.**

3. **The search distance should not exceed 30m.** This means the distance that has to be travelled by a searcher inside a zone to determine visually the position of a fire should not exceed 30m. The use of remote indicator lamps outside doors may reduce the number of zones required.

4. **Where stairwells or similar structures extend beyond one floor but are in one fire compartment,** the stairwell should be a separate zone.

5. **If the zone covers more than one fire compartment, then the zone boundaries should follow compartment boundaries.**

6. If the building is split into several occupancies, **no zone should be split between two occupancies.**

Notes:

1. A fire compartment is an area bordered by a fire resisting structure usually at least 30 minutes resistance.

2. Zone limits can be relaxed only in certain manually operated systems.

3. It may be an advantage to have manual call points on separate zones to detectors. This will avoid misleading information regarding the position of fire, particularly on staircase landings.

4. Removal of a detector from a zone circuit must not isolate a break glass call point on the same circuit.

16.2 ADDRESSABLE SYSTEMS

In an addressable system several zones may be connected to the control panel by a single loop circuit.

Maximum area covered by one loop is 10,000 sq m.

In addressable systems the detector or manual call point in alarm can be shown by the use of an alpha numeric display. This on its own will not be acceptable and the zone in which the detector/manual call point has operated must be displayed.

The zonal indication may be mounted adjacent to the control panel, and the plan of the building/floor should also be displayed. This means, the use of mimic diagram would seem to be the most suitable means for zone identification.

However in small systems where the identification of location of an incident by an individual device is not confusing, then zonal information may not be required.

16.3 BREAK GLASS AND MANUAL CALL POINTS

The break glass call point is a device to enable personnel to raise the alarm in the event of a fire, by simply breaking a frangible element and thus activating the alarm system.

The following guidelines should be observed for the correct siting and positioning of break glass call points:

1. Break glass call points should be **located on exit routes** and in particular on the floor landings of staircases and at all exits to the open air.

2. Break glass call points should be located so that no person need travel more than 30m from any position within the premises in order to give an alarm.

3. Generally, call points should be fixed at a height of 1.4m above the floor, at easily accessible, well-illuminated and conspicuous positions free from obstruction.

4. The method of operation of all call points in an installation should be identical unless there is a special reason for differentiation.

5. Manual and automatic devices may be installed on the same system although it may be advisable to install the manual call points on separate zones for speed of identification.

16.4 ALARM SOUNDERS

An important component of any fire alarm system is the alarm sounder, normally a bell or electronic sounder, which must be audible throughout the building in order to alert and/or evacuate the occupants of the building.

The following guidelines should be observed for the correct use of alarm sounders:

1. A minimum sound level of either 65dBA or 5Dba above any background noise likely to persist for a period longer than 30 seconds, whichever is greater should be produced by the sounders at any occupiable point in the building.
2. If the alarm system is to be used in premises such as hotels, boarding houses etc., where it is required to wake sleeping persons then the sound level should be 75dBA minimum at the bedhead.
3. All audible warning devices used in the same system should have a similar sound and be distinct from any other audible alarms used for other purposes. Except in noisy areas where high performance sounders may be required.
4. A large number of quiter sounders rather than a few very loud sounders may be preferable to prevent noise levels in some areas from becoming too loud.
5. It is unlikely that sounder noise levels in a room will be satisfactory if more than one dividing wall or door separates it from the nearest sounders.
6. The level of sound provided should not be so high as to cause permanent damage to hearing.
7. The number of fire alarm sounders used inside a building should be sufficient to produce the sound level recommended, but should in any case be at least two.

16.4.1 Other requirements include:

1. The sounders should be arranged on at least two separate circuits, so that the failure of one circuit does not case all sounders in the building to fail.

2. Frequency range between 500 – 1000Hz.

3. Most single doors will cause a 20db drop in sound level. Fire doors – 30db.

4. Where mains sounders are being used to supplement 24V DC sounders, the 240V AC supply should be monitored.

5. To achieve 75db at the bedhead, a sounder should be installed in the bedroom.

16.5 SELECTION OF EQUIPMENT DETECTION TYPES

When choosing the type of detector to be used in a particular area it is important to remember that the detector has to discriminate between fire and the normal environment existing within the building, i.e. smoking in hotel bedrooms, fumes from forklift trucks in warehouses, steam from bathrooms, kitchens etc.

16.5.1 Heat detectors

Heat detectors may be the Point type (which responds to temperatures surrounding one particular spot), or the Line type (which responds to temperature change along its line).

All Point type heat detectors should include a fixed temperature element operating at a pre-determined temperature. Some may also include a rate-of-rise element designed to operate in response to a rapid rise in temperature. Heat detectors are in general less sensitive than other types of detector and should therefore not be used where a small fire will cause unacceptable losses.

16.5.2 Smoke detectors

There are two principal methods of smoke detection: the ionisation chamber, and the optical scatter chamber. The detection method chosen will usually depend on the type of risk to be protected against. In the ionisation chamber, an electric current flows between two electrodes and is reduced by smoke. Ionisation detectors are particularly sensitive to small particle smoke such as that produced in rapidly burning fires but are relatively insensitive to large particle smoke such as that produced by overheated PVC or smouldering polyurethane foam. In the optical chamber, light is scattered, or in some cases absorbed by smoke. Optical detectors are more sensitive to large particles found in optically dense smoke, but are less sensitive to the small particle smoke.

Today, optical smoke detectors are more widely used than ionisation types due to the growing use of flame retardant materials in building construction, decoration and furnishings. Careful consideration must be given to any specific risks that might occur.

16.5.3 Siting and spacing of detectors

In a building the greatest concentration of smoke and heat will generally collect at the highest parts of the enclosed areas and it is here therefore, that detectors should normally be sited. Heat detectors should be sited so that the heat sensitive element is not less than 25mm, nor more than 150mm, below the ceiling or roof. If a protected space has a pitched or north light roof, then smoke detectors should be installed in each apex. The following parameters should be followed when spacing detectors:

The maximum horizontal distance between any point in the area and the nearest detector:

16.5.3.1. Under flat horizontal ceilings and corridors more than 5m wide

i) For Point type Heat Detectors 5.3m (maximum area $50m^2$)

ii) For Point type Smoke Detectors 7.5m (maximum area $100m^2$)

Heat Detectors

Max area of coverage per detector = $50m^2$

Max distance covered = 5.3m (for square layout this is 3.5m to wall 7m between detectors)

Smoke Detectors

Max area of coverage = $100m^2$

Max distance covered – 7.5m (for a square layout this is 5m to wall, 10m spacing)

16.5.3.2. **In a corridor less than 5m wide (where adjoining rooms are protected by automatic detection)**

ADD to the maximum horizontal distance 50% of the difference between 5m and the actual width of the corridor.

e.g.: In a 2m wide corridor, the difference between: 2m and 5m = 3m

50% of 3m = 1.5m

Maximum distance of travel for a Point type Smoke Detector = 7.5m + 1.5m = 9m

16.5.3.3. In the apex of a pitched or north light roof

A row of detectors should be sited in the apex. One row of detectors should be sited at the highest point, a minimum distance of 0.5m from the vertical wall.

ADD to the maximum horizontal distance 1% for each degree of slope up to a maximum increase of 25%

e.g.: A Point type detector at the apex of a 20 degree slope.

20% of 7.5m = 1.5m

Maximum distance of travel 9m

The maximum area of coverage may also be increased proportionally.

16.5.3.4. Obstructions

(i) Where the passage of smoke or hot gas from a position to a detector is likely to be disturbed by a ceiling obstruction (such as a beam) having a depth greater than 150mm, but less than 10% of the height of the ceiling, then the horizontal distance should be decreased by twice the depth of the obstruction.

e.g.: For a point type smoke detector obstructed by a beam of 200mm depth Maximum distance of travel

= 0.2 x 2 = 0.4m

7.5m – 0.4m = 7.1m

(ii) Where a ceiling obstruction, such as a beam, is greater than 10% of the height of the ceiling then the areas either side of the obstruction should be considered as separate rooms.

(iii) Ceiling beams less than 150mm can be ignored.

16.5.3.5. Detectors (Other than beam type)

Detectors should not be mounted less than 500mm from any walls or partitions. Where rooms are divided into sections by walls, partitions or storage racks reaching within 300mm of the ceiling, the dividers should be considered as if they reach the ceiling.

16.6 LIMITS OF CEILING HEIGHT

Detectors should not normally be mounted on ceilings higher than the general limits on Table 1 below. If small sections of a ceiling (not exceeding in total 10% of the ceiling area) exceed in height the general limits of the table , those higher sections may be protected by Point type heat detectors provided that the ceiling height in the higher sections does not exceed 10.5m, or by Point type smoke detectors provided that the ceiling height in the higher sections does not exceed 12.5m.

Limits of ceiling height		
Detector type	*Ceiling heights in metres* **General Limits**	Rapid attendance
Heat detectors BS5445: Part 5		
Grade 1	9.0	13.5
Grade 2	7.5	12.0
Grade 3	60	10.5
Point smoke detectors BS 5445: Part 7	10.5	15.0

High temperature heat detectors BS 5445: Part 8	6.0	10.5
Optical beam smoke detectors BS 5839: Part 5	25.0	40.0
Siting limits for smoke beam detectors	**Minimum (m)**	**Maximum (m)**
Height of optical beam above floor	2.7	25.0*
Optical beam length	10.0	100.0
Distance of optical beam from a flat ceiling or apex	0.3	0.6
Horizontal distance between optical beams measured at right angles to a beam	--	14.0
Horizontal distance between optical beam and an adjacent wall or partition.	See Note	7.0

* The height may be increased to 40m provided that the rapid attendance criteria are met.

Note: Generally the beam should not pass closer to the wall or partition than 500mm, and not closer to an obstruction than 500mm. However, up to 3m of the beam may be closer than this.

16.7 CEILING HEIGHT LIMITS WITH RAPID ATTENDANCE

Although an increased ceiling height means that the fire will be larger when it is detected, the size of the fire when fire fighting starts will also depend on the delay between detection and the start of fire fighting. If this delay is small, then the increase in fire size at detection due to a higher ceiling can be acceptable.

If the detection system is automatically connected to the fire brigade either directly or via a central (fire alarm) station and the usual attendance time of the fire brigade is not more than 5 minutes, then the rapid attendance limits of ceiling height given in the table in the top right may be applied. If small sections of a ceiling (not exceeding in total 10% of the ceiling area) exceed in height the limits of the table in the top right, those higher sections may be protected by Point type heat detectors if their height does not exceed 18 metres.

16.8 CONTROL EQUIPMENT

The control and indicating panel will depend on the size of the protected building and the extent of the automatic protection provided.

Specification of equipment would be based on numbers of zone circuits, sounder circuit, battery standby, remote center link ancillary control relays, and other individual customer requirements.

Next to the control unit should be a diagrammatic plan showing zone locations.

Siting of control and indication equipment

1. In an area of low fire risk
2. On the ground floor by entrance used by the fire brigade.

3. In an area common to all building users.
4. Where automatic detectors are in use, the control equipment area must be protected.
5. Alarm sounder must be sited next to the control unit.

16.9 STANDBY POWER SUPPLIES

Standby supplies will usually be from secondary batteries with automatic chargers. These batteries must have an expected life of at least 4 years and the code specifically bans the use of automotive type batteries.

When the mains supply fails the standby must be able to operate the alarm load for 30 minutes after a certain minimum duration. The minimum duration varies with the type of system and building occupancy.

For life protection (L) if a mains failure will be recognized within 12 hours, a standby duration of 24 hours is required. If the 12-hour requirement is not likely to be met, a standby of 24 hours after the detection of the fault is required.

For property protection (P) if the mains failure will immediately be recognized then a 24 hours standby is required, if not, then the required duration is 24 hours longer than the building may remain unoccupied.

16.10 WIRING

The satisfactory operation of a fire alarm system depends on the interconnection of its components. Some interconnections may have to function correctly for significant periods after being attacked by fire, e.g: cables to power supplies, control equipment and sounders.

Other cables must function when a trigger device operates, but are not needed after an alarm has been raised, e.g: cables to manual call points, smoke detectors and heat detectors.

Cables can therefore be classed in two groups:

1. Cables permissible if operation is not required during fire, e.g: Cables to manual call points, smoke and heat detectors.
2. Cables permissible if operation is required during a fire, e.g: Cables to power supplies, control equipment and alarm sounders.

While mineral insulated cables are preferable for fire alarm applications, the following cables can be used for the two groups:

Group 1

1. **MICC** to BS 6207: Part 1 with or without **PVC** sheath.
2. Cables complying with BS 6387 at least in categories **AWX** or **SWX** or **A** or **S.**
3. **PVC** – insulated to BS 6004 sheathed or non-sheathed with mechanical protection.
4. Rubber insulated to BS 5007
5. **PVC** single type **BK**, **BR** and **BU** to BS 6231.
6. **PVC** insulated **SWA** to **BS** 6346
7. Cross-linked polyethylene or hard ethylene-propylene rubber insulated **SWA**
8. to BS 5467
9. Polyethylene insulated PVC sheathed coaxial cable to the dimensional requirements of BS 2316: Part 3 but with a minimum of 16-strands/0.2mm diameter central conductor.
10. Cables designed for the detection of heat.

Group 2

Cables 1 & 2 in Group 1 may be used for Group 2 applications. All the other cables shown above may also be used provided that they are protected either by burying them within a wall and covering them with 12mm of plaster or equivalent, or protecting them from a significant fire risk by shielding them with a wall, partition or floor having a minimum demonstrate 0.5 hour fire resistance.

These requirements may in certain cases be reduced when included in areas of low risk or when covered by an automatic extinguishing system.

Certain cables may also need mechanical protection against impact, abrasion or rodent attack. As a guide, cables 1, 6 and 7 above will not need further protection but all others may in risk circumstances. BS5839 Part 1 gives full details.

Other types of cables can be used provided that their suitability can be clearly demonstrated.

Conductors carrying fire alarm power or signals should be separated from conductors used for other systems.

16.11 INSTALLATION OF CABLES

Cables should be installed in accordance with the good practices recommended in the latest edition of the IEE wiring regulations.

Connection to a mains supply should be via an isolating switch fuse reseved solely for the purpose. Its cover must be painted red and labelled **fire alarm – do not switch off.**

Conductor size should take voltage drop into account. In any case conductors should have a cross-sectional area of not less than 1 square mm or, if stranded, of not less than 0.5 square mm.

Where possible, cables should be routed through areas of low fire risk.

Cables installed in damp, corrosive or underground locations should be PVC sheathed. Where there is a risk of mechanical damage, cables should be protected accordingly.

Cables in cavities or voids should be separated from other cables by 300mm, unless enclosed in a conduit, ducting or trunking.

Screened cables complying to be BS 7629 can be run in duct or tray without segregation.

16.12 ROUTINE TESTING OF SYSTEM

The system should be regularly tested and serviced. BS5839 Part 1 makes the following recommendations:

Daily

(i) Check that the panel indicates normal operation. If not, record any fault indicated in the event log and report the fault to a responsible person.
(ii) Check that any fault recorded for the previous day has received attention

Weekly

(i) Operate a manual call point or smoke detector to ensure the system operates properly. Each week a different detector should be checked.
(ii) Check that the sounders have operated and then reset the system
(iii) Check the battery connections.
(iv) Complete the event log with details of date, time, trigger device tested and enter "**Routine Weekly Test**" the "**Action Required**" and reported to a responsible person

Quarterly

(i) Check entries in the log book and take any necessary action.
(ii) Examine the batteries and their connections.
(iii) Operate a manual call point or smoke detector to ensure the system operates properly, checking that all sounders are operating.
(iv) Check that all functions of the alarm control panel operate by simulating fault conditions.
(v) Visually check that structural alterations have not been made that could have an effect on the siting of detectors and other trigger devices.
(vi) Complete the event log with details of date, time, trigger device tested and "**Quarterly Test**" in the event sections. Any defects or alterations to equipment should also be entered.

Annually

(i) Carry out an inspection as detailed for the quarterly inspection.
(ii) Every detector should be tested **in situ**.
(iii) All cable fittings and equipment should be checked to ensure that they are secure and undamaged.

16.13 ANALOGUE ADDRESSABLE FIRE DETECTION SYSTEMS

Analogue Addressable Systems provide combined enhanced detection sensitivity and reduced false alarm potential to create a safer, trouble-free detection environment.

Analogue addressable systems should achieve levels of fire detection and protector which embrace the virtues of fast and accurate response and high levels of detection sensitivity with a significantly reduced false alarm potential.

The addressable system to meet the following:-

- The requirements of BS. EN54 Pt. 2 and 4: 1998
- Installer-friendly ‘plug in’ feature
- 2km maximum loop length
- Up to 120 devices per loop.
- **Other Required Features:-**
- Programmable sounder circuits direct from control panel.
- Capability to add manual sounder circuits, via loop alarm interface units.
- Sounders wired directly on to the detector loop
- Large capacity high intensity LCD-8 lines, with 40 characters per line
- Capacity for repeater panels on loop
- Facilities for on-site programming
- Password protected user and service menus

- Networking facility
- Dirty detector fault warning facility
- Day/night sensitivity adjustment capability
- Coincidence detection
- Pre-alarm facility
- Power supply remote option

16.13.1 Network Capability

The loop control panels should be capable of being interconnected easily to produce larger systems.

When a fire or fault condition is detected on any of the control units an event message is passed to all the other panels connected to the system. It should be possible to interconnect fire detection systems on larger sites to form a single-site network.

Within information from individual panels, available across the network, an overall fire plan, involving alerting or evacuating affected parts of the site can be implemented.

When a fire or fault condition is detected on any of the control units, an event message is passed on to all other panels connected to the system. Each panel will then display event information such as panel number, loop, zone/sector and address data. Alarm line operation across the network can be facilitated using zone and sector numbering.

Alarm sounder options

Alarm sounders can be connected to the system as follows:

(i) On dedicated alarm lines, wired directly from the control panel. Four and eight separate alarm outputs to be are provided in the two and four loop control panels respectively.

16.13.1 Network Capability

Each alarm circuit to be separately programmable to activate from any designated zone or zones of devices on the detection loop.

(ii) Additional alarm lines to be connected to the system via alarm line interface units. Each unit to provide four programmable alarm line outputs and be capable of being positioned anywhere on the detection loop wiring.

(iii) Where loop-wired sounders are used, these should be connected directly on the detector loop wiring. These units to be programmed either to sound a general alarm or be individually operated by a signal from any designated zone or zones of detection devices-hence offering a complete analogue addressable system on a single pair of wires.

Electronic sounders to give sound outputs complying with the requirements of BS5839 Pt 1: 1998. The sounders to be capable of giving various sound types.

16.13.2 **Additional programmable features**

The following additional features to be programmed into the system:

- address to zone number allocation (up to 128 zones)
- address to device type (e.g. detector or call point)
- zone, address, device type and sector text (24 characters each)
- zone or sector intermittent alarm pattern allocation
- 2 stage alarm timer
- zone or sector to auxiliary relay timed operation. Further relays may be added by using remote relay interface units.
- auxiliary input operation (e.g. silence/sound/evacuate etc)
- 40 characters of site text displayed by the panel in normal state, with the time and date.
- customer fire or fault programming
- double knock/coincidence
- day/night sensitivity
- adjustable detector threshold levels

16.14 SYSTEM FEATURES

Styled for the buildings of tomorrow

Information relating to the status of the system to be clearly indicated via the panel's alphanumeric 8 line, high intensity liquid crystal display.

16.14.1 1, 2 or 4 Loop options

The panels to be capable of being connected to either 1, 2 or 4 detector loops each loop being up to 2 km in length and 4 or 8 programmable sounder circuits, respectively.

Additionally, the panels to be capable of being networked together to provide even higher levels of detection and alarm system capacity. When networked, each panel to be configured to provide information relating to the entire fire detection system, thus enhancing the level of building safety.

16.14.2 Operation

Access level one controls to be positioned on the front of the panel, for ease of operation. Level two controls are to be concealed behind a key operated cover, and once exposed, they should enable the operator to interrogate the system's memory to obtain information on the location, status and progress of any fire incident.

Further levels of control, for example the disablement of, and reinstatement of detectors and zones, to be available via a security access code.

The system's memory to be capable of recording historical information relating to the minimum, maximum and current analogue levels received from any address, providing the facility for the constant monitoring of detector condition and a record of 'normal' fluctuations in the environment at each location, for simplification of routine testing and maintenance procedures.

16.14.3 Installation

Each panel to be supplied with address modules 1-60 for each loop. These are to be inserted into each appropriately numbered detector or call point on the system. Address modules 61-120 to be supplied separately to cater for systems with more than 60 addressable devices per loop.

16.14.4 Standard

The system to comply with BS EN54 Pt 2 1998 – Control and Indicating Equipment (CIE) and BS EN54 Pt 4 1998 – Power Supply Equipment (PSE)

16.15 SYSTEM OPERATION

16.15.1 Operational characteristics

The following is a brief summary of the main functions and the expected operational characteristics of the system.

- Adjustable pre and full alarm facilities

Adjustable pre and full alarm thresholdsto be set for individual detector addresses.

Once a pre-alarm threshold has been reached, a signal to be sent to designated locations, alerting those responsible for system monitoring, that the potential for a fire incident may exist. When the full alarm threshold is reached, the system to automatically provide warning signals to pre-determined areas of the system, for purposes of facilitating orderly evacuation of those areas affected.

16.15.1 Operational characteristics

A day/night operation facility to be provided to give a desensitized level of detection during the day and full sensitivity during night time operation, without affecting immediate alarms from manual call points.

- Automatic detector fault facility

High and low- level fault thresholds to be indicated. If a device's analogue level drifts, over a period of time from its normal background value, a fault indication to be given at the panel, showing the address of the detector. The detector can then be inspected and serviced or replaced if necessary. This facility to be included to increase building safety through simplification of routine maintenance, and testing.

- Line extensions

Alarm and relay extension lines to be connected at any address on the analogue detection loop, using the appropriate interface.

- Repeater facility

The dedicated repeater panel to be either connected to the detection loop, or spurred directly from a panel, if preferred. The Repeater Unit to be supplied with an 80 character LCD and integral power supply unit.

- Enhanced detector addressing

Each system to be programmed to provide an address/detector indication for each device, which enables a 'DEVICE TYPE ERROR' indication to be displayed at the control panel in the event of a wrong device being fitted.

- PC control colour graphics and date acquisition facility

This add-on package, to feature a PC and monitor, complete with software and the origination of up to 12 site plans. Additional plans can be added as extras.

ANALOGUE ADDRESSABLE DETECTORS

16.16 ANALOGUE DETECTORS

The analogue photoelectric smoke detector is ideally suited to the detection of slow burning fires. It employs an infra-red light source and photodiode to provide early warning of a hazard. Smoke particles entering the detection chamber cause light scatter, which is detected by the photodiode. The detector to be resistant to false alarms caused by dust, insects, high humidity and draughts.

16.16.1 Analogue Ionization Smoke Detector

Particularly suitable for identifying clean burning fires. The detector to incorporate twin sampling chambers which provide enhanced stability and inhibit the potential for false alarms caused by changing environmental conditions.

Analogue Heat Detector **to be capable of being configured by the control panel to operate either as a fast response, medium response heat detector, or a high temperature detector.**

Common Mounting Base to be compatible with detectors (both analogue and conventional). The base to incorporate a secure locking tab and position indicator, facilitating the correct orientation of the detector for optimum viewing of the detector's LED.

16.17 ANALOGUE REPEATER PANELS

16.17.1 Analogue Addressable Repeater Panel

The repeater unit to incorporate a 2 x 40 character liquid crystal display, with the optional facility of an integral printer. Additional features to include own log, to receive and store information from the main panel, and an output to facilitate the addition of a mimic repeater panel. The standard unit to be surface or flush mounted.

16.17.1 Analogue Addressable Repeater Panel

Slimline Mimic Diagram (SMD)

The slimline machine is designed to augment the information provided by main or repeat panel.

The SMD helps to maximize alarm flexibility, whilst reducing system wiring to an absolute minimum.

The module is installed either as a sounder detector base or as a stand-alone wall or ceiling mounted unit. Either option is accommodated directly on the two wire detector loop.

The fully programmable SMD to allow alarm organization on a single sounder, zonal or general alarm basis.

The self-powered facility to allow up to 120 detection devices and up to 55 addressable sounders to be connected on to the loop wiring.

The SMD to have selectable tones, continuous intermittent or warble. To be used in systems designed to BS5839 Pt 1. The sound output to be rated at 93 dB.

Addressable Sounder

The loop wired addressable sounder is to be used with analogue addressable fire systems.

Installed either in conjunction with a detector or on a stand alone basis, the sounder is addressed and powered directly from the detector loop.

The unit to provide a sound level of 85 dBA, and offer continuous intermittent or warble sound types, all within the recommended BS5839 Pt 1 frequency.

Each analogue loop to have a maximum of 30 units.

16.18 LOOP INTERFACE UNITS

To help provide input/output signals from anywhere on the loop wiring. This device to enable automatic operation of building plant in the event of a fire or the interface with existing fire detection or fire extinguishing systems to be easily incorporated.

16.18.1 Alarm/power supply interface units to allow additional alarm lines to be wired from any loop location. Each unit to provide the facility for using four independent programmable alarm circuits (1A maximum per alarm line, 3A maximum load). Alarm lines to be controlled without the need to wire directly back to the panel.

16.18.2 Relay/power supply interface unit to provide four additional programmable relay contacts (5A, 30 VDC) to enable output signals for operating external equipment.

This unit to have a dedicated 240VAC supply and should be capable of being connected at any address location on the detection loops.

16.18.3 Interface units, loop maximums. A maximum of 3 alarm interfaces and 4 relay interfaces may be connected to each loop controller, with each loop controller controlling two loops.

As a two loop panel contains a single loop controller, a maximum of 3 alarm line interfaces and 4 relay interfaces may be connected to loops 1 and 2 or a combination of both. A four loop panel contains 2 loop controllers enabling a maximum of 3 alarm interfaces to be connected to either loop 1 or 2 with a similar number on either loop 3 or 4.

16.18.4 Short circuit isolator provides protection of the detection loop. This ensures that the remainder of the loop protected by the short circuit isolator arrangement continues to function should a fault occur.

16.18.5 Standard interface unit enables a spur, containing a maximum of 5 standard detectors, and an unlimited number of conventional call points to be connected to the detection loop. UP to 10 interface units may be connected to a loop. Conventional call

points should be wired before conventional detectors on any spur circuit. They should not be mixed.

16.18.6 Input/Output interface unit

Provides both input and output signals directly on to the loop. Input signals from other fire protection systems can be displayed at the control panel. Output signals can be provided in order to operate plant shut down or door release equipment.

16.19 ADDRESSABLE BREAK GLASS CALL POINTS

The call point is addressed in a similar manner to the addressable detector bases, using the same set of address modules. There is no restriction on the number that may be used on a loop, up to a maximum of 120 address points. An LED indicator is incorporated as standard to confirm that the unit has operated.

16.19.1 Weatherproof break glass callpoint

For exterior applications, where required.

SPECIFICATIONS: ELECTRICAL INSTALLATIONS

PART 17: SUPPLY AND INSTALLATION OF A 500 KVA GENERATOR SET SPECIFICATIONS

17.0 SCOPE OF WORKS AND SERVICES

17.0.1 The work covered by this specification includes the supply, delivery, installation, setting at work, commissioning to the satisfaction of the Architect/Engineer and maintenance for a period of twelve months, of one Diesel Engine Generating Set complete with all necessary auxiliary equipment and as indicated.

17.1 RELATED DOCUMENTS

17.1.1 The specification shall be read in conjunction with any supplementary specification(s), schedule(s) and drawing(s) issued with it and enumerated in the invitation to tender. In the event of a discrepancy between this specification and any drawing issued with it or forming part of the contract the drawing shall be followed.

17.1.2 The words 'as indicated', 'where indicated', 'unless otherwise indicated' refer to items or requirements indicated elsewhere in the tender documents issued in connection with the contract e.g. on a drawing, in a supplementary specification or in Schedule 1.

17.2 REGULATIONS

17.2.1 The equipment shall comply with all relevant statutory standards and regulations current at the date of tender (unless otherwise indicated) and in particular the following:

1) I.E.E. Regulations for the Electrical Equipment of Buildings.
2) Regulations under the Electrical Power Act.
3) Factories Act.
4) Any special regulations issued by the local Electricity or Water Undertakings.

17.3 STANDARDS

17.3.1 The equipment and all components shall comply with all relevant British Standards and Codes of Practice or other equal and approved standard specifications and codes. Where the equipment or part of it complies with other internationally recognized standards which are less stringent than British Standards or Codes or Practice, then the difference is to be stated in writing and must accompany the tender submission.

17.4 OPERATING CONDITIONS

17.4.1 The equipment and all components shall be suitable for operation in ambient conditions of 5^{o} to 40^{o} centigrade and up to 100% relative humidity in an unheated ventilated building.

17.4.2 All ratings of equipment and components shall be interpreted as site ratings and NOT sea level or other ratings. Details of the site are given in Schedule 1.

17.4.3 Contractor is deemed to have visited the site and if unable to locate it to apply to Feradon Associates, P.O. Box 7375-00300, Nairobi, for directions to enable him to do so. The Sub-Contractor is deemed to have acquainted himself therewith as its nature, position, means of access, etc., and no claim in this connection will be allowed. No claim will be allowed for travelling or other expenses which may be incurred by the Sub-Contractor in visiting the site or preparing a tender for the contract works, and subsequent site visits to be called by the Architect during the contract period.

17.4.4 The set shall be capable of operating continuously and satisfactorily in a medium dust laden atmosphere as defined in BS 1701 and in accordance with BS 5514.

17.5 FUNCTIONAL REQUIREMENTS

17.5.1 As specified in Schedule 1, the set shall be used for emergency operation (standby power operation). It shall be possible to start, operate and stop the set manually independently of any automatic features.

17.5.2 Within the operating conditions specified (Section 5) the set shall be capable of starting and accepting full load within the shortest possible time and in any case not more than 10 seconds. Any special features included to achieve this shall be stated in Schedule 2.

17.6 PERFORMANCE

17.6.1 The output rating of the set in kVA, the voltage, the number of phases and the frequency shall be as specified in Schedule 1.

17.6.2 Within the operating conditions specified, each set, equipped with its standard air intake filters, shall 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 for a period of one hour in any 12 hour period.

17.6.3 The steady state voltage shall be maintained within 2½% of the rated voltage under the control of the voltage regulator between the cold start ambient conditions and the maximum working temperatures, at any load from no load to 10% overload and from unity to 0.8 lagging power factor. After any change of load the voltage shall not vary by more than plus or minus 15% of the rated voltage and shall return to within plus/minus 3% within 3 seconds and to within plus/minus 2.5 % 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.

17.6.4 The governing of the set shall be such that the steady load speed band shall not exceed 1% of rated speed. Sudden removal of the full load at rated frequency shall not cause the frequency to rise above 10% of rated frequency and it shall return to within 5 % of rated frequency within 3 seconds. The resultant steady state frequency shall return to 4% within 15 seconds. If full load is then re-imposed the frequency shall not fall below 94% of rated frequency and shall return to 99% within 3 seconds and to the rated frequency within 15 seconds.

17.6.5 The cyclic irregularity of the set at full load shall not be worse than 1/150.

17.6.6 The deviation of the waveform of the voltage output from a pure sine wave shall not exceed the limits specified in BS 2613.

17.6.7 Radiated interference shall be suppressed to the limits specified in B.S. 800 and B.S. 833.

17.7 SET ARRANGEMENT

17.7.1 The set and its auxiliaries shall be mounted on a sufficiently substantial underbase. All items which must be held in correct relative alignment shall be located by means of dowels.

17.7.2 The set shall be designed and supplied for operation bolted to the floor on robust anti vibration and shock absorbing devices.

It 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 floor or to any surroundings.

17.7.3 A new generator house will be constructed. The Sub-Contractor shall provide early enough full details of fixing requirements, and any modifications that may be necessary for the proposed house and foundation. Particularly, the Sub-Contractor appointed to supply the generator must confirm if the proposed house is adequate for the generator in terms of height, length, width and provision of natural ventilation. The Sub-Contractor will be responsible for the cost of modifying the generator house if he fails to provide the above information immediately.

The Sub-Contractor shall however provide means for bolting down the set. If the plinth provided is not sufficient the Sub-Contractor shall arrange to extend it to the Architect's satisfaction.

17.7.4 Bearings shall be suitable for operation over long periods without the need for replacement of the lubricant. Oil lubricated bearings shall be fitted with a visible oil level gauge.

17.8 DIESEL ENGINE

17.8.1 The engine shall be designed for satisfactory operation on fuel oil complying with BS 2869 Class D and the lubricating oils stated in Schedule 2.

17.8.2 The governor shall control the frequency with the limits stated in Section 7.4. Manual speed adjustment shall be provided over a range $\pm$ 5% of the rated speed at any load.

17.8.3 The engine shall be totally enclosed, with forced lubrication from an integral pump having on the suction side a coarse strainer and on the delivery side a dual 'full flow' fine filter fitted with a changeover cock incorporating pressure by-passes, so that the oil flow to the engine is maintained if the filter should chock.

Alternatively a single filter of the self-cleaning type fitted with a by-pass relief valve and having the same filtration performance may be provided. The capacity of the lubricating oil system shall be sufficient to enable the engine to run continuously for 72 hours.

17.8.4 A filter fitted with by-pass relief shall be inserted in the fuel line immediately before the pump(s). The fuel filter element shall be incapable of passing particles larger than 5 micrometers. The fuel system shall be so arranged that fuel resulting from filter, pump or pipe spillage shall be incapable of entering the engine pump.

17.8.5 Air filters complying with BS 1701, Grade 'A' or Grade 'B' suitable for use in a medium atmosphere shall be fitted on the engine air intake(s).

17.8.6 No significant critical speed of the complete shaft system, including the generator, shall be within 15% of the rated speed.

17.8.7 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 shall be equipped with a pair of contacts which close on operating 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.

17.8.8 The set shall be arranged such that on shut-down the cooling water temperature shall not rise with residual heat so that the high water temperature lock-out operates (Section 23.1 (4) (a)).

17.8.9 The engine shall be naturally aspirated as indicated in Schedule No. 1.

17.8.10 Starting shall be by means of electricity supplied from a starter battery. The starter motor shall be of the axial type, de-energised by a device operated from the engine.

17.8.11 Suitable means shall be provided for turning by hand the engine main shaft and the associated generator to facilitate inspection and overhaul. A means of manual starting is to be provided as indicated in Schedule No. 1.

17.8.12 The engine shall be capable of being started from any crank position.

17.8.13 A thermostatically controlled 240 - volt immersion heater may be fitted in the engine lubricating oil sump to facilitate starting. The heating surface loading of any lubricating oil heater(s) shall not exceed 0.015 watt per sq. milimetre to avoid carbonisation of the oil.

17.8.14 An efficient exhaust silencer with adequate draining facilities shall be supplied, and as indicated in Schedule 1 shall be installed in the generator house with the exhaust discharge into the steel chimney. The exhaust silencer shall be so arranged that it may be readily relocated if required.

17.9 FUEL STORAGE TANK

17.9.1 The fuel storage tank shall be located close to the building and in the current Kenya laws relating to fuel storage close to buildings or be mounted on a plinth, which shall be properly fenced. Type of location is given in Schedule 1.

A minimum capacity of the tank shall be as per schedule 1. The tank shall be fitted with a hand operated fuel transfer pump and the necessary piping to allow the transfer of fuel from it to the daily service tank.

17.9.2 A three-way cock shall be fitted in the line from the tank to the engine to enable fuel to be supplied from a source other than the fuel tank. The position of the cock shall be clearly marked "TANK", "OFF" and "AUXILLARY".

17.9.3 The daily service fuel tank shall be equipped with a clearly visible plastic tube fixed vertical on its side to enable the level of the fuel in the tank to be seen readily. In addition to that it shall be supplied with drain, vent, overflow and inlet and outlet connections.

17.10 ENGINE INSTRUMENTS

17.10.1The following instruments shall be provided:

1) a lubricating oil pressure gauge
2) a tachometer
3) a water thermometer
4) an exhaust gas pyrometer or thermometer mounted near the manifold.
5) lubricating oil thermometers on the inlet to and outlet from the engine, when a lubricating
oil cooler is fitted.

17.11 COOLING SYSTEM

17.11.1The engine shall be both air cooled and water cooled as indicated in Schedule 1.

17.12 AIR COOLING OF ENGINE

17.12.1 Cooling air for the engine and lubricating oil shall be provided by fan(s) mechanically driven from the engine. The cooling system shall be adequate for the total requirements of the engine when running on continuous full load and on 10% overload for one hour in accordance with BS 5514 and under the conditions of Section 5.

17.12.2 The engine shall be so designed that the cooling air discharges into or is drawn through a reasonable airtight ducted assembly enclosing the lubricating oil cooler, the cylinder barrels and the cylinder heads of the engine.

This assembly shall terminate in a flanged outlet to which trunking shall be readily attached, to enable hot air from the cooling system to be ducted and discharged outside the building together with exhaust.

Belt driven fans shall have at least two belts and the drive shall be capable of transmitting the full load with one belt removed. The cooling air temperature shall be controlled so as to maintain a safe working temperature of the cylinder head(s) and the engine shall shut down if the maximum is exceeded (see section 22.1 (4) (b)).

17.13 WATER COOLING OF ENGINE

17.13.1 A radiator of the air blast type shall be provided. It shall either have separate section for water and for lubricating oil or be arranged for jacket water cooling only.

17.13.2 Belt driven fans shall be provided with at least two belts and the drive shall be capable of transmitting the full load with one belt removed.

17.13.3 Circulation of the jacket water and lubricating oil through the respective radiator sections and/or heat exchanger shall be by means of pumps mechanically driven by the engine. Belt driven pumps shall be provided with at least two belts and the drive shall be capable of transmitting the full load with one belt removed.

17.13.4 An easily visible flow indicator provided with contacts shall be fitted in the water outlet from the engine; the contacts shall close in the 'no-flow' condition and shut down the set.

Alternatively in thermosyphon systems and scaled or pressurised radiator systems the flow indicator may be dispensed with providing the engine shuts down by the operation of the high temperature or low oil pressure safety devices in accordance with Section 22.1.

17.13.5A thermostatically controlled diverter valve shall be inserted in the engine water discharge pipe with a return to the circulating pump section, to maintain the circulating water at the optimum temperature irrespective of load. Alternatively a thermostatic by-pass will be accepted.

17.13.6A radiator makeup/expansion tank, fitted with float control inlet shall be provided. If a sealed or pressurised unit is offered the tank may be dispensed with.

17.13.7Where indicated in Schedule 1 provision shall be made on the radiator framework to permit the attachment of ducting for the discharged air.

17.13.8A thermometer shall be mounted near the cylinder head(s) to indicate water temperature. Where a lubricating oil cooler is fitted, inlet thermometers shall be mounted at the oil to and outlet from the engine. Alternatively, thermocouples may be provided at all thermometer positions and taken out to an instrument panel.

17.13.9Adequate drains shall be provided at low points in the water and lubricating oil systems of the radiator and, where applicable, of the heat exchanger.

17.14 ALTERNATOR AND EXCITER

17.14.1The alternator shall be directly coupled to the engine and be sized such that it will accept the maximum output of the engine including overload.

17.14.2Where the alternator is of the rotating armature type a slipring shall be provided for the neutral.

17.14.3The alternator shall be capable of operating within the range of $\pm$ 5% of the nominal voltage according to the setting of the automatic voltage regulator.

17.14.4 Three-phase machines shall be star connected, and a diagram showing the terminal markings and phase rotation shall be provided in the terminal box. Cables connecting the machine winding and machine terminals shall not have a higher derating factor for temperature than the windings.

17.14.5 Machines shall be both clean protected and drip proof. Overall drip proof covers will be accepted.

17.14.6 The insulation shall comply with BS 2757 excluding Classes Y and A. The insulation shall have an oil, moisture and fungus proof finish, with a surface which will not retain dust or condensation, it shall be possible to put the set in service after long periods, in unheated storage without the necessity for drying up the insulation.

17.14.7 The alternator shall be capable of withstanding a short circuit for three seconds when under the control of the automatic voltage regulator.

17.15 EXCITATION

Alternators using exciters with commutators shall be designed for an excitation voltage of full load of not less than 50 volts unless prior approval is given.

17.15.1 Where rotary exciters are fitted they may be direct coupled or driven by Vee-belts or chains. The speed of belt or chain driven exciters shall not be within 5% of a multiple of the alternator speed. Vee belt drive shall have at least two belts and shall operate satisfactorily if one belt is removed. Special attention shall be given to ensure satisfactory commutation, brush life and freedom from voltage drift. The neutral and running, positions of the brushes shall be clearly marked.

17.15.3 If static excitation and/or control system are offered, a description of the equipment and method of operation shall be submitted for approval.

17.16 ELECTRICAL CONTROL PANELS

A control panel shall be provided to accommodate the following:

1) An automatic voltage regulator
2) A hand field regulator and a 'HAND AUTO' switch
3) An alternator field switch
4) Meters (Section 21)
5) A neutral earthing link
6) A change - over - Contactor

17.17 AUTOMATIC VOLTAGE REGULATOR

The automatic voltage regulator shall be of a type which will maintain its adjustment for long period without attention. It shall be provided with an adjustment for setting the level of the controlled voltage to within ± 5% of the nominal voltage.

17.18 HAND FIELD REGULATOR

17.18.1 The hand field regulator shall give stable control of the voltage from 90% of the normal voltage at no load when cold to normal voltage at 10% over-load when hot, under the specified operating conditions.

If a static excitation system is offered which does not permit the use of a hand field regulator this shall be stated in the Tender together with performance details.

17.18.2 If the hand field regulator must be left in a precise position when the set is under the control of the automatic voltage regulator then this position shall be clearly marked.

17.19 METERS

The following meters shall be provided. They shall comply with BS.89, Table 7.

1) One maximum demand ammeter in each line

2) One voltmeter, and a selector switch to read line to line and line to neutral voltages.

3) A frequency meter

4) A field ammeter
5) Maximum KVA meter and Kilowatt hour meter.

17.20 AUTOMATIC STARTING PANEL

17.20.1Automatic starting panel shall be provided which shall contain all necessary equipment for controlling the automatic starting and stopping of the set, lubricating oil priming (if necessary), auxiliaries, fault warnings and shut-downs. All faults, warnings and shut-downs shall be separately indicated. There shall be test facilities for indication lamps etc., preferably by means of a single test button.

17.20.2Means shall be provided for isolating all supplies to the starting panel either by an isolating switch or by withdrawable fuses. For external use, a 24 volt battery supply from fused outlet terminals shall be provided only when the engine is running and in service (see Section 28.3).

17.20.3The starting and control circuits shall be rated at 2 amps at the control circuit voltage.

17.20.4A selector switch shall be fitted having three positions as follows:

1) 'Local' In this position it shall be possible to start and stop the set by push buttons mounted on the panel.

2) 'Remote' In this position the set shall be capable of being started and stopped from a remote circuit.

3) 'Off' In this position all the automatic features shall be inoperative.

17.20.5When the set is stopped other than under lock-out conditions it shall be self-resetting17, ready for the next start.

17.20.6In the 'Off' position (Section 2.4 (3)) or with the automatic equipment disconnected, the set shall be suitable for starting by manual means, e.g. by cranking or direct operation of the starter solenoid.

17.20.7All switches and push buttons shall be clearly marked to indicate their function.

17.20.8It shall be possible to operate the “Start and Stop” buttons and the three-position switch and to see the “Set Failure” indications without opening the panel doors.

17.21 AUTOMATIC CHANGEOVER CONTACTOR UNIT

17.21.1Where the functional requirements (see Section 6) indicate the set is to be used for automatic standby or mains failure duty a contactor unit shall be provided which on failure of the normal electricity supply will automatically initiate the starting of and effect the transfer of load to the standby generator.

The unit shall be incorporated in the Automatic Starting Panel (see Section 21).

17.21.2Where failure of the normal supply is referred to, it shall be defined as the complete loss of voltage or the falling below 85% of the normal voltage between any two lines or line and neutral.

17.21.3The power circuit shall consist of two contactors feeding the distribution branch to which the load will be directly connected. One contactor shall control the normal supply, the other the standby supply, they shall be electrically and mechanically interlocked so that they cannot both be closed at the same time.

17.21.4On the failure of the normal supply (Section 22.2) the unit shall operate in the following manner:-

1) After a delay, adjustable from 0 to 5 seconds (to avoid operation by a transient dip in voltage) a signal shall be given to start the standby generating set.

2) On receipt of a signal from the standby generating set that it is ready to take the load, and providing that the failure of the normal supply still persists, the normal supply contactors shall open and the standby contactor shall close. If the normal supply has been restored before the changeover has taken place, the contactors

shall not operate and the starting relay contacts shall open to initiate the shutting down of the standby generating set.)

17.21.5When the standby supply is in operation and the normal supply is restored and remains within 10% of rated voltage on all phases for a pre-set time (adjustable upto to 30 seconds) the standby contactor shall open and the normal supply contactor shall close; the starting relay contacts shall then open to shut down the standby generating set.

17.21.6Provision shall be made so that automatic return to normal supply can be prevented if required (Section 22.9 (s).

17.21.7Once a start signal has been sent to the standby generating set the engine starting sequence shall be allowed to continue until the set is ready to take the load before a stopping signal is sent.

17.21.8By the additional external connections the following facilities shall be available:-

1) Remote starting of the standby generating set and transfer of the load to it.

2) Restoration of the normal supply on failure of the standby generating set.

17.21.9Each switch shall be labelled with its duty and each position shall be marked. The following switches shall be provided and fitted:-

1) A Contactor Control Switch with make before break contacts and 'Hand' and 'Auto' positions. In the 'Hand' position the unit shall be controlled by the 'Contactor Hand Control Switch' (Section 23.9 (2). In the 'Auto' position the unit shall operate automatically irrespective of the position of the 'Contactor Hand Control Switch'.

2) A Contactor Hand Control Switch with 'Standby' and 'Normal' positions. This switch shall enable either contactor to be closed when the 'Contactor Control Switch' is in the 'Hand' position.

3) An Auto Return Switch having 'On' and 'Off' positions. In the 'On' position the return to normal supply shall be automatic when the normal supply is restored. In the 'Off' position the standby supply contactor shall remain closed when the normal supply is restored.

4) Contactor By-Pass Switches shall be provided to enable the essential load circuits to be served direct from the normal supply to enable the generator and/or the control equipment to be serviced. The by-pass switches shall be provided with a suitable and conspicuous label warning against leaving the generator in the disconnected position.

17.21.10 Indicating lamps or illuminated panels shall be provided on the front of the panel. They shall be appropriately labelled, easily visible and shall give the following information:

'Normal Supply Available'

'Standby Supply Available'

'Normal Supply in Use'

'Standby Supply in Use'

17.21.11 A push button labelled 'Test' shall be provided to enable a failure of normal supply to be simulated. If the button is pressed and released the equipment shall complete the starting sequence, and when the set is ready to take load it shall be shut down. If the button is held depressed the equipment shall change over to the standy supply when the set is ready to take load.

17.21.12 The control circuit supply will be either 12 volts d.c. or 24 volts d.c. depending upon the starting battery and charger (see section 28).

No current shall be drawn from the control supply when the unit is accepting the normal power supply.

17.22 LOCK-OUT

17.22.1 The set shall stop and lock out to prevent further starting when:

1) It fails to start when the electric starter motor has been in operation for 20 seconds under automatic start conditions;

2) The lubricating oil pressure falls to a value at which it would be unsafe to continue running the engine;

3) The cooling water does not flow, where the engine is fitted with a visible flow indicator on the cooling water system.

4) a) in water cooled engines the cooling water temperature exceeds a predetermined

limit.

b) in air cooled engines the cylinder head temperature exceeds a safe maximum

5) The overspeed trip has operated.

17.22.2 Failure of the circuits concerned in sub-sections 23.1(2) to 23.1(5) shall not cause a set to shut down.

17.23 FAULT INDICATION

Each lock-out detailed in Section 23.1 shall be indicated by a lamp on the panel together with an indication of the fault causing the shut-down. The fault warning lights shall be set to operate before the lock-out.

17.24 LOCK-OUT REMOTE INDICATION CIRCUIT

Where indicated in Schedule 1, an auxiliary circuit suitable for 2 amps 50 volts d.c. and 1 amp 250 volts a.c. shall be provided with a contact which is open when the set is available and closed when it is locked-out. This lock-out circuit shall be connected to terminals for the connection of external wires to provide remote indication of lock-out.

17.25 LOCK-OUT RESET

Reset of the lock-out shall be by hand.

17.26 FIRE SERVICE TERMINALS

17.26.1Where indicated in Schedule 1 an emergency stop circuit shall be provided with terminals marked FS1 and FS2. These terminals shall be initially fitted with a link and are for optional connection to a remote fire switch. Opening of this circuit shall stop the set if it is running, and as long as the circuit remains open the set shall be incapable of being started by 'Hand' or 'Automatic' control. This circuit shall be self-resetting so that the set is available for automatic starting when the circuit is restored.

17.26.2Terminals shall be provided in the battery circuit for optional connection to a fire service battery switch. Opening of this switch shall isolate the control circuits from their supply.

17.27 STARTING BATTERY AND CHARGER

17.27.1The battery shall be either 12 or 24 volts and capable of withstanding the loads imposed upon it by its specified duties. It may be of lead-acid or alkaline 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.

17.27.2The battery shall be used to supply any automatic starting and control equipment, and relay operation shall not be impaired when the battery is supplying current to the starter motor.

17.27.3A single phase supply for battery charging shall be available from the set when it is in service, and where circumstances permit, from an external supply (Section 17(9).

A charger shall be provided which will recharge the battery after engine starting and maintain it in a charged condition when the set is standing or is in service. It shall also supply the load of any automatic starting and control equipment, and any additional load upto 24 volts level when the set is running and in service. An alternative quick charge rate shall be provided. The charger shall be fitted with an ammeter to measure the charge and discharge current excluding the starter motor current.

17.28 WIRING

Power cables and small wiring cables interconnecting major components shall be of the heat and oil resistant type and shall be metal sheathed or run in metal ducts or metal conduit, which shall be flexible where appropriate. All cabling and small wiring shall be coded and terminated with lugs or be soldered; the terminations shall be clearly marked with the numbers and letters of terminals to which they are connected. Terminals shall be numbered or lettered, easily accessible and fitted with individual insulating barriers or adequately spaced barriers shall be fitted to separate control terminals from power wiring terminals.

17.29 EARTHING AND EARTH FIELD

17.29.1 All metal work housing electrical equipment shall be bonded to a brass earthing terminal of not less than ISO bolt M10.

17.29.2 Where indicated in Schedule 1 an earth field is to be provided suitable for requirements.

17.30 CONTACTORS

Contactors shall have magnetic circuits designed for a.c. or d.c. operation and shall be rated in accordance with BS 775 for Uninterrupted Duty and Utilization Category AC4. Four-pole contactors shall be fitted for three-phase equipment and two-pole contactors for single phase equipment. Main and auxiliary contacts shall be silver faced or better.

17.31 RELAYS

17.31.1 Relays shall preferably be of the sealed type mounted in approved plug-in bases with spring loaded retainers but if this is not practicable they shall be mounted on individual sub-bases and wired so that easy access is obtained to soldered connections. Unsealed relays shall be enclosed in individual or common dust protecting cases.

17.31.2 Time delays, if of the pneumatic type, shall operate on filtered air. The thermal type of time delay relay will not be accepted.

17.32 FUSES

Fuses shall comply with BS 88, category of duty AC 46, fusing factor class A1. A spare fuse cartridge for each pole shall be mounted inside each equipment.

17.33 RECTIFIERS AND CAPACITORS

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17.33.1 Rectifiers and capacitors shall be suitable for any transient voltages likely to be encountered during the operation of the equipment and for the internal operating temperature of the enclosures at the specified maximum external ambient temperature.

17.33.2Electrolytic capacitors will not be accepted unless approved for a specified purpose.

17.34 ENCLOSURES FOR ELECTRICAL AND CONTROL EQUIPMENT

Enclosures for electrical and control equipment shall be drip proof and dust protecting, with adequate front and rear access as necessary for maintenance and repair. Special attention shall be given to the method of construction and to the mounting of the components to minimize the effect of vibration. Diagrams of connections in durable form shall be mounted inside the enclosures.

17.35 GUARDING

All live and moving parts shall be adequately guarded to prevent injury to personnel.

17.36 INFORMATION PLATES

A non-ferrous metal rating plate shall be fixed on the front of the alternator control panel door, giving the following information:

Continuous output		KVA at 0.8 p.f.	
Voltage		V	-phase - wire
Frequency	Hz	Speed	rev/min
Control Supply		v.d.c	Maker's Serial Number
Year of supply			

17.37 DANGER PLATES

Since this set is automatically started a reversible plate 400 x 250 mm shall be fixed by screws in a prominent position on each side of the set. One side of the plate shall be blank and painted the same colour as the set; the other side of each plate shall be signal red (BS 2660, colour 0-006) with the following inscription in white.

DANGER

THIS MACHINE IS AUTOMATICALLY CONTROLLED

DO NOT WORK ON IT UNTIL

STARTING EQUIPMENT IS ISOLATED

OR DISCONNECTED AND CAUTION

NOTICES ARE DISPLAYED

17.38 TROPICALISATION OF COMPONENTS

All components shall be fully tropicalised and protected against mould growth.

17.39 FINISH

17.39.1 All ferrous metal works shall be either painted or processed to give a rust proof coating.

17.39.2 Ferrous metal work to be painted shall first be either shot blasted or thoroughly wire brushed to remove all scale and oxide and immediately given one brushed coat or two sprayed coats of primer. After not less than 4 hours, one brushed or two sprayed undercoats followed by one brushed or two sprayed finishing coats of heat and oil resisting quality paint shall be applied.

17.39.3 Successive coats of paint shall be of slightly differing shades. Interior surfaces of electrical equipment enclosures shall be finished white and all external surfaces shall be finished grey (BS 2660, colour 9-097). Engine crank cases shall not be painted internally unless the paint is resistant to the lubricating oil.

17.40 MAINTENANCE MANUAL

17.40.1 Upon Practical completion of the Works the Sub-Contractor shall furnish to the Engineer four copies of a Maintenance Manual relating to the installation forming part of all of the Works.

17.40.2 The Manual shall contain full operating and maintenance instructions for each item of equipment, plant and apparatus set out in a form dealing systematically with each system. It shall include as may be applicable to the Sub-Contract Works the following and any other items listed in the text of the Specification hereinafter.

1) System Description
2) Plant
3) Valve Operation
4) Switch Operation
5) Procedure of Fault Finding
6) Emergency Procedure
7) Lubrication Requirements
8) Maintenance and Servicing Periods and Procedures
9) Colour coding Legend for all Services
10) Schematic and wiring Diagrams of Plant, Apparatus and switchgear.
11) Record Drawings, true to scale, reduced to International A4 size.
12) Lists of Primary and Secondary Spares.

17.40.3 The Manual is to be specially prepared for the Contract Works, and Manufacturers' standard descriptive literature and plant operating instruction cards will not be accepted for inclusion unless exceptionally approved by the Engineer. The Sub-Contractor shall, however, affix such cards, if suitable, adjacent to plant and apparatus. One spare set of all such cards shall be furnished to the Engineer.

17.40.4Manuals shall be printed on good quality paper preferably International A4 size and shall have stiff covers of durable material. The maker's name and the rating of the set shall appear on the front covers.

17.41 DRAWINGS

The Sub-Contractor shall provide to the Architect four sets of the following drawings:-

1) Where indicated, a building drawing showing details of cable entries, pipe entries and ducts required, and the exhaust system.

2) A general arrangement drawing showing the principal dimension and weight of the set.

3) A general arrangement of the diesel engine.

4) A general arrangement of the alternator and exciter showing terminal markings, polarity and phase rotation.

5) A general arrangement of the electrical control panel(s).

6) A schematic and wiring diagram of the electrical control panel(s).

17.42 WORK TESTS

17.42.1The set shall be tested as a unit at the manufacturer’s works (or elsewhere by agreement) for output and performance generally in accordance with the requirements of BS 649 and BS 2613. The Engineer shall be given adequate notice in writing of the date and time of the works tests and he, or his representative shall if he so desires, he present at such tests and be given all reasonable facilities for his own inspections during the course of the tests.

17.42.2Whether or not the Engineer or his representative attends the tests, he shall be furnished by the Sub-Contractor with copies of all relevant test certificates.

17.43 COMMISSIONING

17.43.1The Sub-Contractor shall include for fully commissioning the set and its control equipment and, for the purpose of the required tests, shall provide all necessary instruments, tools, fuel and lubricating oil.

17.43.2The following tests and checks as applicable shall be carried out by the Sub-Contractor in the presence of the Architect or his representative.

1) Check that the main frame is level in all directions, Engine and generator shafts are in proper alignment and the vibration absorbing devices are properly installed and located.

2) Check water and sump oil levels and that the water jacket and radiator heaters (if fitted) are in working order.

3) Check the battery electrolyte level and the specific gravity.

4) Examine the containers in which the fuel and lubricating oils were delivered and check that the types and grades of oils are as recommended for the units.

5) Ensure that sufficient fuel oil is in the tank for a two hours test run.

6) Check that all radiator and engine block water drain points are free from sludge and other blockages.

7) Check engine bolts, main drive coupling, valve clearances, fuel pump settings, governor settings, pipe line connections, water hose, 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 over flow work.

8) Check all outgoing connections on the generator and at the control panel. All lugs for principal connections shall have clean and bright contact surfaces. A suitable abrasive material shall be used where necessary.

9) Check access panels and doors for proper opening and closing and for the functioning of any interlocks fitted.

10) With the set isolated from the main supply and the selector switch in the 'manual' position, start the engine by means of the 'start' push button and allow it to run up to normal speed. Check that during the time the engine starter motor is in operation, the mains battery charger is automatically switched off to avoid its being overloaded by the reduction in voltage across the battery. Where a battery charging dynamo is fitted, Check that the main battery charger is disconnected by the operation of the auxiliary Sub-Contactor during the time the engine is running.

11) 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.

12) Stop engine by turning selector switch to 'off' position and verify that generator contactor opens at between 95%. and 85% of normal voltage.

Re-check water and oil levels.

13) 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 the restoration of the mains supply and 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.

14) Operate the necessary isolators and switches to put the set on standby for the essential services network with the selector switch in the ‘Auto' position, and using the mains failure simulation push, verify that the set operates correctly with the appropriate time delay for taking up load and that the carrying of the load and its distribution over the three phrases are satisfactory.

15) Run the set at various loads for periods totalling at least 30 minutes. Check the voltage and current in each phase in turn and that the voltage and frequency are being maintained within the required limits with large alterations of loads.

Note the rate of charge on the dynamo ammeter with the engine running (if a dynamo is fitted) and the rate of charge on the battery charging ammeter with the engine stopped. Check against manufacturer's recommendation and adjust charging rates if necessary.

16) Check the operation of the turbo-charger unit(if fitted) and the colour of the exhaust gas at various loads.

17) Check that the various engine safeguards operate satisfactorily.

18) Check the vibration absorbing devices for proper operation and that the performance of all flexible connections both mechanical and electrical, are satisfactory.

19) When all tests are satisfactory and agreed with the Architect or his representative, the lubricating oil and water levels shall be finally checked, the fuel oil tank replenished and the set left in normal operating order.

20) An initial supply of all lubricating oils and greases shall be provided by the Sub-Contractor.

21) Additional lubricating oil shall be provided for recharging the engine sump once together with a supply of lubricating oils and greases to cover the normal use and servicing of the set during the 12 months maintenance period referred to in section 47.

17.44 SPARE PARTS

The Sub-Contractor shall submit with his tender a separate priced list of spare parts, including any optional extras which he recommends should be purchased for the set and its control equipment and which are not supplied as standard with the unit.

17.45 TOOLS

A complete set of tools and general and special testing equipment shall be provided, including grease and oil guns, necessary for the normal maintenance of the set and its controls. The tools shall of the best quality, the spanners being of chromevanadium steel and shall be contained in a suitable robust steel tool box with lid fitted with a lock and two keys. All tools and testing equipment may be used by the Sub-Contractor in the execution of the Contract works but will not be accepted as part of the Contract works unless they are handed over in clean and undamaged condition, in perfect working order and effectively in new condition.

17.46 MAINTENANCE

17.46.1 The Sub-Contractor shall maintain the complete set and associated control equipment forming the unit for a period of twelve of calendar months from the date that the unit is put into commission and regular use.

17.46.2 During the maintenance period, the Sub-Contractor shall at his own expenses:-

1) Make good any defects in the unit and replace any parts that fail or show signs of weakness or undue wear in consequence of faulty design, workmanship or materials on notification of the defect.

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 serving of the unit at the intervals laid down by the manufacturer or every three months, whichever is the sooner; the service examination to include all necessary adjustments, greasing, oiling, cleaning changing of lubricating oils 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.

17.46.3If 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 due to neglect of maintenance by the Sub-Contractor, the Sub-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.

17.46.3At the end of the twelve months period of maintenance the Sub-Contractor shall (in addition of the normal servicing work) carry out a comprehensive examination and test of 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.

SPECIFICATIONS: ELECTRICAL INSTALLATIONS

PART 18: APPENDICES TO SPECIFICATIONS FOR SUPPLY AND INSTALLATION OF A 500 KVA GENERATOR SET

18.1 APPENDIX NO. 1: INFORMATION TO THE TENDERER

Section	Item	Requirements
17.4	Operating Conditions:-	
17.4.1	Site (address and details)	Embakasi , Nairobi
17.4.2	Altitude	1600 m asl
17.4.3	Temperature range humidity	As stated in Part 5 Technical Specifications to operate in unheated building
17.4.4	Dust conditions if not as stated	
17.5	Functional requirements	Automatic Mains failure
17.6	Performance	500KVA,415/240V,3-Phase
17.7	Set arrangement	
	Weather proof roof and removable side panels	Required

17.8.2	Remote governor control	Electronic governor required
17.8.9	Aspiration	Natural
17.8.11	Manual starting for sets larger than 35 kW	Required
17.8.15	Silencer	
	Details of additional pipework and fittings if required	Required
17.9.1	Daily service tank	Required

APPENDIX No. 1 (Contd)

Section	Item	Requirements
17.9.2	Fuel transfer pump With float switch	Required
17.9.3	Fuel storage tank (external)	Required
17.9.4	Fuel jettison cock, fuel tank	
17.10	Engine Instruments Details if not as stated	Required.
17.11	Cooling system	Water/Air
17.13.2	Water cooling Radiator mounting	On engine
17.13.8	Provision for hot air ducting	Required
17.16	Electrical control panel	
	17.16(1) main switch	Circuit breaker
	17.16(2) provision for parallel running	Not required
	17.16(4) alternator field circuit	Switch
	17.16(10) "exciter"	Not required
17.19(5)	Kilowatt meter	Required
17.24	Lock-out remote indication circuit	Required
17.26.1	Service terminals	Required
17.29.2	Earth field	Required
17.41(1)	Building drawings, as comments to issued drawings.	Required

PART 18: APPENDICES TO SPECIFICATIONS FOR SUPPLY AND INSTALLATION OF A 500 KVA GENERATOR SET

18.2 APPENDIX NO. 1: INFORMATION TO BE SUPPLIED BY THE TENDERER

	Item	Details
1.	**Diesel Engine**	
	Make and type	
	Bore	
	Stroke	
	Net continuous rating in HP (B.S. 5574)	
	a) at sea level	
	b) on site	
	Speed	
	Year this type put into service	
	Total number sold	
	a) World wide	
	b) in East Africa	
	c) in Kenya	
	Supercharger: make and type number in use	
	Thermometers: make and type	
	Air cooling:-	
	Quantity of air required	
	details of ducting required	
	Water cooling:-	
	details of water cooling circuits	

APPENDIX No. 2 (Contd)

	Item	Details
	Radiator: make and type	
	length	
	breadth	
	height	
	Heat exchanger: make and type	
	Aspiration	
	Quantity of air required	
2.	**Auxiliaries**	
	Lubricating oil circuits	
	Filters	
	Coolers	
	Primary pumps	
	Tachometer and drive	
	Governor	
	Special cold start devices	
	Running hours meter	
	Safety devices:-	
	High temperature	
	Low pressure (lubricating oil)	
	Cooling water flow trip	
	Over speed trip	
	Speed sensing devices	
	Lubricating oil thermometers:-	
	Number	
	position(s)	
	Water thermometer:-	
	position	
	Starting battery and charger	
3.	**Lubrication**	
	Recommended oil(s)	

APPENDIX No. 2 (Contd)

	Item	Details
4.	**Alternator and Exciter**	
	Make and type	
	Bearings	
	Insulation (B.S. 2757)	
	Quantity of cooling air required	
5.	**Electrical Control Panel**	
	Automatic voltage regulator:	
	make and type	
	where mounted (if not on panel)	
	Control circuits and wiring diagrams	
	Relays:-	
	make and type	
	method of delayed operation	
	Meters: make and type	
	Circuit Breaker: make and type	
6.	**Automatic Changeover**	
	Contactor Unit	
	Dimensions	
	Type and control switches	
	Current drawn from control supply under standby conditions	
	Type of mounting	
	Contactor: make and type	
	Relays : make and type	
	Fuses : make and type	

APPENDIX No. 2 (Contd)

	Item	Details
7.	**Performance Data**	
	Fuel consumption	
	Rated Output %	**Fuel Consumption L /hr**
	110	
	100	
	75	
	50	
8.	**Exhaust Fans**	
	Type	
	Rating	
9.	**Generator Set**	
	Full Length	mm
	Width	mm
	Height	mm
	Weight	Kg

APPENDIX NO. 3 - DATA FROM THE TENDERER

1.	Initial sound level measured in accordance with the N.E.M.A. standards (Must be less than 60 dBA at 1m)	dBA
2.	Means of vibrations dampers mounted on the generator set to prevent vibrations to be transferred from the generator set to the building	

APPENDIX NO. 4

LIST OF TOOLS TO BE SUPPLIED WITH EACH SET

The following tools shall be handed over to the Client or Engineer before completion of the contract:-

Item	Description	Price KShs.
1.	Metal tool box with lock and kevs	
2.	Set of 8 No. Chrome vanadium ring spanners in sizes	
3.	Set of 8 No. Chrome vanadium open-ended spanners	
4.	Set of screwdrivers, 75 mm, 200 mm and 300 mm	
5.	One set of feeler gauges	
6.	One grease gun to suit greasing points	
7.	One oil can, trigger type	
8.	One Hydrometer and Plastic Filler bottle with pouring	
	Total carried forward to Price Summary Schedule	

The tenderer shall give below details of any special tools which he recommends should be purchased as an optional extra.

Item	Description	Price KShs.

Signed: (as in Tender) _____

Date: _____

APPENDIX NO. 5
LIST OF SPARE PARTS AND LUBRICANTS TO BE SUPPLIED WITH EACH SET

The following items shall be handed over to the Client or Engineer before completion of the contract.

These items shall not be used by the Sub-Contractor to carry out his normal maintenance.

Item	Description	Price KShs.
1.	Oil Filters - 3 Nos.	
2.	Air Filters - 3 Nos.	
3.	One injector to suit the set	
4.	One set of fan belts comprising.....	
5.	One set of indicator bulbs comprising	
6.	One set of indicator lenses comprising .....lenses	
7.	One overhaul kit	
8.	One set of fuses comprising..... fuses	
9.	One 200 litre drum of sump grade oil	
10.	One 2 kilogram tin of grease of grade	
11.	One 10 litre plastic container of distilled water	

The tenderer shall give below details of any other spares which he recommends should be purchased as optional extra.

Item	Description	Price KShs.

Signed: (as in Tender) _____

Date: _____

APPENDIX NO. 6

EARTHING

Item	Description	Price KShs.
1.	Supply and install, for each set, 4 No. steel cored copper earth rods, 1200 mm x 12 mm threaded for extension, connected by brass clamps to 30 metres of 25 mm x 3 mm copper earth tape laid in trenches of minimum depth 300 mm and fixed to the wall of the generator room with brass spacer bar saddles at 1 metre of intervals, connected to the station earth bar via a brass test clamp.	
	Total carried forward to Price Summary	

Note: The earthing must be carried our strictly as above.

Signed: (as in Tender) _____

Date: _____

APPENDIX NO. 7

1. Details of Drawings, Literature, manuals etc. included with tender documents.

2. Time in **weeks** from acceptance of tender to delivery of equipment on site. _____Weeks

3. Time in **weeks** from acceptance of tender to commissioning of set(s)._____Weeks

Signed: (as in Tender) _____

Date: _____

APPENDIX NO. 8

WARRANTY

The warranty period for the set and all its auxiliaries, from the date of commissioning,

will be _____ months

(Note: A minimum of 12 months is required).

Signed: (as in Tender) _____

Date: _____

APPENDIX NO. 9 - FOREIGN CURRENCY

State Foreign currency used in the pricing and rate of exchange to the Kenya Shilling.

1 _____ (Foreign Currency) = _____ Shillings.

Signed: (as in Tender) _____

Date: _____

APPENDIX NO. 10 - ANNUAL MAINTENANCE

Cost of Annual Maintenance shall be Ksh. _____ per year.

Signed: (as in Tender) _____

Date: _____

APPENDIX NO. 11 – EXTERNAL FUEL TANK

- 2 X 5000 litres (2x5.0 m^3) external diesel fuel tank made from 10 gauge galvanized pressed steel,

external (welded) 50mm square steel-bar diagonal and vertical supports.

1m high x 2.5m long x 2m wide steel stand in 8 gauge 100mm x 100mm (welded) hollow steel tubes and the following:-

- Internal stays
- 18 gauge galvanized steel cover lid
- Automatic fuel transfer pump with hose connection
- Connection for 15mm diameter class B gms pipe with "CRANE" gave valve and union.
- 6m long 15mm diameter class B gms pipe
- 4 No. Galvanized malleable iron elbow
- 20mm diameter drain pipe with "CRANE gate valve

- Clear accurately-calibrated level indicating tubing connection on the outside.

- All other accessories

KSh. _____

PART 19: TECHNICAL SPECIFICATIONS FOR PASSENGER LIFTS INSTALLATIONS

19.01 EXTENT OF WORK

This Sub-contract shall include for supply of the lift equipment, labour, installation, fixing, connecting, commissioning and delivering up clean and in working order in every detail the following lift installation. **The supplier will be liable for installing, setting to work and maintaining for a period of one year after commissioning of the lifts.**

QUANTITY	:	Twelve (12)
TYPE	:	Single Wrap Traction Passenger Lifts, Machine room-less
CABIN	:	Luxury Car
	:	Curved Ceiling
	:	Rubber flooring (or as specified by Architect)
DOORS	:	Stainless Steel, Sheaves, 1100mm wide, 2000mm high, Centre Opening, 2 panel (To be reconfirmed on site).
CAPACITY	:	1200 Kg, 13 persons
DRIVE	:	Gear-less, VVVF
SPEED	:	1.0 m/s
STARTS/HR	:	180
NUMBER OF STOPS/OPENINGS	:	6/6
NUMBER OF OPENINGS	:	Six openings in line for each lift.

TRAVEL HEIGHT	:	20 metres **(please verify on site)**
OPERATION	:	Duplex Selective-Collective Automatic (two car group) with possibility of one car running independently of the other.
SPECIAL OPERATION	:	Key operated priority call for emergency use, Automatic re-levelling of lift car, over-load control, Independent Service, Fireman service, Intercom System, Standby power
CONTROL	:	Fully software based microprocessor control system.
OPERATION	:	Fully collective.

PART 19: TECHNICAL SPECIFICATIONS: PASSENGER LIFTS INSTALLATIONS

19.01 EXTENT OF WORK

PLATFORM SIZE	:	Approximately 2200mm wide x 2400mm deep with load weighing. (please reconfirm on site).
PIT	:	1800mm (To be reconfirmed on site).
OVERHEAD	:	3600mm
COMPENSATION	:	Required.
MACHINERY	:	To be installed inside the lift shaft.
BELTS	:	Flat polyurethane – coated high-tensile grade steel belts to be used instead of conventional steel ropes. (NO ROPES)
POWER	:	415V, 3-phase, 50 Hz.
LANDING BUTTONS	:	The pair of lifts, 2 for intermediate floors, 1 for terminal floors. Buttons to have background LED illumination, plus Baille indication for use by the Blind.
BUFFERS	:	Spring / Rubber.
LEVEL/DIRECTION INDICATOR	:	1 per floor for each pair

LANDING DOORS	:	Two panel centre opening with small frames. 1100mm wide x 2000mm high. Painted to a final colour of client's choice.
CAR DOORS	:	Stainless Steel centre opening with 900 mm
DOOR OPERATION	:	Heavy duty, high speed intensive traffic doors with heavy duty Variable Frequency (VF), variable speed digital controls. Fully adjustable door open/close speeds,
DOOR PROTECTION DEVICE	:	Full curtain electronic door re-open device.
CABIN DIMENSIONS	:	
(Supplier to indicate)		
FLOOR DESIGNATION	:	As per Architects indication.

PART 19: TECHNICAL SPECIFICATIONS: PASSENGER LIFTS INSTALLATIONS

DRIVE SYSTEM	:	Gearless, AC Variable Voltage Variable Frequency (VVVF), with embedded permanent magnets.
SIGNALS	:	Call acknowledging lights, car position indicators, (in car/main floor), waiting passenger lanterns at all openings and landing position indicators at the first level. Travel continuation indicator at all floors. All indicators to be in Light Emitting Diode (LED) Display.
COMMUNICATION	:	3-station intercom units in all cars.
MACHINE LOCATION	:	THERE SHALL BE NO MACHINE ROOM.
LIFT SHAFT	:	2150 wide x 2000 deep (please verify on site)
GUIDE RAILS	:	Required.
LIGHTING	:	Built in curved skin car operating panel with two fluorescent lights with reflectors in translucent plastic diffuser on one side of the cabin panels. Provision to be
FLOOR BUTTONS	:	Micro motion with LED ring illumination. Translucent back-bit numbers complete with Braille indication for the visually impaired.
MAIN MOTOR	:	Gearless design Permanent magnet motors (No brushes)
CONTROL UNIT	:	Stainless Steel Controllers E-Pac to prevent electronic interference

CAR OPERATING PANEL	:	2 per car fitted on the side panel. To be complete with the following: electro-luminescent back-lit button, micro-motion buttons, intercom speaker, audio/visual overload,
LANDING FIXTURES	:	Wide angle view combined hall position indicators with signal hall lanterns in high resolution LED on ground floor. Elegantly designed hall buttons with ring illumination.
OTHERS	:	Three station intercom system. (Car, reception, security room).
	:	Compact Disc Music in car. (Wiring only, music by others).
	:	Speaker micro-phone built in car operating panel.
	:	Speech synthesis.

PART 19: TECHNICAL SPECIFICATIONS: PASSENGER LIFTS INSTALLATIONS

19.01 EXTENT OF WORK

OTHERS	:	Door open button.
	:	Door close button.
	:	Forced ventilation key switch
	:	Floor levelling guaranteed ± 3mm.
	:	Independent service key switch.
	:	Emergency fire service.
	:	Quiet-operation, drought-free multi-directional cabin extract fan.
	:	Audio/Visual car overload indication device.
	:	Powerful quiet, drought free mutli-directional cabin extract fan.
	:	Electronic Reverse Phase Relay built in controller.

	:	Siren type emergency alarm system.
POWER SUPPLY	:	Mains 3 phase / 50 Hz
	:	Lighting 1 phase – 240 v
FLOOR LEVELLING	:	± 3mm guaranteed
HEAT DISSIPATION	:	0.7 KJ/S
CODE COMPLIANCE	:	European Code EN 81 or British Standard Specification Equivalent (BS5655) **The Lift MUST be manufactured in Europe.**
MOTOR RATING	:	Kw

PART 19: TECHNICAL SPECIFICATIONS: PASSENGER LIFTS INSTALLATIONS

19.01 EXTENT OF WORK

STARTING CURRENT	:	Amps
NOMINAL CURRENT	:	Amps
SHEAVE	:	Stainless Steel
MISCELLANEOUS	:	Heat sensor in the machine room and controller to shut the car as its safety levels at the next landing.
	:	Rescue operation during power failure with emergency and inspection panel, to move the car to the next landing in event of power failure.
	:	Electronic light ray device and infrared curtain on car doors.
	:	Door lock monitoring to put the car on inspection when safety circuits malfunction.
CODE COMPLIANCE	:	European Code EN 81.
STANDARD	:	BS 5655 / EN 81 **The Lift MUST be manufactured in Europe.**
COUNTER WEIGHT	:	Required.

Immediately after appointment the sub-contractor shall provide to the Engineer a general arrangement drawing showing important dimensions and weights of the lifts, and submit colour samples for the Engineer's approval.

The sub-contractor must provide all beams, brackets and fixing devices for fixing of guide rails, counter weights, buffers, door frames, architraves etc. It shall be the responsibility of the lift supplier to ensure the lifts are properly fixed into position, and properly aligned for smooth up/down travel.

All fixing devices to be cast in or cut into structural walls shall be supplied and fixed by the sub-contractor. It is the responsibility of the sub-contractor alone to ensure that such devices are cast in or otherwise fixed in the right position and in a proper manner.

Partitions in the lift well shall be made in steel net or wire mesh, fixed to concrete beams to be supplied and installed by the sub-contractor.

PART 19: TECHNICAL SPECIFICATIONS FOR PASSENGER LIFTS INSTALLATIONS

19.02 WORK BY OTHERS

Excluded from this sub-contract is lighting in the plant room and the electrical power supply which shall be brought up to an isolator and distribution board in the plant room by others.

Connection to machinery and for lighting in cars shall be carried out by the lift sub-contractor.

19.03 OPERATION

The cars shall travel at a maximum speed of 1.5 m/s in all floors.

The car must not start unless the car doors are in a closed position and all landing doors are locked in a closed position.

Should the load on the car exceed the maximum load, the car and landing doors are to be prevented from closing.

Car levelling shall be within 3mm by means of an automatic self-levelling device.

An emergency stop button in the car shall stop the car completely even after the button is released. Re-starting shall take place only by activation of a push button in the car and not by a call from any landing.

Terminal limit switches must stop the car automatically at the terminal landings.

Final limit switches must cut off power and apply the brake automatically, should the car pass the terminal landings.

The installation must be provided with a complete controller device to control starting, stopping and speed as well as emergency stopping of the car in case any of the safety devices do not operate or excessive descending or ascending speed is attained by cutting off power to the motor and activation of the brake.

PART 19: TECHNICAL SPECIFICATIONS FOR PASSENGER LIFTS INSTALLATIONS

19.03 OPERATION

Calls in the car must be given preference over calls from landings.

At ground floor, calls shall be by means of a key operated switch only for authorised people.

The cars must deal with calls in sequence and not be intercepted during their trips by additional calls from cars or landings.

The lifts must be provided with automatic bypass devices to prevent unnecessary stops when the cars are full.

If the cars are idle and a landing button is pressed, the car positioned nearest to the pressed button has to go to the landing.

The car must not stop during the "up" trip at any landing in response to a "down" landing call, unless this call is the highest one registered.

When the cars at the same time are "up" trip or "down" trip, only the leading car must stop for landing calls.

If one of the cars is out of operation the other car has to answer all calls aforesaid. The operation is still to be collective.

For inspection purpose a manually operated switch on the controller connected to "up" and "down" direction buttons exposed on the top of the car, must be provided. This switch must permit the car to be operated at slow speed from the top of the car. During this inspection the car must not respond to any calls.

Provision to be made in the controls so that the cars can travel permanently in opposite directions when required.

PART 19: TECHNICAL SPECIFICATIONS FOR PASSENGER LIFTS INSTALLATIONS

19.04 CARS

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.

Car finishes shall be :-

FLOOR FINISH	:	12mm granite finish to match lift lobby floor finish to architect's approval. Other preferred finishes may be substituted.
REAR – WALLS	:	Full height mirror.
HANDRAIL	:	On 3 walls to be satin finished stainless steel rail and brackets.

SIDE WALLS	:	Half-size mirror.
CAR DOORS	:	Stainless Steel, satin finish.
LANDING DOORS	:	Mild-steel, painted.
CEILING	:	To be removable diffuser set. In anodized or painted aluminium frame. Diffuser to be white honey comb plastic. To be fitted with a silent exhaust fan yielding approximately 650 m^3/hr. Alternative ceiling finishes may be suggested by the Architect. Allow for any additional costs.
LIGHTING	:	2 No. Indirect LED lights built in the car operating panel. Allow for purpose-made interior lighting to Architect's details.

PART 19: TECHNICAL SPECIFICATIONS FOR PASSENGER LIFTS INSTALLATIONS

19.04 CARS

The colour and type of finishes shall be approved by the Architect before ordering.

Each car shall be equipped with 2 sets of illuminated push or touch buttons in silver anodized or stainless steel flush mounted operating panels. Two car operating panels shall be provided in each car.

The operating panels in all cars must comprise :

. Floor buttons, one of each floor served

. Emergency call button

. Car inspection switch

. Emergency stop button

Each car shall have direction of travel indicators at high level opposite doors.

Each car shall also be equipped with a digital floor position indicator above the sliding doors.

All lamps, buttons, etc., must be changeable from within the car.

All material used shall be approved by the local fire authority.

A load plate shall also be fitted in the car showing the maximum load allowed, in kilograms and number of passengers.

PART 19: TECHNICAL SPECIFICATIONS FOR PASSENGER LIFTS INSTALLATIONS

19.05 DOORS AND ARCHITRAVES

The entrance to the car to be provided with two panel automatic centre opening stainless steel, satin finished sliding doors, guided at the bottom by non-metallic shoes sliding in suitable grooves. Doors are to be installed both in car and landings. The doors must be complete with electronic mechanical interlock and emergency opening key.

The 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. The car door and landing door to move simultaneously in opening and closing, being 5 seconds (to be adjustable). In open position the doors automatically have to move back to locked position, even if

the car is stationary at the landing. By means of sensitive edge and one photocell the doors have to stop and reverse during their closing cycle if obstructed.

All door panels in landings and cars (like all walls) to be made from materials described earlier. All architraves to be made from spray painted matt finish steel. All plugs, brackets, etc., for architrave-fixing to be provided by the sub-contractor, and cast in by the sub-contractor. The appearance of the cabin will have to be approved by the Architect before ordering.

It is emphasized that great importance is attached to silent functioning of the doors.

19.06 LANDING CALL BUTTONS

At each mid-landing, two stainless steel flush-mounted panels, per car, with two push or touch buttons for "up" and "down" traffic shall be provided between the landing doors. The buttons must light up when a call is registered.

Direction arrow lights shall be incorporated in all landing call panels, arranged so that when a button is pressed the corresponding arrow will illuminate indicating the direction of the call which is registered.

At terminal landings one button only to be installed in each landing panel.

At ground floor two illuminated digital car travel position indicators with arrows shall be placed, one above each door.

PART 19: TECHNICAL SPECIFICATIONS FOR PASSENGER LIFTS INSTALLATIONS

19.07 SHAFT INSTALLATIONS

Guide rails for cars and counterweights to be T-steel guide rails planed on three edges. Rails must be placed accurately and fixed firmly to the shaft walls with sufficient spacing between brackets. The rails shall be brought totally to the bottom of the shaft.

The fixing of rails and the 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 in the structure.

Guide rails for the car to be either rubber roller guides or Telfon (Tufnol). Roller and shoes shall be renewable.

Buffer must be provided to bring the car counterweight to rest at the extreme limits of travel, should the car for any reason pass the limit switches.

The guide rails, roller shoes, buffers, counter-weight all to be provided and installed by the Sub-contractor.

19.08 LIFTING MACHINERY

The machine shall be gearless, single wrap traction type, mounted on steel beams fitted on the shaft walls. The beams to be as per structural engineers details.

The following information on the machinery must accompany the tender.

Make

Size, h.p.

Voltage, V

Power consumption at full load, KW

Revolutions per minute, r.p.m.

Full load current, A

Starting current, A

Duration of starting current, sec

Power factor, cos θ

Acceleration time, sec

Retardation time, sec

PART 19: TECHNICAL SPECIFICATIONS FOR PASSENGER LIFTS INSTALLATIONS

19.08 LIFTING MACHINERY

The motor must be provided with overload and phase failure cutout devices.

The control system to be fitted with a special battery/charger to enable technicians to move cabin to the nearest level to release trapped passengers in case of power failure. The system must prevent engaging of the turning device, until the power supply for the motor is switched off.

The aggregate must be dimensioned for the full load in continuous operation and for a temporary overload of 10%. The sub-contractor must provide information on the highest permissible operating temperature for optional functioning of the lift, and about the heat produced by the entire installation.

19.09 ROPES AND SHEAVES

The lifts shall be provided with durable, flat polyurethane-coated high-tensile steel belts.

The sheaves shall be of ample diameter for ropes used. 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.

19.10 ELECTRICAL INSTALLATION

All motors and switchgear shall be rated for operation at 240V/415V, 50 cycles. Relays and components must be tropicalised.

The installation must comply with the IEE Regulations. All wiring shall be carried out in a neat and orderly manner. Cables run on walls or ceilings to be in straight line and right angle bends enclosed in steel ducting.

Connections to equipment more than 400mm from wall 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.

PART 19: TECHNICAL SPECIFICATIONS FOR PASSENGER LIFTS INSTALLATIONS

19.11 ALARM

An alarm button in the car shall simultaneously activate a bell situated on the car and bell positioned at the security station near the lift lobby at ground floor. The bells shall be supplied with power from a rechargeable dry cell battery supplied by sub-contractor. All wiring and installation of the alarm system shall be done by the sub-contractor.

19.12 LIFT FOR DISABLED

All the Passengers lifts shall be suitable for use by disabled persons. The following additional facilities shall be provided in this lift:

i. Full length handrails shall be provided on the rear and side wall panels.
ii. The door closing time shall be set for min. 5 seconds and the door closing speed shall not exceed 0.25 m/sec.
iii. The “door open” and “door closed” announcements shall be audibly made in the car.
iv. Braile signs / buttons.

19.13 CONTROL AND DISPLAY SYSTEM

A control and display system shall be provided at the security room. The system, comprising a colour video monitor and keyboard shall indicate real-time elevator status, passenger traffic and demand, etc. It shall also be possible to feed commands to the controller from the keyboard, to adjust operation of the cars and for faults diagnosis.

PART 19: TECHNICAL SPECIFICATIONS FOR PASSENGER LIFTS INSTALLATIONS

TECHNICAL DETAILS OF LIFTS OFFERED BY THE TENDERER

1. Lifting Machinery

a) Make
b) Size, h.p.
c) Power consumption at full load, KW
d) Revolutions per minute, r.p.m.
e) Full load current, A
f) Starting current, A
g) Duration of starting current, sec
h) Power factor, cos θ
i) Acceleration time, sec
j) Retardation time, sec

2. Delivery Details

Time in weeks from acceptance of tender to delivery of all equipment on site _____ Weeks.

Time in weeks from acceptance of tender to installation and commissioning _____ Weeks.

3. Deviations from the Specification

The Tenderer shall give below details of any Specification, or any deviations, omissions, additions of alternatives in respect of the lifts which he is offering.

If none, write None.

PART 19: TECHNICAL SPECIFICATIONS FOR PASSENGER LIFTS INSTALLATIONS

MAINTENANCE CONTRACT

The Tenderer shall insert in this section the cost of a fully comprehensive Maintenance Contract after one of the initial 12 months maintenance or defects liability period. The sum to be inclusive of regular monthly inspection and breakdown service, and shall include for all tools, parts replacement and service material such as oils, lubricants, etc.

ITEM	KSHS.
Annual Maintenance cost for 8 No. lifts as described in the following pages inclusive of all spares and 24 hour call services (start date assumed end of building contract).	_____

WARRANTY

The warranty period for the equipment and all the associated accessories shall be _____ months from the date of commissioning. (A minimum of 12 months will be allowed).

FOREIGN CURRENCY

State the foreign currency applied and the exchange rate to the Kenya Shilling.

1 _____ (Foreign Currency) = _____ KSh.

PART 20: TECHNICAL SPECIFICATIONS FOR CONFERENCE LIFTS INSTALLATIONS

20.01 EXTENT OF WORK

This Sub-contract shall include for supply of the lift equipment, labour, installation, fixing, connecting, commissioning and delivering up clean and in working order in every detail the following lift installation. **The supplier will be liable for installing, setting to work and maintaining for a period of one year after commissioning of the lifts.**

QUANTITY	:	Two (2)
TYPE	:	Single Wrap Traction Passenger Lifts, Machine room-less
CABIN	:	Luxury Car
	:	Curved Ceiling
	:	Rubber flooring (or as specified by Architect)
	:	White Skin Car Operating Panel
	:	Full Height Mirror on 1 side. Half-height mirror on two sides
	:	Round Sectioned hand-rails with bright chrome plating
	:	Satin Chrome plated kick panels on the bottom of the cabin panels
	:	Stainless steel car door panels and car façade
	:	One half button riser with ring illuminated micro-motion sensors.
DOORS	:	Stainless Steel, Sheaves, 1100mm wide, 2000mm high, Centre Opening, 2 panel (To be reconfirmed on site).
CAPACITY	:	1600 Kg, 18 persons
DRIVE	:	Gear-less, VVVF
SPEED	:	1.0 m/s
STARTS/HR	:	180

NUMBER OF STOPS/OPENINGS	:	3/3

PART 20: TECHNICAL SPECIFICATIONS FOR CONFERENCE LIFTS INSTALLATIONS

20.01 EXTENT OF WORK

NUMBER OF OPENINGS	:	Three openings in line for each lift.
TRAVEL HEIGHT	:	10 metres **(please verify on site)**
OPERATION	:	Duplex Selective-Collective Automatic (two car group) with possibility of one car running independently of the other.
SPECIAL OPERATION	:	Key operated priority call for emergency use, Automatic re-levelling of lift car, over-load control, Independent Service, Fireman service, Intercom System, Standby power operation., priority travel control, Key operated landing call only at ground floor. Provision to be made so that the two cars on each side can be made to travel in opposite directions at all times. Intercom from cabin to security room and reception.
CONTROL	:	Fully software based microprocessor control system.
OPERATION	:	Fully collective.
PLATFORM SIZE	:	Approximately 2200mm wide x 2400mm deep with load weighing. (please reconfirm on site).
PIT	:	1800mm (To be reconfirmed on site).
OVERHEAD	:	3600mm

COMPENSATION	:	Required.
MACHINERY	:	To be installed inside the lift shaft.

PART 20: TECHNICAL SPECIFICATIONS FOR CONFERENCE LIFTS INSTALLATIONS

20.01 EXTENT OF WORK

BELTS	:	Flat polyurethane – coated high-tensile grade steel belts to be used instead of conventional steel ropes. (NO ROPES)
POWER	:	415V, 3-phase, 50 Hz.
LANDING BUTTONS	:	The pair of lifts, 2 for intermediate floors, 1 for terminal floors. Buttons to have background LED illumination, plus Baille indication for use by the Blind.
BUFFERS	:	Spring / Rubber.
LEVEL/DIRECTION INDICATOR	:	1 per floor for each pair
LANDING DOORS	:	Two panel centre opening with small frames. 1100mm wide x 2000mm high. Painted to a final colour of client's choice.
CAR DOORS	:	Stainless Steel centre opening with 900 mm
DOOR OPERATION	:	Heavy duty, high speed intensive traffic doors with heavy duty Variable Frequency (VF), variable speed digital controls. Fully adjustable door open/close speeds,
DOOR PROTECTION DEVICE	:	Full curtain electronic door re-open device.
CABIN DIMENSIONS	:	
(Supplier to indicate)		
FLOOR DESIGNATION	:	As per Architects indication.

PART 20: TECHNICAL SPECIFICATIONS FOR CONFERENCE LIFTS INSTALLATIONS

20.01 EXTENT OF WORK

DRIVE SYSTEM	:	Gearless, AC Variable Voltage Variable Frequency (VVVF), with embedded permanent magnets.
SIGNALS	:	Call acknowledging lights, car position indicators, (in car/main floor), waiting passenger lanterns at all openings and landing position indicators at the first level. Travel continuation indicator at all floors. All indicators to be in Light Emitting Diode (LED) Display.
COMMUNICATION	:	3-station intercom units in all cars.
MACHINE LOCATION	:	THERE SHALL BE NO MACHINE ROOM.
LIFT SHAFT	:	2150 wide x 2000 deep (please verify on site)
GUIDE RAILS	:	Required.
LIGHTING	:	Built in curved skin car operating panel with two fluorescent lights with reflectors in translucent plastic diffuser on one side of the cabin panels. Provision to be made for purpose-made interior lighting to Architect's detail.
FLOOR BUTTONS	:	Micro motion with LED ring illumination. Translucent back-bit numbers complete with Braille indication for the visually impaired.

MAIN MOTOR	:	Gearless design
	:	Permanent magnet motors (No brushes)
CONTROL UNIT	:	Stainless Steel Controllers
		E-Pac to prevent electronic interference.

PART 20: TECHNICAL SPECIFICATIONS FOR CONFERENCE LIFTS INSTALLATIONS

20.01 EXTENT OF WORK

CAR OPERATING PANEL	:	2 per car fitted on the side panel. To be complete with the following: electro-luminescent back-lit button, micro-motion buttons, intercom speaker, audio/visual overload, keyswitch for fan, keyswitch for lights.
LANDING FIXTURES	:	Wide angle view combined hall position indicators with signal hall lanterns in high resolution LED on ground floor. Elegantly designed hall buttons with ring illumination.
OTHERS	:	Three station intercom system. (Car, reception, security room).
	:	Compact Disc Music in car. (Wiring only, music by others).
	:	Speaker micro-phone built in car operating panel.
	:	Speech synthesis.
	:	Door open button.
	:	Door close button.
	:	Forced ventilation key switch
	:	Floor levelling guaranteed $\pm$ 3mm.
	:	Independent service key switch.

	:	Emergency fire service.
	:	Quiet-operation, drought-free multi-directional cabin extract fan.
	:	Audio/Visual car overload indication device.
	:	Powerful quiet, drought free mutli-directional cabin extract fan.
	:	Electronic Reverse Phase Relay built in controller.
	:	Siren type emergency alarm system.
POWER SUPPLY	:	Mains 3 phase / 50 Hz
	:	Lighting 1 phase – 240 v
FLOOR LEVELLING	:	± 3mm guaranteed
HEAT DISSIPATION	:	0.7 KJ/S
CODE COMPLIANCE	:	European Code EN 81 or British Standard Specification Equivalent (BS5655) **The Lift MUST be manufactured in Europe.**
MOTOR RATING	:	Kw
STARTING CURRENT	:	Amps
NOMINAL CURRENT	:	Amps
SHEAVE	:	Stainless Steel
MISCELLANEOUS	:	Heat sensor in the machine room and controller to shut the car as its safety levels at the next landing.
	:	Rescue operation during power failure with emergency and inspection panel, to move the car to the next landing in event of power failure.
	:	Electronic light ray device and infrared curtain on car doors.

	:	Door lock monitoring to put the car on inspection when safety circuits malfunction.
CODE COMPLIANCE	:	European Code EN 81.
STANDARD	:	BS 5655 / EN 81 **The Lift MUST be manufactured in Europe.**
COUNTER WEIGHT	:	Required.

PART 20: TECHNICAL SPECIFICATIONS FOR CONFERENCE LIFTS INSTALLATIONS

20.01 EXTENT OF WORK

Immediately after appointment the sub-contractor shall provide to the Engineer a general arrangement drawing showing important dimensions and weights of the lifts, and submit colour samples for the Engineer's approval.

The sub-contractor must provide all beams, brackets and fixing devices for fixing of guide rails, counter weights, buffers, door frames, architraves etc. It shall be the responsibility of the lift supplier to ensure the lifts are properly fixed into position, and properly aligned for smooth up/down travel.

All fixing devices to be cast in or cut into structural walls shall be supplied and fixed by the sub-contractor. It is the responsibility of the sub-contractor alone to ensure that such devices are cast in or otherwise fixed in the right position and in a proper manner.

Partitions in the lift well shall be made in steel net or wire mesh, fixed to concrete beams to be supplied and installed by the sub-contractor.

20.02 WORK BY OTHERS

Excluded from this sub-contract is lighting in the plant room and the electrical power supply which shall be brought up to an isolator and distribution board in the plant room by others.
Connection to machinery and for lighting in cars shall be carried out by the lift sub-contractor.

20.03 OPERATION

The cars shall travel at a maximum speed of 1.0 m/s in all floors.
The car must not start unless the car doors are in a closed position and all landing doors are locked in a closed position.

Should the load on the car exceed the maximum load, the car and landing doors are to be prevented from closing.

Car levelling shall be within 3mm by means of an automatic self-levelling device.

An emergency stop button in the car shall stop the car completely even after the button is released. Re-starting shall take place only by activation of a push button in the car and not by a call from any landing.

PART 20: TECHNICAL SPECIFICATIONS FOR CONFERENCE LIFTS INSTALLATIONS

20.03 OPERATION

Terminal limit switches must stop the car automatically at the terminal landings.

Final limit switches must cut off power and apply the brake automatically, should the car pass the terminal landings.

The installation must be provided with a complete controller device to control starting, stopping and speed as well as emergency stopping of the car in case any of the safety devices do not operate or excessive descending or ascending speed is attained by cutting off power to the motor and activation of the brake.

Calls in the car must be given preference over calls from landings.

At ground floor, calls shall be by means of a key operated switch only for authorised people.

The cars must deal with calls in sequence and not be intercepted during their trips by additional calls from cars or landings.

The lifts must be provided with automatic bypass devices to prevent unnecessary stops when the cars are full.

If the cars are idle and a landing button is pressed, the car positioned nearest to the pressed button has to go to the landing.

The car must not stop during the “up” trip at any landing in response to a “down” landing call, unless this call is the highest one registered.

When the cars at the same time are “up” trip or “down” trip, only the leading car must stop for landing calls.

If one of the cars is out of operation the other car has to answer all calls aforesaid. The operation is still to be collective.

For inspection purpose a manually operated switch on the controller connected to "up" and "down" direction buttons exposed on the top of the car, must be provided. This switch must permit the car to be operated at slow speed from the top of the car. During this inspection the car must not respond to any calls.

Provision to be made in the controls so that the cars can travel permanently in opposite directions when required.

PART 20: TECHNICAL SPECIFICATIONS FOR CONFERENCE LIFTS INSTALLATIONS

20.04 **CARS**

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.

Car finishes shall be :-

FLOOR FINISH	:	12mm granite finish to match lift lobby floor finish to architect's approval. Other preferred finishes may be substituted.
REAR – WALLS	:	Full height mirror.
HANDRAIL	:	On 3 walls to be satin finished stainless steel rail and brackets.
SIDE WALLS	:	Half-size mirror.
CAR DOORS	:	Stainless Steel, satin finish.
LANDING DOORS	:	Mild-steel, painted.

CEILING	:	To be removable diffuser set. In anodized or painted aluminium frame. Diffuser to be white honey comb plastic. To be fitted with a silent exhaust fan yielding approximately 650 m^3/hr. Alternative ceiling finishes may be suggested by the Architect. Allow for any additional costs.
LIGHTING	:	2 No. Indirect LED lights built in the car operating panel. Allow for purpose-made interior lighting to Architect's details.

PART 20: TECHNICAL SPECIFICATIONS FOR CONFERENCE LIFTS INSTALLATIONS

20.04 **CARS**

The colour and type of finishes shall be approved by the Architect before ordering.

Each car shall be equipped with 2 sets of illuminated push or touch buttons in silver anodized or stainless steel flush mounted operating panels. Two car operating panels shall be provided in each car.

The operating panels in all cars must comprise:

. Floor buttons, one of each floor served

. Emergency call button

. Car inspection switch

. Emergency stop button

Each car shall have direction of travel indicators at high level opposite doors.

Each car shall also be equipped with a digital floor position indicator above the sliding doors.

All lamps, buttons, etc., must be changeable from within the car.

All material used shall be approved by the local fire authority.

A load plate shall also be fitted in the car showing the maximum load allowed, in kilograms and number of passengers.

PART 20: TECHNICAL SPECIFICATIONS FOR CONFERENCE LIFTS INSTALLATIONS

20.05 DOORS AND ARCHITRAVES

The entrance to the car to be provided with two panel automatic centre opening stainless steel, satin finished sliding doors, guided at the bottom by non-metallic shoes sliding in suitable grooves. Doors are to be installed both in car and landings. The doors must be complete with electronic mechanical interlock and emergency opening key.

The 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. The car door and landing door to move simultaneously in opening and closing, being 5 seconds (to be adjustable). In open position the doors automatically have to move back to locked position, even if the car is stationary at the landing. By means of sensitive edge and one photocell the doors have to stop and reverse during their closing cycle if obstructed.

All door panels in landings and cars (like all walls) to be made from materials described earlier. All architraves to be made from spray painted matt finish steel. All plugs, brackets, etc., for architrave-fixing to be provided by the sub-contractor, and cast in by the sub-contractor. The appearance of the cabin will have to be approved by the Architect before ordering.

It is emphasized that great importance is attached to silent functioning of the doors.

20.06 LANDING CALL BUTTONS

At each mid-landing, two stainless steel flush-mounted panels, per car, with two push or touch buttons for "up" and "down" traffic shall be provided between the landing doors. The buttons must light up when a call is registered.

Direction arrow lights shall be incorporated in all landing call panels, arranged so that when a button is pressed the corresponding arrow will illuminate indicating the direction of the call which is registered.

At terminal landings one button only to be installed in each landing panel.

At ground floor two illuminated digital car travel position indicators with arrows shall be placed, one above each door.

PART 20: TECHNICAL SPECIFICATIONS FOR CONFERENCE LIFTS INSTALLATIONS

20.07 SHAFT INSTALLATIONS

Guide rails for cars and counterweights to be T-steel guide rails planed on three edges. Rails must be placed accurately and fixed firmly to the shaft walls with sufficient spacing between brackets. The rails shall be brought totally to the bottom of the shaft.

The fixing of rails and the 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 in the structure.

Guide rails for the car to be either rubber roller guides or Telfon (Tufnol). Roller and shoes shall be renewable.

Buffer must be provided to bring the car counterweight to rest at the extreme limits of travel, should the car for any reason pass the limit switches.

The guide rails, roller shoes, buffers, counter-weight all to be provided and installed by the Sub-contractor.

20.08 LIFTING MACHINERY

The machine shall be gearless, single wrap traction type, mounted on steel beams fitted on the shaft walls. The beams to be as per structural engineers details.
The following information on the machinery must accompany the tender.

Make

Size, h.p.

Voltage, V

Power consumption at full load, KW

Revolutions per minute, r.p.m.

Full load current, A

Starting current, A

Duration of starting current, sec

Power factor, cos θ

Acceleration time, sec

Retardation time, sec

The motor must be provided with overload and phase failure cutout devices.

PART 20: TECHNICAL SPECIFICATIONS FOR CONFERENCE LIFTS INSTALLATIONS

20.08 LIFTING MACHINERY

The control system to be fitted with a special battery/charger to enable technicians to move cabin to the nearest level to release trapped passengers in case of power failure. The system must prevent engaging of the turning device, until the power supply for the motor is switched off.

The aggregate must be dimensioned for the full load in continuous operation and for a temporary overload of 10%. The sub-contractor must provide information on the highest permissible operating temperature for optional functioning of the lift, and about the heat produced by the entire installation.

20.09 ROPES AND SHEAVES

The lifts shall be provided with durable, flat polyurethane-coated high-tensile steel belts.

The sheaves shall be of ample diameter for ropes used. 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.

20.10 **ELECTRICAL INSTALLATION**

All motors and switchgear shall be rated for operation at 240V/415V, 50 cycles. Relays and components must be tropicalised.

The installation must comply with the IEE Regulations. All wiring shall be carried out in a neat and orderly manner. Cables run on walls or ceilings to be in straight line and right angle bends enclosed in steel ducting.

Connections to equipment more than 400mm from wall 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.

PART 20: TECHNICAL SPECIFICATIONS FOR CONFERENCE LIFTS INSTALLATIONS

20.11 **ALARM**

An alarm button in the car shall simultaneously activate a bell situated on the car and bell positioned at the security station near the lift lobby at ground floor. The bells shall be supplied with power from a rechargeable dry cell battery supplied by sub-contractor. All wiring and installation of the alarm system shall be done by the sub-contractor.

20.12 **CONTROL AND DISPLAY SYSTEM**

A control and display system shall be provided at the security room. The system, comprising a colour video monitor and keyboard shall indicate real-time elevator status, passenger traffic and demand, etc. It shall also be possible to feed commands to the controller from the keyboard, to adjust operation of the cars and for faults diagnosis.

PART 20: TECHNICAL SPECIFICATIONS FOR CONFERENCE LIFTS INSTALLATIONS

TECHNICAL DETAILS OF LIFTS OFFERED BY THE TENDERER

3. Lifting Machinery

a) Make
b) Size, h.p.
c) Power consumption at full load, KW
d) Revolutions per minute, r.p.m.
e) Full load current, A
f) Starting current, A
g) Duration of starting current, sec
h) Power factor, cos θ
i) Acceleration time, sec
j) Retardation time, sec

4. Delivery Details

Time in weeks from acceptance of tender to delivery of all equipment on site _____ Weeks.

Time in weeks from acceptance of tender to installation and commissioning _____ Weeks.

3. Deviations from the Specification

The Tenderer shall give below details of any Specification, or any deviations, omissions, additions of alternatives in respect of the lifts which he is offering.

If none, write None.

PART 20: TECHNICAL SPECIFICATIONS FOR CONFERENCE LIFTS INSTALLATIONS MAINTENANCE CONTRACT

The Tenderer shall insert in this section the cost of a fully comprehensive Maintenance Contract after one of the initial 12 months maintenance or defects liability period. The sum to be inclusive of regular monthly inspection and breakdown service, and shall include for all tools, parts replacement and service material such as oils, lubricants, etc.

ITEM	**KSHS.**
Annual Maintenance cost for 12 No. lifts as described in the following pages inclusive of all spares and 24 hour call services (start date assumed end of building contract).	_____

WARRANTY

The warranty period for the equipment and all the associated accessories shall be _____ months from the date of commissioning. (A minimum of 12 months will be allowed).

FOREIGN CURRENCY

State the foreign currency applied and the exchange rate to the Kenya Shilling.

1 _____ (Foreign Currency) = _____ KSh.

PART 21: TECHNICAL SPECIFICATIONS FOR COMMUNICATION SERVICES

21.0 AN OVERVIEW OF CABLING STANDARDS

21.01 ANS/TIA/EIA-568-A and ISO/IEC 11801

The latest editions of the ANS/TIA/EIA-568-A (568-A) AND iso/iec 11801 (‘11801) cabling standards were both published in 1995. The following overview provides some of the requirements and recommendations of each standard including differences between them.

21.02 ANS/TIA/EIA-568-A

Commercial Building Telecommunications Cabling Standard.

The Telecommunications Industry Association (TIA) TR42.1 (formerly TR41.8.1) working Group on telecommunications cabling published the ANSI/TIA/EIA-568-A standard in 1995.

21.03 **ISO/IEC 11801**
Information Technology – Generic Cabling for Customer Premises.

The International Organization for Standardization (ISO) SC 25/WG 3 Working Group on telecommunications cabling published the ISO/IEC 11801 standard in 1995.

Following are highlights of the '568-A 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-A based terminology is used in the following overview.

Purpose

- To specify a generic voice and data telecommunications cabling system that will support a multi-product, multi-vendor environment.

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21.03 **ISO/IEC 11801**

- 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.

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

PART 21: TECHNICAL SPECIFICATIONS FOR COMMUNICATION SERVICES

21.03 **ISO/IEC 11801**

Cabling Elements

- Horizontal Cabling:
    - Horizontal Cross-connect (HC)
    - Horizontal Cable
    - Transition Point (optional)
    - Consolidation Point (optional0
    - 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

21.1 **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.

21.11 **Some points specified for the horizontal cabling subsystem include:**

- Recognized Horizontal Cables:

PART 21: TECHNICAL SPECIFICATIONS FOR COMMUNICATION SERVICES

21.1 HORIZONTAL CABLING SYSTEM STRUCTURE

21.11 Some points specified for the horizontal cabling subsystem include:

4 pair 100 Ω unshielded twisted-pair.

2-fiber (duplex) 62.5/125 μm or multimode optical fiber 9note: 50/125 μm multimode fiber will be allowed in '568-B)

- A minimum of two telecommunications outlets are required for each individual work area.

First outlet: 100 Ω twisted pair (category 5e is recommended)

Second outlet: 100 Ω twisted pair.

Two-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.

▪

PART 21: TECHNICAL SPECIFICATIONS FOR COMMUNICATION SERVICES

21.2 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.

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21.3 **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-A and '11801, but are expected to be specified in the next edition of these standards.

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21.4 **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.

HORIZONTAL DISTANCES OF COPPER LINKS (OPEN OFFICE)

Copper work area cables connected to a MuTOA, shall meet the requirements of '568-A (sec. 10.5 and 11.5). The maximum length of copper work area cables shall be determined according to:

$$\mathbf{C} = (102 - H)/12$$

$$\mathbf{W} = C - 7 \ (<29 \text{ m})$$

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.

PART 21: TECHNICAL SPECIFICATIONS FOR COMMUNICATION SERVICES

21.4 OPEN OFFICE CABLING:

HORIZONTAL DISTANCES OF COPPER LINKS (OPEN OFFICE)

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

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21.5 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.

PART 21: TECHNICAL SPECIFICATIONS FOR COMMUNICATION SERVICES

21.6 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-A.
- 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.

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.

PART 21: TECHNICAL SPECIFICATIONS FOR COMMUNICATION SERVICES

21.7 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-A (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-A (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

PART 21: TECHNICAL SPECIFICATIONS FOR COMMUNICATION SERVICES

21.7 **TWISTED-PAIR (BALANCED) CABLING**

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	Performs to category

	specified up to 100 MHz.	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

PART 21: TECHNICAL SPECIFICATIONS FOR COMMUNICATION SERVICES

21.7 **TWISTED-PAIR (BALANCED) CABLING**

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.

Category 6 and 7 industry are currently under development.

21.8 UTP TELECOMMUNICATIONS OUTLET/CONNECTOR

- 8-position modular jack per IEC 60603-7 (.568-A 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.

21.9 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.

21.10 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).

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21.10 UTP CONNECTING HARDWARE VS. CABLE NEXT PERFORMANCE.

- 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 5e) in addition to safety markings.
- Installed connectors shall be protected from physical damage and moisture.

21.11 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.
-

21.12 **SCREENED CABLING (ScTP)**

As a result of the release of TIA/EIA/IS-729 and the maturity of the '568-A 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.

21.12.1**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".

PART 21: TECHNICAL SPECIFICATIONS FOR COMMUNICATION SERVICES

21.12.2**ScTP Connectors:**

- Interface and pair assignments same as IEC 60603-7 ('568-A 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".

21.12.3**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.

21.12.4**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.

21.13 FULLY SHIELDED CABLING (SSTP)

Fully shielded cabling requirements are under development by ISO. Cable and connector specification will extend to at least 600 MHz and are intended to support the pending class F cabling requirements.

21.13.1**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 are under development by ISO.

21.13.2**Fully Shielded Connectors:**

- Interface and pair assignments are under development by ISO and will be entirely different from the T568A and T568B assignments.
- Mechanical and transmission requirements are under development by ISO.

21.13.3**Fully Shielded Patch Cables.**

- Mechanical and transmission requirements are under development by ISO.

21.13.4**Fully Shielded Installation Practices**:

- Installation Practices are under development by ISO.-

21.13.5**TSB67**

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 5 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-A.Additional transmission performance and applicable field test requirements are referenced in TSB95, '568-A-5 and amendment 2 to '11801 (FDAM 2)

21.13.6**Some points specified for TSB67 transmission field testing for UTP Cabling Systems**

- UTP cabling systems are comprised of cables and connecting hardware specified in TIA/EIA-568-A.
- 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 5e and FDAM 2 performance.
- Requirements are intended for performance validation and are provided in addition to '568-A requirements on components and installation practices.

PART 21: TECHNICAL SPECIFICATIONS FOR COMMUNICATION SERVICES

21.14 **OPTICAL FIBER CABLING**

The current '568-A specification on optical fiber cabling consists of one recognized cable type for horizontal subsystems and two cable types for backbone subsystems:

Horizontal – 62.5/125 μm multimode (two fibers per outlet).

Backbone - 62.5/125 μm multimode or singlemode.

‘568-B will allow 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

21.14.1**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”.)

21.14.2**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.

21.14.3**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. Informative Annex H of ‘568-A is provided for recommended optical fiber link performance testing criteria.

21.14.4**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).

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21.14.5**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.

21.14.6**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 the proposed '568-B.3 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.

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21.14.7**TSB72**

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-72 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.

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21.14.8**TIA/EIA-568-A-1**

Propagation Delay and delay Skew

This addendum to ‘568-A describes propagation delay and delay skew requirements for all ‘568-A compliant 4-pair 100ς cables. Propagation delay and delay skew requirements of multipair cables are subject to additional study.

Propagation delay is equivalent to the amount of time that passes between when a signal is transmitted and when it is received at the other end of a cabling channel. Delay skew is the difference between the pair with the least delay and the pair with the most delay. Transmission errors that are associated with excessive delay and the delay skew include increased jitter and bit error rates.

The maximum propagation delay skew requirement for 4-pair 100ς cables is frequency dependent and is specified by the following equation:

Delay (ns/100m) [534 + 36/√fMHz

Cable delay skew shall not exceed 45 ns/100m between 1 MHz and the highest referenced frequency for a given category.

It is anticipated that the requirements of ‘568-A-1 will also be applicable to pending category 6 cable propagation delay and delay skew specifications while more stringent performance criteria will be specified for pending category 7 cables.

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21.14.9**TIA/EIA-568-A-2**

Corrections and additions to TIA/EIA-568-A

This addendum to ‘568-A provides modifications and corrections to the content of ‘568-A as a result of advances in telecommunications research and development. Revisions are as follows:

1. Centralized optical fiber cabling is referenced in two locations (5.2.1 and 7.4.1) as an alternative to the optical cross-connection located in the telecommunications closet when deploying 62.5/125 μm optical fiber cable in the horizontal. TIA/EIA TSB72 Centralized Optical Fiber Cabling Guidelines are also referenced.

2. The ANSI/ICEA reference in section 10.2.3 was updated to ANSI/ICEA S-90-661-1994 for specifying the physical and mechanical requirements of ‘568-A recognized cables.

3. Additional text was incorporated into section 10.4.3.4 specifying that the connecting hardware used for 100ς UTP cabling shall not result in or contain any transposed (e.g transposition of pairs 2 or 3) or reversed (also called tip/ring reversals) pairs. It is further noted that applications requiring transposed or reversed pairs shall utilize adapters, work area or equipment cords to swap pairs.
4. A reference to the TSB67 field test methodologies is added to section 10.6.4
5. The 568SC optical fiber connector axial pull off strength requirement was decreased from 22 N (5 lbf) to 19.4 N (4.4 lbf)

6. Globally, the word “polarization” was replaced with “polarity”.
7. The initial contact resistance specified in Annex A for connecting hardware was increased from 1 mς to 2.5 mς and the contact resistance measurement method was re-written to be more user-friendly.

8. A provision for common mode terminations for testing connecting hardware NEXT loss and return loss was incorporated into Annex B. This revision accommodates telecommunications networking implementations that may employ common mode terminations in the active equipment.

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21.14.10**TIA/EIA-568-A-3**

Addendum 3 to TIA/EIS-568-A

As a result of the demand for open office architecture and the need to support multiple telecommunications applications in a shared sheath, this addendum to '568-A addresses revised performance specifications for hybrid cables. '568-A-3 also introduces a new term called "bundled cables" to describe 4-pair cable assemblies that are not covered by an overall sheath (as specified for hybrid cables), but by any generic binding method such as "speed-wrap" or "cable-ties"

The new hybrid and bundled cable requirements state that power sum NEXT loss between all non-fiber cable types within that cable shall be 3 dB better than the specified pair-to-pair NEXT loss for each cable type.

21.14.11**TIA/EIA-568-A-4**

Production Modular Cord NEXT Loss Test Method and Requirements for Unshielded Twisted-Pair Cabling

TIA/EIA-568-A-4 defines a generic and non-destructive methodology for NEXT loss testing of modular plug cords. NEXT loss performance requirements for category 5 modular plug cords, when measured with the particular test head specified in the Standard, are provided. Note that, although the methodology may be used as the basis for determining the minimum NEXT loss performance requirements of other categories of modular plug cords, at present, the Standard does not define a test head or specific test limits for category 5e or category 6 patch cords. The methodology described in the Standard contains the detailed NEXT loss calculations (which are based upon patch cable NEXT loss, test head NEXT loss, and cable and connector attenuation contributions) for the determination of the NEXT loss limits for any category patch cord and suitably designed teat head.

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21.14.12**TIA/EIA-568-A-5**

Transmission Performance Specifications for 4-pair 100ς Enhanced Category 5 Cabling.

‘568-A-5 specifies enhanced category 5 (category 5e) performance requirements. These requirements are recommended for new category 5 cabling installations and are expected to become the de facto minimum standard for category 5 cabling. This document addresses the minimum equal level far-end crosstalk (ELFEXT) and return loss requirements necessary to support developments in applications technology and defines the minimum performance needed for a worst case for-connector channel to support applications that utilize full-duplex transmission schemes, such as Gigabit Ethernet. To ensure additional crosstalk headroom for robust applications support, this document also specifies power sum performance requirements for category 5e cables and cabling.

Addendum ‘A-5 is a normative document and, unlike TSB95, it provides mandatory requirements, not recommendations.

21.14.13**TIA/EIA TSB95**

Additional Transmission Performance Guidelines for 100ς 4-pair Category 5 Cabling.

TSB95 outlines minimum recommendations for the new channel parameters of return loss and equal level far-end crosstalk (ELFEXT). These return loss and ELFEXT recommendations are specified to ensure the support of Gigabit Ethernet over installed or “legacy” category 5 cabling and were derived from worst case performances of channels with only two connection points. The two-connector channel topology is consistent with the IEEE committee’s assumption that cabling used to support Gigabit Ethernet systems will most likely utilize an interconnect instead of a cross-connect field and will not include a consolidation or transition point connection. Existing installed category 5 cabling should be verified to ensure that performance meets the minimum recommendations of this document. Channel configurations with three or four connectors that meet the specified ELFEXT and return loss recommendations will also support Gigabit Ethernet. Because the specifications of this document are applicable for the qualification of existing, installed cabling only, they are not recommended to be used as the minimum performance criteria for new category 5 cabling.

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21.14.15**TIA/EIA/IS-729**

Technical Specifications for 100ς Screened Twisted-Pair Cabling.

IS-729 is an interim standard that supplements TIA-568-A and ISO/IES 11801 screened twisted-pair cabling specifications by describing additional technical requirements on the outlet interface, shield effectiveness, installation practices, and performance relative to ScTP links and components.

21.14.15 **ISO/IEC 11801:1995 FDAM 2**

Draft Amendment 2 to ISO/IEC 11801

The performance specifications in ISO amendment 2 provide new requirements for return loss and ELFEXT loss to compliment the existing ISO class D requirements. The new specified return loss and ELFEXT loss requirements are in harmony with the values proposed in '568-A-5, however, the document does not specify additional NEXT loss margin over and above the existing class D requirements. FDAM 2 also includes propagation delay and delay skew requirements for channels and permanent links that are in harmony with the requirements of TIA/EIA-568-A-1

The requirements of amendment 2 to ISO/IES 11801 are normative and this document will become the governing international standard for new class D cabling installations.

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21.15 CABLING SPECIFICATION CROSS-REFERENCE CHART (ANSI/TIA/EIA-568-A 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-A and ISO/IEC 11801.

ANSI/TIA/EIA-568-A (and addenda)	ISO/IEC 11801 (and amendments)
Commercial Building Telecommunications	Generic Cabling for Customer
Cabling Standard	Premises

21.15.1**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.

21.15.2**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-A-3.

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21.15.3**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 except that 20 percent more attenuation is allowed by ‘568-A and 50 percent more attenuation is 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-A-4
- Color codes for stranded, 100 Ω UTP patch cord:

Option 1		Option 2
White/blue-blue	PAIR 1	green-red
White/orange-orange	PAIR 2	black-yellow
White/green-green	PAIR 3	blue-orange
White/brown-brown	PAIR 4	brown-slate

Note: Because of their identical pair groupings, patch cords terminated with either T568A or T568B pair assignments may be used interchangeably, provided that both ends are terminated with the same pin/pair scheme.

21.15.4**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 Annex D of ‘568-A.
- 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)

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21.16 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.

21.16.1MODULAR 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.

Modular cords wired to the T568A color scheme on both ends are compatible with T568B systems and vice versa.

21.16.2STRAIGHT 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.

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21.16.3 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".

21.17 COMMON OUTLET CONFIGURATIONS

Two wiring schemes have been adopted by the '568-A and '11801 standards. They are nearly identical except that pairs two and three are reversed. T568A is the preferred scheme because it is compatible with 1 or 2-pair USOC systems. Either configuration can be used for Integrated Services Digital Network (ISDN) and high speed data applications. Transmission categories 3, 4, 5, 5e, and 6 are only applicable to this type of pair grouping.

USOC wiring is available for 1-, 2-, 3-, or 4-pair systems. Pair 1 occupies the center conductors, pair 2 occupies the next two contacts out, etc. One advantage to this scheme is that a 6-position plug configured with 1, 2, or 3 pairs can be inserted into an 8-position jack and still maintain pair continuity. A note of warning though, pins 1 and 8 on the jack may become damaged from this practice. A disadvantage is the poor transmission performance associated with this type of pair sequence. None of these pair schemes is cabling standard compliant.

10Base-T wiring specifies an 8-position jack but uses only two pairs. These are pairs two and three of T568A and T568B schemes.

The MMJ is a unique wiring scheme for DEC® equipment.

21.18 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.

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21.19 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.

21.20 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.

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21.21 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:

Purpose

- Standardize design and construction practices.
- Provides a telecommunications support system that is adaptable to change during the life of the facility.

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.

Elements

- Horizontal
- Backbone
- Work Area
- Telecommunications Closet
- Equipment Room
- Main Terminal Space.
- Entrance Facility

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21.21.1 HORIZONTAL

Pathways from telecommunications closet to work area.

Includes:

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.

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21.21.1 HORIZONTAL

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.

Design Considerations:

- Grounded per code and ANSI/TIA/EIA-607 (‘607)
- Designed to handle recognized media as specified in ANSI/TIA/EIA-568-A (‘568-A)
- Not allowed in elevator shafts.
- Accommodate seismic zone requirements
- Installed in dry locations

21.21.2BACKBONE

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-A)
- Integrity of all fire stop assemblies shall be maintained.

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21.21.3**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.
- Control center, attendant, and reception areas shall have direct and independent pathways to the serving telecommunications closet.
- 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:

1) Standard NEMA opening (NEMA OS 1 (Ref D. 14), WD-6 (Ref D. 15))
2) 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 (National Electric Code) shall be applied.

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21.21.4 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 (78 (3) trade size) 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.
- Accommodate seismic zone requirements.
- Two walls should have 20mm (0.75 in.) A-C plywood 2.4m (8ft.) high.
- Lighting shall be a minimum of 500 lx (50 foot candles) and mounted 2.6m (8.5 ft.) above floor.
- False ceilings shall not be provided.
- Minimum door size 910mm (36 in.) wide and 2000mm (80 in.) high without sill, hinged to open outwards, or slide-to-slide or removable, and fitted with a lock.
- Minimum of two dedicated 120V 20A nominal, non-switched, AC duplex electrical outlet receptacles, each on separate branch circuits.

- Additional convenience duplex outlets placed at 1.8m (6 ft.) intervals around perimeter, 150mm (6 in.) above floor.
- Access to the telecommunications grounding system as specified by ANSI/TIA/EIA-607.
- HVAC requirements to maintain temperature the same as adjacent office area. A positive pressure shall be maintained with a minimum of one air change per hour or per code.

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21.21.5**EQUIPMENT ROOM**

A centralized space for telecommunications equipment that serves specific occupants of the building.

Any or all of the functions of a telecommunications closet or entrance facility may alternately be provided by an equipment.

Location

- Site locations should allow for expansion.
- Accessible to the delivery of large equipment.
- Not located below water level.
- Away from sources of EMI
- Safeguards against excessive vibration
- Sizing shall include projected future as well as present requirement.
- Equipment not related to the support of the equipment room shall not be installed in, pass through, or enter the equipment room.

Design Considerations

- Minimum clear height of 2.4m (8 ft.) without obstruction.
- Protected from contaminants and pollutants.
- Access to backbone pathways.
- HVAC provided on a 24 hours-per-day, 365 days-per-year basis.
- Temperature and humidity controlled range 18° C (64° F) to 24° C (75° F) with 30% to 55% relative humidity measured 1.5m (5 ft.) above floor level.

- Separate power supply circuit shall be provided and terminated in its own electrical panel.
- Minimum lighting 500 ix (50 foot candles). Switch location shall be near entrance door to room.
- Minimum door same as telecommunications closet. Double doors without center post or sill is recommended.
- Access to ground per ANSI/TIA/EIA-607.

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21.21.6**MAIN TERMINAL SPACE**

Centralized space that houses the main cross-connect. Commonly used as a separate space in multi-tenant buildings to serve all tenants.

- Location considerations are as specified for equipment room.
- Provisioning area as specified for telecommunications closets except power is reduced to convenience receptacles.

21.21.7**ENTRANCE FACILITY**

Consists of the telecommunications service entrance to the building and backbone pathways between buildings.

Location

- Providers of all telecommunications services shall be contracted to establish requirements.
- Location of other utilities shall be considered in locating the entrance facility.
- Alternate entrance facility should be provided where security, continuity or other special needs exist.
- Equipment not related to the support of the entrance facility should not be installed in, pass through, or enter the telecommunications entrance facility.
- Dry location not subject to flooding and close as practicable to building entrance point and electrical service room.

Design Considerations.

- Accommodate the applicable seismic zone requirements.
- A service entrance pathway shall be provided via one of the following entrance types: Underground, buried, Aerial, Tunnel.

- Minimum one wall should be covered with rigidly fixed 20mm (0.75 in.) A-C plywood.
- Minimum lighting same as telecommunication closet.
- False ceilings shall not be provided.
- Minimum door same as telecommunications closet.
- Electrical power same as telecommunications closet. No convenience receptacles mentioned.
- Grounding same as telecommunications closet.

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21.21.8**MISCELLANEOUS**

- Fire stopping per applicable code
- Horizontal pathway separation from Electromagnetic interference (EMI) sources:
    - Separation between telecommunications and power cables (Article 800.52 of ANSI/NFPA 70)
    - Building protected from lighting (ANSI/NFPA 780 (Ref D.4)
    - Surge protection (Article 280 of ANSI/NFPA 70 and 9.11 of ANS/IEEE 1100 (Ref D.1)
    - Grounding (ANS/TIA/EIA-607)
    - Corrected faulty wiring (Section 7.5 of ANSI/IEEE 1100)
- 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
    - Use fully enclosed grounded metallic raceway or locate cabling near grounded metallic surface.

21.22 **TIA/EIA-569-A-1**
Perimeter Pathway Addendum

This addendum deals with the constriction, applications, premises design and installation of perimeter pathways also known as surface raceway systems

It describes both single and multi channel systems mounted on walls s at a variety of heights and directions. The sizing of such pathways are based on 40% fill for initial installations but allows up to 60% fill for moves adds or changes to the installed cabling system during its life cycle. Fitting for perimeter raceway systems must allow for the band radius requirements of the installed cable.

21.23 **TIA/EIA-569-A-2**

Furniture Pathway Fill Addendum.

The sizing of such pathways are based on 40% fill for initial installations but allows for up to 60% fill for moves, adds and changes to the installed cabling system during its life cycle. Furniture fittings such as outlets and connectors used to terminate the installed cables need to be considered when determining the percentage of fill. Fish and pull techniques may result in reduced capacity of the pathway as compared to furniture manufacturers which allow placing cables into the pathways.

PART 21: TECHNICAL SPECIFICATIONS FOR COMMUNICATION SERVICES

21.23.1**SP-4198**

Revision to subclause 4.3, "Access Floor", of TIA/EIA-569-A

Introduces low profile floors as compared to standard height floors. Low profile floors are 6" or lower while standard height floors are 6" or greater. This revision describes the use of access floors as it refers to guidelines and installation.

21.23.2**SP-4517**

Addendum 4 to ANSI/TIA/EIA-569-A Poke-Thru Devices

A poke-thru is a device for routing cables through a floor while maintaining the fire-rating integrity of the floor. These devices are an option for routing horizontal cables when other pathway types are not typical. Types include flush floor mount and those that rise up above floor level, also known as pedestal, raised, tombstone or monument.

PART 22: TECHNICAL SPECIFICATIONS FOR INSTALLATION OF UPS SERVICES

PART 1: DESCRIPTION

22.0 Introduction

This technical specification describes an electronic Uninterruptible Power Supply (UPS) with a three-phase input and output, connected in series between the electrical distribution system and the load. This system is designed to operate in conjunction with the electrical distribution system of a building in view of supplying the load with a clean and uninterrupted source of power, regardless of disturbances on the upstream AC power system.

22.1 System Operation

Double-conversion (on-line) UPS, designed to operate in the following modes:

22.1.1 Normal

The UPS must continuously supply the critical loads.

The rectifier/charger draws alternating current (AC) from the normal AC input source and converts it into direct current (DC) for the inverter while simultaneously maintaining the battery charged.

22.1.2 Battery Backup

In the event of a failure of the normal AC input source, the critical loads are supplied by the inverter with power from the battery.

22.1.3 **Battery Recharge**

When the normal AC input source has been restored, the rectifier/charger again supplies the load via the inverter and recharges the battery. The inverter supplies current identical to that supplied during operation in normal mode.

22.1.4 **Via the Automatic Bypass**

In the event of UPS shutdown (voluntary or not), the automatic bypass ensures no-break transfer of the critical loads to the bypass AC source. Transfer back occurs automatically when the UPS has returned to normal operation.

22.1.5 **Via the Manual Bypass (maintenance / test)**

A manual-bypass switch to be used to isolate the inverter output and the automatic bypass for maintenance purposes. This facility to make it possible to repair the UPS without interrupting the load which remains supplied directly by the normal AC source.

22.1.6 **Economy Mode (For Less Sensitive Loads)**

On this mode, the UPS to operate as follows:-

The load is supplied by the bypass AC source via the automatic bypass. If the source fails or goes out of tolerance, the load is automatically transferred to the inverter without any interruption. No-break transfer back to the bypass AC source is carried out when the source returns to within tolerances.

22.2 **Rectifier/Charger**

22.2.1 **Operation**

A solid-state rectifier, fully microprocessor controlled, to be provided to convert the AC power from the normal AC input source into regulated DC power. A temperature sensor is to be provided for regulation as a function of temperature. The power is then filtered to supply the inverter and charge the battery. The rectifier/charger to be sized to support an inverter supplying full rated load and simultaneously charge the battery to 95% of its full capacity over a period equal to ten times the battery backup duration.

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22.2.2 **Input protection**

The input of the rectifier/charger is to be protected by fuses.

22.2.3 **Input current limiting**

125% of the rated input current.

22.4 **The Battery Bank**

A battery bank shall be provided to give back-up of not less than 15 minutes.

22.5 **The Inverter**

22.5.1 **Operation**

The inverter to be made up of three inverter legs with IGBT transistors. To operate in free-frequency mode with pulse width modulation (PWM) and have a built-in transformer.

22.5.2 **Input Voltage and Frequency**

Voltage : 415V $\pm$ 20%

Frequency: 50Hz $\pm$ 7.5%

22.5.3 **Output voltage and frequency**

Voltage : 415V ± 1.5%

Frequency: 50Hz ± 1%

22.5.4 **Thermal Overloads**

The inverter to operate for a maximum time that depends on the current drawn, before shutting down to protect the various components against excessive temperature rise. The permissible operating times are listed below (where P.F. □= 0.8):

2 hrs for 1.05 In to 1.1 In

30 minutes for 1.1 In to 1.15 In

PART 22: TECHNICAL SPECIFICATIONS FOR INSTALLATION OF UPS SERVICES

10 minutes for 1.15 In to 1.25 In

3 minutes for 1.25 In to 1.35 In

1 minute for 1.35 In to 1.65 In.

22.5.5 **Steady-state variations**

+/- 1% in voltage for the rms values of the phase-to-neutral and phase-to-phase voltages.

22.5.6 **Synchronisation range**

0.25 to 2 Hz (0.5Hz as standard) adjustable in 0.25 Hz steps.

22.5.7 **Dynamic performance**

operation with battery (battery-backup mode):

+ 2% / - 2% for load steps of 100% to 0 and 0 to 100%.

operation without battery (normal or battery-recharge mode):

+ 2% / -4 % for load steps of 100 % to 0 and 0 to 100%.

return to the 1% range (rms value) in less than 20 ms.

22.5.8 **Performance with non-linear loads**

All phase conductors to be sized for the rated current.

The neutral conductor to be sized for 1.5 times the rated current.

load crest factor: up to 3

output-voltage (Ph-Ph) distortion = 2 % maximum.

output-voltage (Ph-N) distortion = 3 % maximum.

22.6 **Automatic Bypass**

The automatic bypass to be sized for continuous operation under the following conditions:

PART 22: TECHNICAL SPECIFICATIONS FOR INSTALLATION OF UPS SERVICES

22.6.1 **Transfer without interruption to the load**

The automatic bypass to ensure automatic, no-break transfer of the load to the bypass AC source when the control logic detects one of the following situations:

a. the load is greater than the UPS rated power;

b. battery backup time has elapsed and the bypass AC source is available;

c. UPS failure.

22.6.2 **Bypass source tolerances / transfer conditions**

The bypass AC source MUST BE within tolerances and MUST accept no-break load transfers

from the inverter if:

a. voltage is within the range Un - 20% to Un + 20%;

b. frequency is within the personalised tolerances;

c. phase shift between inverter and bypass-source voltages less than 3 degrees.

22.6.3 **Manual Transfer**

It must be possible to carry out a manual transfer from the UPS control panel.

22.6.4 **Overload Capacity of the Automatic Bypass**

Thermal overloads < 1.35 In: same overload capacity as the inverter (no derating for power factor)

Overloads > 1.35 In: 1 minute.

The short-circuit capacity (x In) for 20ms at 415V to be 23/In.

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22.7 **Maintenance Bypass**

The UPS to be equipped with a maintenance bypass which may be used to transfer the load directly to the bypass AC source.

This to be carried out using three switches. Step by step help to be provided on the front panel of the UPS when the doors are open.

The manual-bypass switch to isolate the inverter output and the automatic bypass for maintenance purposes. Prior to transferring the load to the maintenance bypass, the UPS (or the parallel-connected UPS units) must be shut down.

22.8 **Micro-processor-based control functions**

The UPS control circuits to be microprocessor-based. All operations and parameters to be managed by internal software. Manual settings and potentiometers will not be accepted. Self-test and diagnostics circuits to be used to detect and isolate a fault, right down to the PC-board or wiring connections.

22.9 Control and Indication Panel

The UPS to be equipped with a control panel comprising system-status indications that may be used to control, monitor and display various system functions and parameters. The graphic display to be capable of displaying data in English, French, Spanish, Dutch, Italian, German, Swedish, Portuguese and, as an option, in Kiswahili

22.9.1 System Parameters

The following parameters to be displayed:

- input voltage (phase-to-phase);
- input current per phase;
- bypass input voltage (Ph/Ph and Ph/N);
- bypass input frequency;
- inverter output voltage (Ph/Ph and Ph/N);

PART 22: TECHNICAL SPECIFICATIONS FOR INSTALLATION OF UPS SERVICES

22.9.1 System Parameters

- inverter output current per phase;
- input, output and bypass frequency;
- percent load on inverter;
- inverter output power factor;
- inverter output in kVA and kW;
- DC voltage;
- crest factor;
- battery current (charge/discharge);
- battery backup time and remaining service life;
- temperature in the battery cabinet.

22.9.2 Mimic Panel

Five LEDs to indicate the status of the following elements:

- rectifier/charger;
- battery;

- automatic bypass;
- inverter;
- load.

22.9.3 **Buzzer OFF button**

This button to be provided to turn the buzzer OFF. However, a new malfunction will activate the buzzer again.

22.9.4 **Complete Shutdown**

Pressing the "complete shutdown" button to activate the following:

- shutdown of the inverter;
- opening of the static switch on the bypass;
- opening of the battery circuit-breaker;

It should be possible to activate the "complete shutdown" function externally via a relay contact in order to implement an EPO (Emergency Power Off) function.

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22.10 **Event Log**

This PC board should have a capacity to store at least 500 events (alarms, UPS status information, etc.). It should also provide statistical information on the UPS parameters (battery backup time, number of transfers to battery power, number of transfers to the automatic bypass, current limiting, operating time on the inverter and on the bypass AC source).

It should be possible to access this information locally on the standard display or on a remote terminal via the JBUS protocol.

22.11 **Optimised Footprint**

It should be possible to position the UPS cabinet against a wall. It will be the contractor's due to give information on the cabling (size/type) required, and the floor cable trenches, cable trays, trunking etc. which may be required for efficient cable management and termination.

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PART 2:INSTALLATION

22.12 **Positioning**

22.12.1**Layout of Cabinets on a False or Normal Floor**

The attached diagrams show the required clearances for the UPS installations.

22.13 Cable Sizes

22.13.0 Electrical Parameters to Determine Cable Size for EACH UPS Unit will be as follow

22.13.1**Live Current**

- Normal AC Source (240/415V): 30A for 20 KVA, 70A for 50 KVA
- By-pass AC Source (240/415V):30A for 20 KVA, 70A for 50 KVA
- Battery 60A for 20 KVA, 140A for 50 KVA

22.13.2**Cable Size (mm²)**

- Normal AC Source (240/415V): 16mm² for 20 KVA, 25mm² for 50 KVA

- By-pass AC Source (240/415V): 16mm² for 20 KVA, 25mm² for 50 KVA,
- Battery 2x16mm² for 20 KVA, 2x25mm² for 50 KVA,

22.14 **Upstream Protection**

Max permissible level : 23 In

Recommended circuit breakers are :

20 KVA

- Normal AC input: MG NS 63N 1P with STR23E trip unit.
- By-pass AC input: MG NS 63N 1P with STR23E trip unit

50 KVA

- Normal AC input: MG NS 125N 3P with STR23E trip unit.
- By-pass AC input: MG NS 125N 3P with STR23E trip unit

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22.15 **Downstream Protection**

These protection devices ensure discrimination on each of the outgoers downstream of the UPS. If the downstream protection indications are not observed and a short-circuit occurs on one outgoer, the result may be an outage longer than 20 ms on all the other outgoers.

The following circuit breakers are recommended – (on 415V A/C input):-

MG NS 100N with TM 80D trip unit.

PART 3: ARCHITECTURE

22.16 **Single-UPS Configurations**

22.16.1 **Single UPS in normal mode**

A single UPS is a modular unit made up of:

two AC inputs

a rectifier/charger

a battery

an inverter

a static switch (automatic bypass)

a manual bypass (maintenance bypass)

In normal mode, the load is continuously supplied by the rectifier and inverter modules. If the normal AC source fails, the static switch ensures no-break transfer to battery power (battery mode). The load is transferred to the bypass AC source only if the inverter fails or the battery has reached the end of its backup time.

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22.11.6.2**Single UPS in Economy mode**

This operating mode must be part of the UPS basic design.

It increases efficiency by using the bypass AC input as long as its power characteristics remain within strict tolerances (those of the load).

The system must automatically transfer to normal mode if the power characteristics on the bypass AC input go out of tolerances. The system must transfer to battery mode if the normal AC source is not available and the bypass AC source is out of tolerances.

22.16.3**Single UPS operating as a frequency converter**

Operation as a frequency converter is similar to normal mode. However, because the frequencies upstream and downstream are different, bypassing is not possible from the AC input and the automatic and manual bypasses are therefore not included. A static switch ensures automatic, no-break transfer to the battery in the normal AC source fails.

PART 22: TECHNICAL SPECIFICATIONS FOR INSTALLATION OF UPS SERVICES

22.17 Parallel Configurations

22.17.1 Modular Active Redundancy (2 modular UPSs)

In this type of configuration, parallel connection is intended to increase overall UPS reliability through redundancy.

The UPS units are identical and equally share the load. The load rating is less than or equal to the rating of a single UPS unit, such that if one unit fails, the other can continue to supply the entire load.

This type of redundancy is called 1/2.

Parallel connection must be carried out without interrupting the supply of power to the load because each UPS unit is equipped with a maintenance bypass.

22.17.2**Modular Parallel Connection for Capacity (3 or 4 units)**

In this type of configuration, parallel connection (up to 4 units) is intended to increase the overall capacity and provide redundancy.

The UPS units are identical and equally share the total load, with some redundancy.

Example: a UPS configuration with 1/3 redundancy means that there are a total of three UPS units. If one unit fails, the other two can still provide enough power for the entire load.

Parallel connection must be carried out without interrupting the supply of power to the load. The UPS system is made up of identical units with a common external maintenance bypass sized to handle the overall power rating.

22.17.3**Hot Standby Redundancy**

In this configuration, one UPS unit backs up the other. If the downstream unit fails, the static switch transfers the load to the upstream unit without a break in the supply of power. This configuration offers the highest level of availability and protection.

PART 22: TECHNICAL SPECIFICATIONS FOR INSTALLATION OF UPS SERVICES

PART 4: STANDARD FUNCTIONS

22.18 **Cold Start**

This function makes it possible to start the UPS even when the AC input source is absent. The power is supplied by the battery for a period determined by the battery charge level and the power required by the load. However, the battery discharge time should never exceed three times the rated backup time plus two hours.

22.19 **Intelligent Economy mode**

For less sensitive loads, the Economy mode options should be provided to reduce energy consumption. Under normal conditions, the load is supplied continuously by the bypass AC source via the automatic bypass. If the power supply fails or is no longer within tolerances, i.e. voltage outside the permissible ± 20% in amplitude (±25% as an option) or ± 2 Hz, the load is transferred to the inverter. The time required for transfer should be less than 15 ms.

22.20 **Start on engine generator set**

The following features should be provided for use with a standby generator:-

22.20.1**Charger walk-in lasting 6 to 10 seconds**

This function (see fig. 19) avoids an excessive inrush current at start-up that could disrupt engine generator set operation.

22.20.2**Time Delay**

This function, in conjunction with the walk-in, delays charger start. The purpose, in installations comprising multiple UPS units, is to avoid simultaneous starts that could disrupt engine generator set operation.

PART 22: TECHNICAL SPECIFICATIONS FOR INSTALLATION OF UPS SERVICES

22.20.3**Power and Battery Charge Current Limiting**

The UPS should be set to carry out one of the following limiting functions when an external signal is received via an auxiliary contact:

limiting of the power drawn by the rectifier-charger in kVA. In this case, part of the power can be supplied by the battery for a period of up to 3 times the rated backup time.

limiting of the charge current to 0 A, thereby stopping the charger to limit the power drawn during operation on an engine generator set.

22.20.4**Battery-Room Ventilation Fault**

It should be possible to set UPS parameters such that when an external signal is received via an auxiliary contact, the rectifier/charger shuts down when a ventilation fault in the battery room is detected. Reset must be manual for the system to restart (safety function).

22.20.5 **Advanced Battery Management**

The UPS unit should optimise the service life of the battery and continuously maintain a high degree of operational security by ensuring the following functions:

-calculation of the true available backup time, taking into account the battery age, the temperature and the charge level;
-estimation of the battery service life;

-protection against excessive discharges;

-regulation of battery voltage depending on the temperature, which increases battery service life;

-limiting of battery current;
-automatic battery testing:

-battery discharge at programmable time intervals;

-battery status, used for preventive detection of battery faults;

PART 22: TECHNICAL SPECIFICATIONS FOR INSTALLATION OF UPS SERVICES

22.20.5 **Advanced Battery Management**

-continuity of the battery circuit;

-protection against deep discharges depending on the discharge curves and battery isolation by the circuit breaker;

-progressive buzzer indicating the end of backup time;

-temperature monitoring used to:

-regulate the charger voltage depending on the temperature in the battery room;

-warn the operator if the set permissible temperatures are overrun;

-enhance the accuracy of the battery backup time calculation carried out by the standard UPS function.

PART 5: COMMUNICATIONS FUNCTIONS

22.21 **Standard Communication**

22.21.1 **Media contact card**

This board to provide isolated relay contacts 250 V 5 A (6 x 2 changeover contacts) that may be used to activate indicating lights or buzzers to inform the user of the operating status of the UPS and the battery, for the following information:

- load on UPS;
- load on battery power;
- load on bypass (maintenance position);
- low-battery warning;
- general alarm;
- complete shutdown.

PART 22: TECHNICAL SPECIFICATIONS FOR INSTALLATION OF UPS SERVICES

PART 6: OPTIONS

22.22 **"BACKFEED" Protection on Bypass AC Input**

The bypass AC input should be optionally equipped with a device to prevent flow of battery current upstream via the automatic bypass.

This device, placed upstream of the static switch, mechanically disconnects the bypass AC input when the load is transferred to battery power or if the bypass AC source fails. It ensures complete safety for persons servicing the installation upstream of the UPS.

22.23 THM (Total Harmonic Management) Filter

22.23.1 Total Control over Harmonics

The UPS should offer a complete set of solutions to control harmonic phenomena in low-voltage installations. The solutions to cover both harmonics re-injected upstream of the UPS and those created by non-linear loads.

These solutions should comprise:

harmonic filters (see below "other harmonic filters):

passive filters using inductors and capacitors;

active filters, that calculate and compensate harmonics in real time:

SineWave active harmonic conditioners, the universal solution to eliminate harmonics at all points in low-voltage installations;

on-site evaluation visits with guaranteed results for the proposed solution.

22.23.2 THM (Total Harmonic Management) built-in filters

The THM filters built into the UPS to use the SineWave active harmonic conditioner technology, optimised to provide the most cost-effective solution for each UPS.

The filter considerably to reduce the harmonic current reinjected into the distribution system, thus avoiding disturbances for loads. It is also a means to increase the power factor upstream of the UPS.

22.23.3 Other harmonic filters

In addition to built-in THM filters, the following harmonic-filtering should be provided:

non-compensated filters to filter one or a number of fixed harmonics;

compensated or dynamic filters, depending on the case, intended for use when an engine generator set supplies the UPS ;

SineWave active harmonic conditioner, the most effective solution because the system automatically adapts to the harmonics drawn, whatever their spectrum. As a result, the electrical distribution system continuously supplies a perfect sinusoidal current wave.

22.24 **MultiSlot**

MultiSlot is a device which adapts the UPS to the communications protocols of the applications (computer and electrical) by combining three functions.

22.24.1**Expansion Module for Communications Cards**

MultiSlot expands UPS communications capacity if the number of available ports or slots is not sufficient.

Two MultiSlot units can be connected in series to use up to seven communications cards.

22.24.2**Protocol Converter**

MultiSlot converts Basic relay-contact or U-Talk serial communications to the ASCII, SNMP and JBus protocols.

For these two functions, MultiSlot uses a U-Talk/Basic acquisition card.

PART 22: TECHNICAL SPECIFICATIONS FOR INSTALLATION OF UPS SERVICES

22.24.3**Data Concentrator for parallel UPS systems**

MultiSlot monitors an installation made up of two UPS units. It provides an overall view by concentrating the data from the connected units.

22.25 **LED indications unit**

The LED indications unit gives remote indication of the main operating-status information on the UPS.

It supplies the following information via LEDs and a buzzer:

load on battery power;

low-battery warning;

inverter off;

general alarm.

It should be equipped with a battery to ensure operation even in the event of a power outage.

22.26 **Battery Circuit-Breaker Enclosure**

The battery circuit breaker should be housed in an enclosure.

22.27 **External Manual Bypass Enclosure (for greater capacity)**

An external Manual by-pass system, rated 450A (3-phase), should be provided across the UPS. The by-pass system should comprise a 450A TP/N manual change-over switch, 3 No. 450A TP MCCB to isolate manual supply, UPS supply, and load respectively. All the above devices to be enclosed in a common solidly bonded enclosure with adequate internal space for cable management and proper termination.

22.28 **Software**

A software should be included to control and monitor the electrical installation from a PC-type supervision station. To access the commands and measurements for the supervised UPSs, simply click the functions displayed on the screen.

PART 22: TECHNICAL SPECIFICATIONS FOR INSTALLATION OF UPS SERVICES

22.29 **External Surge Protection**

An external surge protection device should be provided to offer surge protection in the ratio 5000:1.

22.30 **Teleservice**

Teleservice is a means to provide continuous remote monitoring of the UPSs via a modem built into the UPS and connected to a telephone line.

22.31 **Voltage – Matching Transformer**

This transformer is to be provided to:
match the electrical distribution-system voltage to hat of the UPS;

create galvanic isolation between the load and the normal AC input source or to set up a suitable system earthing arrangement.

PART 23: TECHNICAL SPECIFICATIONS FOR ACCESS CONTROL SYSTEM

23.0 GENERAL TENDER REQUIREMENTS

23.0.1 The tenderer shall include for the design, cost estimation, supply and commissioning of a complete, integrated access control and alarm point monitoring system, compliant with the technical and performance criteria set out in this document.

The system shall broadly comprise the following:

a) A central administration computer (PC) for the system administration, addition and editing of tokens/cards, report generation and acknowledgement of system alarms.

b) Door controllers and door functions.

c) Readers, door monitoring contacts and exit switches.

d) Alarm control functions on fire doors and other auxiliary alarm points.

23.0.2 The tenderer shall supply a complete and functionally working system including all control equipment, hardware and software, cabling and ancillary services. The tenderer is to make himself familiar with all matters related to the system, its requirements and installation.

23.0.3 The tenderer shall seek clarification of any relevant matters (insert a suitable contact name and telephone number).

23.0.4 After the tender has been awarded there shall be no price variation without prior agreement.

23.0.5 A complete clause by clause compliance response is required.

PART 23: TECHNICAL SPECIFICATIONS FOR ACCESS CONTROL SYSTEM

23.0.6 The systems control software and hardware shall be designed, manufactured and originate from reputable manufacturers, who shall comply with BS EN ISO 9002 or such equivalent standard in the country of origin.

23.0.7 The tenderer shall demonstrate his competence with the equipment he is tendering by either:

The tenderer shall obtain a letter signed by a company director or head of training from the original equipment manufacturer. The letter must state the name of tendering company and a statement to the effect that the tenderer is of sufficient competence to install the tendered equipment.

The tenderer shall provide proof in the form of training certificates from the original equipment manufacturer. Certificates will contain named individuals and the course applicable to the equipment being tendered. The named individuals must be employed by the tenderer and play an active part in the installation of equipment.

23.1 GENERAL SYSTEM FUNCTIONALITY

23.1.1 Electronic Key

23.1.1.1 The access control system shall be based on a non-contact proximity reader technology. The method of operation shall be based on electro-magnetic induction.

23.1.1.2 Each electronic key or card (token) shall have a unique pre-programmed code. The code shall be set at the time of manufacture and must not be capable of being reproduced. Programmable tokens are not acceptable. The token shall have a code that produces no less than sixty-eight (68) thousand million different possible combinations.

23.1.1.3 Any token can be enrolled on to any system in the world. Tokens that contain a facility or site code are not acceptable. Existing tokens must be able to be enrolled on to the system.

23.1.1.4 The token shall be capable of being attached to a key ring and shall be read when held amongst mechanical metal keys. The token shall carry a minimum of 15 years manufacturer's guarantee against electronic failure.

23.1.1.5 The token shall be a credit card sized flat card and have a thickness of no greater than 1.3 mm. The card shall have an option of a high coercivity magnetic stripe and shall allow the printing of a photo ID directly on to the surface of the card. The card shall carry a lifetime manufacturer's guarantee against electronic failure.

23.1.1.6 The token shall not contain a battery.

23.1.1.7 If the system uses "Master" or "Editor" then these tokens shall not be different from any of the other tokens. Any token shall be able to be selected and used as a Master or Editor token. If a Master or Editor token is lost then the system must accept a new master or editor from any of the existing tokens.

23.2 READER AND READER HOUSING

23.2.1 The readers shall be a designed for general purpose use and be suitable for interior or exterior installation. They shall be slim units with a pleasing appearance that blend in with most installation requirements. Ideally the units shall be made of flame retardant plastic. All readers will carry a lifetime warranty against electronic failure.

23.2.2 Two sizes of standard reader are required:

a) Surface mounted to fit a standard UK single gang electrical back box with 60 mm screw spacing. The reader shall have dimensions no greater than:

86 mm (H) x 86 mm (W) x 15 mm (D)

b) A slimline reader to be mounted on door mullions is also required. It shall have dimensions no greater than the following:

130 mm (H) x 40 mm (W) x 15 mm (D)

23.2.3 The readers shall be capable of internal or external mounting without additional environmental protection and shall operate from -20 □C□to +50 □C. All reader types must be of a fully potted assembly and capable of being mounted on exterior walls without additional weather protection.

23.2.4 All readers shall be capable of being mounted on a metallic surface or behind non-metallic materials without any adverse effect on the ability to read the token.

23.2.5 Reading of the token shall be 100% reliable with no misreads. There shall never be a need to present the token to the reader a second time.

23.2.6 The reader cabling shall use multi-stranded unscreened six core cable and the reader shall be capable of operating up to 1,000 metres from its control unit without the need of an additional power supply. Cable from the reader shall be permitted to run next to mains carrying conductors without adverse effect.

23.2 READER AND READER HOUSING

23.2.7 The reader shall incorporate tamper detection to signal that the connecting wires have been broken. This shall be achieved without the use of a tamper switch.

23.2.8 The reader shall incorporate an LED(s). The LED(s) will operate in the following manner:

- LED is constant red when door is closed and secure.
- LED turns green on successful access and remains green until the door lock is re-secured.
- LED(s) flash when an unsuccessful access attempt has been made.

and/or

Vandal Resistant Readers

23.2.9 Vandal resistant readers are to be manufactured from brushed finished stainless steel. The stainless steel shall be of no less than 16 gauge (1.6 mm) and to BS 1449 grade 304.

23.2.10 The reader shall be fixed with a key symbol on its front and its dimensions shall be no greater than the following:

100 mm (H) x 100 mm (W) x 16 mm (D)

23.2.11 It shall be secured with non-standard tamper proof screws.

and/or

PART 23: TECHNICAL SPECIFICATIONS FOR ACCESS CONTROL SYSTEM

23.2 READER AND READER HOUSING

Vandal Resistant Brass Readers

23.2.12 Vandal resistant readers are to be manufactured from lacquered brushed finished brass. The brass shall be of no less than 12 gauge (2 mm) and of CZ 108 half hardened to BS 2870.

23.2.13 The reader shall be fixed with a key symbol on its front and its dimensions shall be no greater than the following:

100 mm (H) x 100 mm (W) x 16 mm (D)

23.2.14 It shall be secured with non-standard tamper proof screws.

and/or

Token and PIN Reader

23.2.15 For more sensitive areas a higher security level may be required. In these areas a token and personal identification number (PIN) reader shall be used. The mode of operation shall be such that a token only can be used or token and PIN. This shall be automatic and programmable from the reader's door controller or the administration PC.

23.2.16 The reader shall be finished in stainless steel surround and shall be flush mounted with the following maximum dimensions

144 mm (H) x 100 mm (W) x 35 mm (D) and protrude no more than 5 mm from flush.

OR

PART 23: TECHNICAL SPECIFICATIONS FOR ACCESS CONTROL SYSTEM

23.2 READER AND READER HOUSING

23.2.17 The reader shall be finished in lacquered brushed finished brass surround and shall be flush mounted with the following maximum dimensions:

144 mm (H) x 100 mm (W) x 35 mm (D) and protrude no more than 5 mm from flush.

OR

23.2.18 The reader shall be finished in stainless steel and shall be surface mounted with the following maximum dimensions:

200 mm (H) x 100 mm (W) x 30 mm (D)

OR

23.2.19 The reader shall be finished in lacquered brushed finished brass and shall be surface mounted with the following maximum dimensions:

200 mm (H) x 100 mm (W) x 30 mm (D)

PART 23: TECHNICAL SPECIFICATIONS FOR ACCESS CONTROL SYSTEM

23.3 DOOR CONTROLLERS

23.3.1 The access control system must be of high integrity and therefore must employ door controllers with fully distributed intelligence with no degraded mode of operation. There shall be no loss of functionality in the event of communications interruption. The relationship of door contact inputs, auxiliary inputs and system alarms to relay outputs must be maintained at all times. Systems that have a degraded mode of access in the event of communications interruption, especially any that will allow access by site code only will not be accepted.

OR

23.3.2 The door controller shall store up to 1000 transactions and have the ability to be connected to a modem via a build in serial port. The door controller shall have the ability to have keys added and deleted by a remote PC over the public telephone network.

23.3.3 The door controller shall unlock the controlled door within 0.3 seconds from the completion of a valid access attempt. It should be possible to lengthen others, or shorten, this time duration through the ……

23.3.4 The door controller shall report the following to the PC administration system:

Access Authorised

No Access - Level

- Locked Out
- Time
- Unknown ID
- Visit Time

No Entry - Passback

No Exit - Passback

Entry Authorised (for anti-pass back doors)

Exit Authorised (for anti-pass back doors)

PART 23: TECHNICAL SPECIFICATIONS FOR ACCESS CONTROL SYSTEM

23.3 **DOOR CONTROLLERS**

PIN Reader Duress

Incorrect PIN

Exit Out of Hours

Repeated Key Use

Request For Exit

Request For Entry

23.3.5 The reader technology offered shall be proximity. The principle of operation shall be electro-magnetic induction. The door controller must also support other reading technologies.

23.3.6 The door controller shall have an option of an in-built user interface comprising of a keyboard, display and administration reader. The keyboard shall have at least 40 individual keys consisting of the ten numeric and 26 alphabetic characters. The display shall be of at least 16 characters and shall be clearly visible in darkness.

23.3.7 The user interface shall display the state of any attached auxiliary inputs and any alarms that occur within the door controller. If communications are interrupted to the controller then an audible sounder will sound and a short English language description of the alarm displayed. The sounder may be silenced by a nominated editor or master token being presented to its administration reader.

23.3.8 All events must be DATE and TIME stamped at the door controller as they occur.

23.3.9 The system must maintain a system clock and all door controllers must be automatically synchronised for DATE and TIME at least once a day.

23.3.10 To ensure the integrity of the system if power to the door controller is lost (both mains supply and back-up battery) then the controller's data must be maintained in non-volatile memory. If communications are interrupted before power failure then all events must be maintained.

PART 23: TECHNICAL SPECIFICATIONS FOR ACCESS CONTROL SYSTEM

23.3 **DOOR CONTROLLERS**

23.3.11 The door controller must have a minimum of a 2,500 event transaction log that stamps the time and date at source and not when received by the central controller.

23.3.12 To increase reliability, the lock outputs shall be a solid state device and not a relay. The solid state device must have a selectable output, capable of sourcing power to its attached lock at 12V DC at 1 Amp or 24V at 0.5 Amps continuous.

23.3.13 The solid state lock output must be protected against short circuit and overload.

23.3.14 The door controller shall control no more than eight doors. When anti-pass back is implemented the controller shall control no more than two doors.

23.3.15 Anti-pass back shall be implemented within the controller. Pass back between the two doors shall not be affected by communication interruptions.

23.3.16 Timed anti-pass back shall be available so that a token holder violating the pass back rules shall be refused access for a minimum of ten minutes after his next attempt to gain access.

23.3.17 When turnstiles are used the door controller set-up shall be selectable so that the IN reader can operate one lock output and the OUT reader another lock output and yet be reported as the same turnstile. Alternatively the door controller set-up shall be selectable so that both readers can operate the same lock output.

23.3.18 The door controller shall include an integral power supply. This power supply shall have sufficient capability to deliver power to the controller and up to four readers. It shall also provide power for up to four locks continuously rated at 12V DC at 1 Amp or 24V DC at

0.5 Amps. The power supply shall in addition provide sufficient charge for two 6.0 Amp hour standby back-up batteries.

23.3.19 The controller shall monitor its readers for cable tamper.

PART 23: TECHNICAL SPECIFICATIONS FOR ACCESS CONTROL SYSTEM

23.3 DOOR CONTROLLERS

23.3.20 The door controller shall be networked on to a data bus whose maximum length is not less than one thousand metres. The data bus shall be a single unscreened cable of no more than eight multi-stranded conductors.

23.3.21 The door controller shall have a card holder data base of at least 10,000 token holders on systems of up to 32 doors and at least 18,000 token holders on larger systems.

23.3.22 Visitor tokens are required. These shall be the same as personnel tokens but be allocated a start and finish date for their validity on the system.

23.3.23 The door controller shall have a minimum of four auxiliary output relays. These relays shall be programmed via the PC administration system to respond to auxiliary inputs or door controller alarms. Each relay may be operated according to a time profile.

23.3.24 Each of the door controller's four doors shall have a door contact input. This input shall be used to indicate the following:

Unauthorised Access

Door Left Open

Door Closed

The door contact shall also indicate to the system when the door has been opened and closed after an authorised access or request to exit operation. Closing the door shall cancel any unused lock release time.

If anti-pass back is being used on a door, then an authorised access transaction is not reported until the door has actually opened.

23.3.25 The door controller shall be mounted in a secure metal cabinet of sufficient size to enable easy cable handling and room for at least two 6.0 Amp hour back-up batteries. It shall have dimensions no greater than:

450 mm (H) x 450 mm (W) x 100 mm (D)

PART 23: TECHNICAL SPECIFICATIONS FOR ACCESS CONTROL SYSTEM

23.3 **DOOR CONTROLLERS**

23.3.26 The door controller shall be programmable so that any controller can be configured to be a network master controller, a network slave controller, a dial-up remote master, or a stand alone door controller. The stand alone door controller shall have a serial RS232 printer output to print transactions and its database set-up. It shall also have a 2,500 event log with time and date stamping with individual token reporting.

23.3.27 The master door controller shall have the ability to be assigned an IP address so that it may function on a TCP/IP network as part of a LAN or WAN.

23.3.28 The door controllers shall have the capacity of being assigned one token as a master and at least 32 other tokens as editor tokens. The editor tokens can have restrictions placed on what functions they can carry out on the door controllers.

23.3.29 **Remote sites with dial-up connection to central network controller**

The door controllers shall if required have the ability of being connected to the system by a dial-up connection over public switch telephone network (PSTN) lines. The central network controller shall dial-up remote sites at least twice a day to download any changes to the system set-up and to receive all event information from the door controllers. You should also be able to utilise an X25 network using X28 PADs.

23.3.30 **Alarm dial-back on remote dial-up sites**

Sites that are connected by dial-up modem shall have the ability to call the central network controller at any time in the event of an alarm occurring at the remote site.

PART 23: TECHNICAL SPECIFICATIONS FOR ACCESS CONTROL SYSTEM

23.4 ALARM MONITORING

23.4.1 Alarm Event Managers (AEMs) shall be supported and shall be attached to the door controllers from which they derive their power. There shall be at least one AEM per reader channel. The AEM shall manage all auxiliary alarms and auxiliary relay outputs.

23.4.2 The AEM shall have a minimum of eight, four state inputs and eight switchable relay outputs. The relay contacts shall have a rating of no less than 2 Amps at 30 VDC or 0.4 Amps at 125 VAC. The inputs shall be selectable to be normally open or normally closed. The AEM must distinguish four states for each input. The input states are: Normal, Active, Open circuit and Short circuit.

23.4.3 Any of the door controllers 36 possible relay outputs (four AEMs and four onboard relays) can be activated by any event within the door controller.

23.4.4 Each relay output shall be programmed so that it can be operated by at least four separate events.

23.4.5 The AEM shall be fitted with a test button and an LED display so the states of each of the eight inputs can be displayed. The LED display shall indicate if each input is normal, active, short or open circuit. It shall also display the state of the case and reader tampers.

23.4.6 Each input shall have a name field of 45 characters and a description of each input that shall be no less than 300 characters long.

23.4.7 Alarm Inputs shall be able to be grouped according to area and will be able to be manually disabled via the central administration system, or alarms can be automatically activated or de-activated by the use of a time profile.

23.4.8 Alarm Inputs shall be able to be grouped according to area and can be enabled and disabled

23.4.9 An input shall also be able to be configured as a 24 hour input and will always be active.

PART 23: TECHNICAL SPECIFICATIONS FOR ACCESS CONTROL SYSTEM

23.4 **ALARM MONITORING**

23.4.10 Each input must have the ability of being configured as normally open or normally closed. Inputs will usually have four states, but may also be required to have two state inputs. Further alarm functions shall include "Acknowledge Required" and "Relay Follows Input". A graphic bit map may also be attached to each input and displayed when the alarm is being accepted.

23.4.11 To prevent the system being flooded by erroneous alarms a re-arm count shall be available. This shall be programmable so that from one to five alarm activation's within a time period will be transmitted as an alarm but and any alarm activation's after that will be ignored and the input described as being in an alarm state. The re-arm count will be reset once the alarm input is dis-armed and re-armed either manually or automatically by a time profile.

23.4.12 The AEM shall be housed in a 1.2 mm mild steel enclosure painted with an epoxy coating complete will tamper switch. It shall have dimensions no greater than 184 mm x 148 mm x 38 mm.

23.4.13 The AEM shall have a maximum cable distance from its door controller of no less than 500 metres.

PART 23: TECHNICAL SPECIFICATIONS FOR ACCESS CONTROL SYSTEM

23.5 ACCESS CONTROL / ALARM INTERFACE

23.5.1 Alarm interface managers (AIMs) shall be attached to the door controller and alarm panel. There shall be at least one AIM per two reader channels.

23.5.2 The AIM shall allow assigned security tokens to arm or disarm the linked alarm panel.

23.5.3 Ordinary keyholders shall be able to gain entry at the main entrance to the premises once the security keyholder has disarmed the alarm.

23.5.4 There shall be the facility to disable perimeter doors when the panel is armed by the use of reader inhibitor modules.

23.6 CENTRAL NETWORK CONTROLLER

23.6.1 The Central Network Controller (CNC) shall be located with the PC Administration system. It shall manage all communications to the door controllers. Connection to the local door controllers shall be via a six wire data bus. Remote sites shall use dial-up modems via the PSTN. The CNC shall manage all local and dial-up communications independently of the PC Administration system.

23.6.2 The CNC shall communicate with up to 128 sites. One of the sites shall be local and of at least 128 doors. At least 32 other sites shall be of at least 32 doors. The remaining sites

shall be of at least 4 doors. The CNC shall have at least three communications ports each of which maybe connected to a dial-up modem.

23.6.3 The CNC shall have a buffer of at least 10,000 events. It shall annunciate all alarms if the PC is off-line. Annunciation of the alarms will be via a scrolling display of at least 16 characters. It shall also have an audible warning alarm.

23.6.4 The time clocks of all controllers on the system, whether local or remote, shall be synchronised by the central network controller automatically at least once a day or manually by an authorised operator as required.

PART 23: TECHNICAL SPECIFICATIONS FOR ACCESS CONTROL SYSTEM

23.6 CENTRAL NETWORK CONTROLLER

23.6.5 It shall be possible to connect up to twenty CNCs to the system. The system shall have the possibility of expanding to at least 2560 sites with at least 30,640 doors.

23.6.6 It shall be possible to connect door controllers directly via serial RS232 rather than with the use of dial-up PSTN lines. In this case the system shall have a capacity of at least 4,480 doors.

23.6.7 As resilience and integrity of the system are of paramount importance the system shall have a distributed topography so that not more that four CNCs or master door controllers are connected to any work station or file server of the PC administration system. If the PC network fails then CNCs or masters connected to its associated work station will continue to function, gather transactions and announce alarms.

23.7 PC ADMINISTRATION SYSTEM

23.7.1 The administration system shall be based on PC's running under Windows NT4.0, Microsoft® Windows™ Version 3.11 or Windows 95 operating systems. In general the system shall be simple to use and to operate.

23.7.2 The PC shall not be solely dedicated to running the access control software. It must be possible to run other Windows programs such as word-processing or database programs on the PC at the same time. However any alarms that occur on the access control system must

be presented over those other applications without delay. Other programs that are running will be put into the background, but data and information must not be lost.

23.7.3 The PC shall meet the following specification:

- PC Pentium 800 Mhz processor, 128 Mb RAM, 4.0 Gb disk drive, 3.5 inch disk drive, CD Drive, PC sound card and speakers, Colour SuperVGA (800x600) display, with 256 colours, 32,000 colours when used with Photo, parallel, mouse and two serial ports, Windows 3.11, Windows 95 or Windows NT 4.0.

- One year on-site maintenance agreement for the PC.

PART 23: TECHNICAL SPECIFICATIONS FOR ACCESS CONTROL SYSTEM

23.7 PC ADMINISTRATION SYSTEM

23.7.4 The system shall archive all events and transactions to the PC hard disk. The hard disk shall store no less than 18,000 and up to 40,000 transactions per mega byte of hard disk.

23.7.5 The software shall be simple to upgrade and easy to expand from a small single site to a large multi-site, multi-PC system.

23.7.6 Multiple Workstations

The system shall have the capacity for at least 50 workstations including the main administration PC. These PC's shall be connected by a network.

23.7.7 System Divisions

The system may be split into 'divisions'. A division shall be a set of one or more sites. Each division will have its own personnel records, token and access information which will be stored in the door controllers on the site. The system shall have between 1 and 128 divisions, to administer independent installations from a central point.

Using divisions will simplify the administration of systems with a large number of sites and token holders. Token holders shall be able to exist in more than one division with the same ID device.

The administrator shall be able to restrict system operators as to which divisions they can edit and view database information. The system shall allow each PC on the system to be configured so as to only display transactions and alarms from designated divisions.

23.7.8 **Detailed on-line Help**

The system offered must have an on-line help facility. This shall provide details of all functions that the system can perform. It is considered imperative that the Help facility is context sensitive in that the Help menu or information given is relevant to the task the operator is performing.

PART 23: TECHNICAL SPECIFICATIONS FOR ACCESS CONTROL SYSTEM

23.7 **PC ADMINISTRATION SYSTEM**

23.7.9 **Editing and Administration reader**

Each PC or workstation on the system shall have an administration reader. This shall be provided either as part of the CNC or a PC interface kit. Operators must use their proximity token to log onto the system and to accept alarms. The use of an operator password may also be required. The administration reader shall also be used to enrol new tokens into the system and to identify tokens that are already in the system database.

23.7.10 **Operator Privileges**

Operators of the PC administration system must be uniquely identifiable. There shall be a minimum of 128 operators. Each operator shall have independent system privileges. The system shall record which operator is currently logged on. When system alarms require acceptance, regardless of which operator is currently logged on, the system shall ask for the operator's name and password. If authorised the operator should present their token to the administration reader to accept the alarm.

23.7.11 **Personnel Database**

The personnel database shall have at least 10,000 token holder records and on larger system configurations at least 18,000 token holder records per division. There shall be a capacity of at least 750 visitor records per division. There shall be up to 128 separate divisions on the system.

23.7.12 **Import and Export**

The system shall have a facility for importing or exporting the personnel database. The import and export shall be achieved via an ASCII text file with field separators.

23.7.13 **Card Trace**

The system shall have a facility to tag or track the use of a token. This facility shall be able to cause an alarm on PC. Access privileges of the token holder will remain the same and the token holder will be unaware that they are being traced.

PART 23: TECHNICAL SPECIFICATIONS FOR ACCESS CONTROL SYSTEM

23.7.14 **Extra information fields**

The personnel database shall have at least twenty extra information fields. The titles of these fields must be user definable. Each information field must be at least 120 characters in length. Each division shall have its own unique extra information fields.

23.7 **PC ADMINISTRATION SYSTEM**

23.7.15 **Departments and Work groups**

When adding new token holders it shall be possible to assign a Department and a Work Group to the token holder. Departments restrict the access groups that can be selected for each token holder record. There shall be at least 128 Departments per division. Work Groups are a subset of Departments and further restrict the number for access groups that can be chosen. There shall be at least 128 Work Groups per division. It shall also be possible to generate reports by Department and Work Group.

23.7.16 **ASCII transaction file**

The PC security administration system shall provide the facility of a data file that contains all personnel access transactions in ASCII data format. This is separate and additional to

the system event log. The format of each record shall consist of personnel identification number, date (DD/MM/YY), door number, time (HH:MM), site number and transaction type. The file should contain at least 15,000 transactions.

23.7.17 **Start and End Dates**

It is required that all ID devices may have the option of a start and end of validity date.

23.7.18 **Alarm Monitoring and Graphics maps**

An alarm manager program shall allow the operator to see any alarms that occur easily and clearly. A text message shall be attached to each alarm and shall tell the operator what action should be taken for each individual alarm.

It must be possible to attach a graphic illustration in the form of a bitmap to specific alarms. There shall be the optional facility to record sounds, including spoken messages, which can be linked to specific alarm events.

The alarm manager program shall keep track of all alarm events, which operator acknowledged them and what action was taken.

PART 23: TECHNICAL SPECIFICATIONS FOR ACCESS CONTROL SYSTEM

23.7 **PC ADMINISTRATION SYSTEM**

23.7.19 **Real-time transaction window and real-time printer**

The system shall have a window where it is possible to display all transactions. It must also be possible to route transactions to a real-time printer. The types of transactions that are displayed or printed may change throughout the day and on different days of the week. For example, some transactions will be displayed only during normal working hours. Outside normal working hours those same transactions may be required to be displayed and printed. It shall be possible to fix the transaction window so that it is always "on top" of all other windows.

23.7.20 **Time Profiles**

The system shall have a minimum of 128 time profiles per division. Each time profile shall consist of at least three time periods. Each time period shall have a start time and end time and the days of the week it will operate. This shall include system holidays.

23.7.21 **Access Groups**

The system shall have at least 128 access groups per site and shall have at least 128 divisional access groups per division. An access group shall consist of two lists of access areas each of which may have a time profile for when access is authorised to those areas. An access area is an area of common security, i.e. a door or number of doors that lead in to a physical area.

There shall be an extra access facility to provide for over 128 access groups in each site by assigning individuals their own access privileges.

23.7.22 **Transaction Reporting**

The system shall have the capability of extensive transaction searching and reporting. Reports must be able to be generated by, but not limited to the following:

Area

Doors

Department

Access group

Transaction type

Token holder

PART 23: TECHNICAL SPECIFICATIONS FOR ACCESS CONTROL SYSTEM

23.7 **PC ADMINISTRATION SYSTEM**

23.7.22 **Transaction Reporting**

Start of period date and time

End of period date and time.

23.7.23 There shall be the facility to report on tokens that have not been used over a specified period of time.

23.7.24 There shall be the facility to produce a "Presence" report. This report shall provide information on which cardholders are currently on site.

PART 23: TECHNICAL SPECIFICATIONS FOR ACCESS CONTROL SYSTEM

23.8 OPTIONAL MODULES

23.8.1 The system shall have an attendance report facility. This report shall be flexible and provide the total time a selected cardholder or cardholders have been on a site over a selected period.

23.8.2 DDE Transaction Routing

The system shall have Dynamic Data Exchange (DDE) output that conforms to Microsoft® Windows™ standards for DDE linking. It shall be possible to route system transactions and events to the DDE output. The system shall be able to change which types of transactions are sent to the DDE according to time of day and week.

23.8.3 Elevator Control

The system shall allow different combinations of relay outputs on Alarm Event Managers to be activated, dependant on the access privileges of individual token holders, when

token holders use their tokens at a designated reader. An example would be a reader fitted inside a lift car (elevator). When the relay outputs of the Alarm Event Managers are connected to the floor select buttons of the lift controller, token holders may be restricted to which floors they can select dependent on their access group privileges.

23.8.4 **Photo ID**

The system shall have an optional facility that allows a token holder's photograph to be captured, stored and displayed with each personnel record. Identification cards shall also be designed and printed from the same menu.

When a token has been presented to a specified reader the recorded image of the token holder shall appear on the screen. The system shall provide the operator with the ability to either allow or deny access if the token is not valid.

23.8.5 **Audit Trail**

A facility shall be available that enables specified operators to conduct searches of previous operator changes to the system. This facility shall allow searches between specified dates for changes made by specified operators or all operators. The system shall also be able to search for specified types or all types of change.

PART 23: TECHNICAL SPECIFICATIONS FOR ACCESS CONTROL SYSTEM

23.8 OPTIONAL MODULES

23.8.6 **Pager Interface**

An optional facility should be available that enables messages detailing the nature and location of alarm events to be sent from the PC administration system via a paging system to designated hand-held pager units.

23.8.7 **Guard Tour**

A facility should be available to monitor security guards as they travel around a building.

23.8.8 **Alarm Graphic Interface (AGI)**

The facility should be available that enables alarm points to be deposited as icons onto a bit map of a building. Icons must change state as alarms are received onto the system.

23.8.9 **Alarm Prioritisation**

The facility should be available that enables alarms to be prioritised.

PART 23: TECHNICAL SPECIFICATIONS FOR ACCESS CONTROL SYSTEM

23.9 CABLING

23.9.1 All cables connecting slave door controllers, including to the master door controller must utilise multi-stranded unscreened six or eight core cable. The use of screened cable on door controller clusters and specialist cables is not acceptable. For door controller network cable runs of up to 500 metres, 0.22 mm^2 multi-stranded six core cable (standard intruder alarm cable) is to be used.

23.9.2 Master door controllers shall have the ability to use existing CAT 5 structured cabling so that TCP/IP communications may be used.

23.9.3 For the connection of readers to door controllers then the following sized cables shall be used:

For distances up to 250 metres	-	0.22 mm^2
up to 500 metres	-	0.5 mm^2
up to 1000 metres	-	1.0 mm^2

23.10 WARRANTIES

23.10.1 The access control equipment, including door controllers, readers, central network controllers shall be warranted by the manufacturer against electronic failure for at least five years. The access control tokens shall carry a lifetime warranted against electronic failure. ("Lifetime" means that if the token electronics should fail at any time it will always be replaced).

23.10.2 It is accepted that the security system will require preventative maintenance.

PART 23: TECHNICAL SPECIFICATIONS FOR ACCESS CONTROL SYSTEM

23.11 COMMISSIONING AND TRAINING

23.11.1 The system shall be programmed with the information supplied. The system must be fully working with all system parameters and token holder's information. It is the tenderer's responsibility to ensure that all the necessary information is obtained before commissioning the system.

23.11.2 At least two and up to four members of staff will be nominated as operators of the system. These operators must receive sufficient training on the operation and configuration of the

system to enable these operators to train others. The training shall be conducted by the manufacturer's own training staff or by other certified training staff.

23.11.3 A copy of the final database of the PC administration system, held on CD or DVD, shall be included at the final hand over of the system.

23.11.4 The tenderer shall supply detailed "as installed" drawings of the entire system.

PART 24: PARTICULAR AND TECHNICAL SPECIFICATIONS FOR CCTV INSTALLATIONS

24.1 PARTICULAR SPECIFICATIONS OF MATERIALS AND WORKS

24.1.1 Location of site

The location of the proposed works is at **Embakasi , Nairobi, Kenya**

24.1.2 Extent of the Works

The works to be carried out include the supply, delivery, installation, testing, commissioning and leaving in servicing condition the Closed Circuit TV network systems in the proposed Barabara Plaza for Kenha and other roads institutions as described in this specification. The works shall include, but not limited to the supply and installation of the following:-

- Digital Signal Processing Camera
- Colour TV Monitors
- Colour Digital Multiplexing Network Video Recorder
- Colour printers for enhancing picture evidence of an event in a specific area under surveillance.

24.1.3 Regulation and Standard

The works shall comply with the provisions of the following as necessary and relevant:

Electric Power Act

Kenya Bureau of Standards (K.E.B.S)

Institution of Electrical Engineers (LE.E) Wiring Regulations

Current recommendation of CCITT and CC1R

PART 24: PARTICULAR AND TECHNICAL SPECIFICATIONS FOR CCTV INSTALLATIONS

24.1.4 ELECTRICAL REQUIREMENTS

The equipment to be supplied shall be capable of being operated from 240V AC 50Hz power supply.

24.2 TECHNICAL SPECIFICATIONS FOR CLOSED CIRCUIT COLOUR TELEVISION SYSTEM

24.2.1 Fixed Colour Digital Television Cameras

Fixed type colour television cameras shall be located and installed in selected areas as indicated in **clause 1.5.1.2** of this section. They shall be linked to the Television Monitors and the Control Equipment through data points.

The mounting height and position of cameras shall be such that the desired coverage shall be achieved as distinctly as possible.

The digital signal processing (DSP) camera shall be aesthetically styled. The DSP chip will enable advanced video processing and manipulation to be carried out in the camera head.

The camera shall be capable of operating at all times, i.e 24 hours a day.

24.2.2 Technical Specifications

The works to be carried out include the supply, delivery, installation, testing, commissioning and leaving in servicing condition the Closed Circuit TV network as herein described in this specification. The works shall include, but not limited to the supply and installation of the following:-

- Fixed Color Digital Signal Processing Camera
- Color TV Monitors
- Color Digital Video Recording multiplexer

The Digital Surveillance system shall support the following:-

PART 24: PARTICULAR AND TECHNICAL SPECIFICATIONS FOR CCTV INSTALLATIONS

24.2 TECHNICAL SPECIFICATIONS FOR CLOSED CIRCUIT COLOUR TELEVISION SYSTEM

24.2.3 Technical Specifications

- Digital based recording system
- Support IP cameras through video servers adapters

- Recording resolution: 1920 x 1080 pixels at 30fps for J-PEG, M-PEG and wavelet images.
- Multi-level password protection and logging facilities
- Integrates with access control, burglar control, burglar alarms and fire alarm system
- Image compression for remote web live and playback viewing
- Multi display monitors
- Automatic daily archiving to hard drive or optical drive.
- Fully adjustable digital video motion detection with exclusion /inclusion multi regions per camera.
- Efficient video collection, storage and retrieval.
- Advanced and instant search capability
- Digitally signed recordings, with audit trails of all operator actions and system event.
- At least one Terabyte storage space to provide back up and redundancy
- Infra red illuminators in poor lighting conditions
- Able to interface with other systems on the ground
- Support various alarm and subnet options including VSAT, IP, GSM/GPRS and Radio.

24.3 DAY/NIGHT, WDR, COLOUR MOTORISED CCD PTZ DOME CAMERA

24.3.1 The **high resolution Camera** shall meet or exceed the following design and performance specifications:-

1. Image Sensor 1/4-inch
2. Scanning System 2:1 interlaced output
3. Effective Pixels PAL – 724 X 582
4. Horizontal Resolution PAL – >550 TVL
5. Lens F1.6 (f=3.6-82.8 mm optical, 23X optical zoom, 10X electronic zoom)

PART 24: PARTICULAR AND TECHNICAL SPECIFICATIONS FOR CCTV INSTALLATIONS

24.3.1 The **high resolution Camera** shall meet or exceed the following design and performance specifications:-

6. Programmable Zoom Speeds 2.9, 4.2, or 5.8 seconds

7. Horizontal Angle of View 54° at 3.6 mm wide zoom – 2.5° at 82.8 mm telephoto zoom

24.3.1 The **high resolution Camera** shall meet or exceed the following design and performance specifications:-

8. Focus Automatic with manual override.
9. Sensitivity at 35 IRE PAL, color: 0.08 lux at 1/1.5 sec shutter speed

   B-W: 0.013 lux at 1/1.5 sec shutter speed

   B-W: 0.3 lux at 1/50 sec shutter speed
10. Synchronization System Internal/AC line lock phase adjustable via remote control, V-sync
11. White Balance Automatic with manual override
12. Shutter Speed PAL – 1/1.5-1/30,000
13. Iris Control Automatic with manual override
14. Gain Control Automatic/ off
15. Video Output 1 volt peak to peak, 75 ohms
16. Video Signal-to-Noise >50 dB
17. Type of Lighting Menu selection of indoor or outdoor lighting for optimum camera performance
18. Wide Dynamic Range 80X
19. Motion Detection User-definable motion detection settings for each preset scene; can activate auxiliary outputs; three sensitivity levels per zone

24.3.2 **Dome type Video color camera**

Type: Varifocal Fixed Dome.

Lens sensor: l/3"

PART 24: PARTICULAR AND TECHNICAL SPECIFICATIONS FOR CCTV INSTALLATIONS

24.3.2 **Dome type Video color camera**

Signal system: PAL Standard.

Lens focal length	4-9mm DD F 1.6-2.4
Line resolution	480 TV Lines
Backlight Compensation	on/off switch
Maximum illumination	l.2 Lux
Video output	1 V peak-peak PAL compatible
Shutter speed	Automatic, I/60 to 1/100,000s

24.3.2 **Dome type Video color camera**

Tolerance	Bright tolerant with minimum blooming and transfer smear
White balance:	Automatic.
Operational temperature	-10˚C to -45˚C
ATW range	3000K – 9000K
Signal to Nose ratio:	More than 50 dB
Auto Gain Control:	On 32dB, off 8dB
Aperture correction:	Horizontal and vertical

Contrast: Shall feature automatic white balance capable of adjusting for variations in scene lighting for consistent time colors from one scene to the other.

Picture quality: The picture produced shall have minimum lag and image Retention.

A continual adjustment feature to facilitate C or CS mount lenses will be incorporated, together with a side mount plug for direct drive Lenses and screw terminals for auto iris lenses. The camera shall be capable of being line locked with phase adjustment.

PART 24: PARTICULAR AND TECHNICAL SPECIFICATIONS FOR CCTV INSTALLATIONS

24.3.2 **Dome type Video color camera**

Contained under a flap will be a bank of switches which will enable the selection of the following features:

- Electronic iris · AGC on/off
- Back light compensation
- Gamma correction select between 0.45 and 1.0

24.3.3 **External view (EXview) Video color camera**

Type:	Solid state color coupled charged device (CCD)
Lens sensor:	l/3" Interline image format
Line resolution	480 TV Lines.
Signal system:	PAL Standard.
Maximum illumination	0.5 Lux
Video output	1 V peak-peak PAL compatible

24.3.3 **External view (EXview) Video color camera**

Shutter speed	Automatic, I/60 to 1/100,000s
Tolerance:	Bright tolerant with minimum blooming and transfer smear.
Signal to Nose ratio:	More than 50 dB
Auto Gain Control:	On 32dB, off 8dB
Aperture correction:	Horizontal and vertical
Contrast:	Shall feature automatic white balance capable of adjusting for variations in scene lighting for consistent time colors from one scene to the other.
Picture quality:	The picture produced shall have minimum lag and image Retention. A continual adjustment feature to facilitate C or CS mount lenses will be incorporated, together with a side mount plug for direct drive Lenses and screw terminals for

auto iris lenses. The camera shall be capable of being line locked with phase adjustment. Contained under a flap will be a bank of switches which will enable the selection of the following features:

- Electronic iris · AGC on/off
- Back light compensation
- Gamma correction select between 0.45 and 1.0

24.3.4 **Lens**

The lens shall:be glass optical vertical 1/3" format with direct driver operation.

Have a standard CS mount.

Have variable focal length of between 4mm and 9 mm and aperture of F 1.6 – 2.4

24.3.5 **Mounting Brackets**

The Brackets shall:

Be suitable for wall or ceiling mounting of a single camera.

Be at least 5.5"length

Have an auto lock facility.

24.3.6 **Camera Housing**

The camera housing shall:

Be IP66 rated with integral cable management.

Be Weatherproof.

Be constructed from aluminium with epoxy coating.

PART 24: PARTICULAR AND TECHNICAL SPECIFICATIONS FOR CCTV INSTALLATIONS

24.4 VIDEO MONITORS

The monitor shall be capable of providing high levels of picture quality 10MHz bars visible at low brightness and reliability stable synchronization, black level clamping, low sensitivity and high stability.

The monitors shall be high performance color video monitors for monitoring scenes from the above cameras and viewing playback scenes from the video cassette recorders. The monitors shall be located at places shown on the drawings.

The monitor shall give stable and interference free pictures of scenes being viewed. It shall also conform to the following specifications:

- Color system PAL
- Screen size 25”
- Resolution Minimum of 550 TV Lines
- Video input signal 1.0 V pk-pk
- Power consumption Not more than 75W
- Power input 240V 50HZ

The unit will be dual standard and be capable of using audio and SVHS in. Full loop through connectors to be provided and monitor to have a metal enclosure for reduced RF interference.

24.5 COLOUR NETWORK VIDEO MULTIPLEXING RECORDER

The multiplexing recorder shall be used to record events from the Surveillance TV cameras. It shall have the following

a) a high performance video multiplexer and digital video recorder.

b) Operate, record, playback and multi-screen viewing with at least 50 PPS.

c) With a wave reader software.

d) Provide multi user remote access including remote control of fully functional cameras.

PART 24: PARTICULAR AND TECHNICAL SPECIFICATIONS FOR CCTV INSTALLATIONS

24.5 COLOUR NETWORK VIDEO MULTIPLEXING RECORDER

The multiplexing recorder shall have the following minimum requirements:-

- Ethernet: 10BaseT/ 100BaseT supplied complete with wave reader software.
- Should be rack mounted for security
- Shall feature time base correction, eliminating the need for external camera synchronization.
- Have an Internal CD-writer for archiving purposes
- Recording:- Automatic Priority Control, Interleaved or exclusive, or none; Programmable
- (Video Motion Detection)VMD Zones Per camera : 256,16x16 grid.
- Multi screen Display : Full, PIP, Quad, 6, 9, 16 way.
- Camera Inputs : 16
- Fully multitasking - simultaneous recording whilst playing back
- To incorporate four removable hard disk drives, allowing upto 3 months storage at 24- hour record rates S-VHS quality without additional equipment.
- Alarm handling inputs 16 N/O or N/C
- Hard disk capacity of 2TB expandable to 3TB using 250
- GB HDD'S
- 2 RS485 ports.
- Resolution: 700(h) x 550(v)
- Time and Date display
- False alarm rejection: 3 levels
- Power supply: 240 V AC, 50 HZ.

24.6 CABLES AND CONNNECTORS

All the cabling shall be carried out in conduits or trunking. Basically cables carrying video signal between cameras and TV monitoring via video control multiplexer equipment shall be UTP cables. The positions for connectors and the equipments shall be directed and identified by the Engineer on site.

Bidders shall be required to visit the proposed site to ascertain cable routes and cable lengths before pricing the Bills of Quantities in this document.

It shall be the responsibility of the contractor to provide wiring and connection diagrams for approval by the Consulting Engineer.

PART 24: PARTICULAR AND TECHNICAL SPECIFICATIONS FOR CCTV INSTALLATIONS

24.7 UNINTERRUPTIBLE POWER SUPPLY (UPS)

This shall be an on-line Un-interruptible power supply with output rating of 7.5 KVA, 240V, 50HZ single-phase supply. It shall provide power to the security surveillance system in case of power failure and/or maintained power failure for a minimum period of 8 hours.

It shall be microprocessor- based so that both output voltage and frequency are closely regulated and continuously monitored and also provide system diagnostic and shut down protection functions. It shall feature a maintenance by-pass to enable normal routine maintenance operations to be performed without interruptions to the system.

It shall be fitted with both visual and audible alarms to indicate any change in equipment status such as:-

- input power problems
- ups faults
- ups overload
- battery discharging
-

Other parameters are:

Input supply:	240VAC50HZ
Power factor:	0.7 lag at full load
Current limit:	125% of the normal
Output voltage:	240V AC 50 HZ
Output voltage tolerance:	2%
Output frequency tolerance	: 0.05%

PART 25: TECHNICAL SPECIFICATIONS AUDIO VISUAL EQUIPMENT

25.1 Multimedia LCD Projectors

a. should be at least 9600 Lumens of brightness, SXGA (1024 x 768) resolution, Network Ready Projector

- ~ At least 9600 Lumens
- ~ Minimum XGA + (1024 x 768) NATIVE Resolution
- ~ Network Capable RJ45
- ~ Multiple interface – 2x RGB, 5x BNC & HDMI, RS232 port, Network RJ45, Video-in, S-video and composite video
- ~ 3LCD Technology
- ~ Flexible installation-ceiling; 90 degrees upwards/downward tilts
- ~ Dynamic detail enhancer – generates high quality images of outstanding clarity.
- ~ Digital keystone adjustment
- ~ Easy lamp replacement
- ~ Whisper quite operation
- ~ Horizontal/vertical picture shift
- ~ Include Anti Theft Projector Ceiling Mount
- ~ Provide 50m VGA Cable with floor box

25.2 Projection Screen

- ~ Electric type – Motor Driven
- ~ Wall/Ceiling mountable
- ~ Size 7.2m x 5.4m viewing angle
- ~ Matte white surface
- ~ Black border
- ~ Wall mount switch

~ Optional wireless remote control

PART 25: TECHNICAL SPECIFICATIONS AUDIO VISUAL EQUIPMENT

25.3 **Mixer Amplifier**

~ At least 4 microphone inputs

~ 600w Amplifier

~ Individual Volume Controls for each mic/aux input

25.3 **Mixer Amplifier**

~ Master volume control

~ Table top type

~ Power surge – AC mains 50/60HZ

~ Frequency response – 50-20,000 Hz

~ 5 input – 4XLR/Jack input

~ 4RCA Pinjack – record speaker- 100V line

25.4 **Loudspeakers**

~ Ceiling/Wall recessed

~ 100w Rated input

~ Impendence – 100v//70 Volt Line

~ Sensitivity – 90db

~ Vented 2 way bass reflex type

~ CD-Horn for large directivity angle of 60^0 x 40^0

~ Durable low foam polypropylene enclosure with superb acoustics

~ Overload protection circulatory

~ Parallel input push in terminals with ¼" phone jacks

25.5 **Wireless Microphones – Lapel/Handheld**

~ UHF type

~ Electric Condenser unit – condenser

- ~ Frequency range 690 – 750 MHz UHF
- ~ 16ch selectable channels
- ~ Battery type – AA

PART 25: TECHNICAL SPECIFICATIONS AUDIO VISUAL EQUIPMENT

25.6 **Digital Modular Mixer**

Fully modular digital mixer featuring a 12 input; 8bus, 8 output ch configuration (12 x 8 matrix) with easy operation that can be expanded as applications require

25.6 **Digital Modular Mixer**

- ~ all in one design
- ~ build in feedback suppressor
- ~ automatic mixing function
- ~ sound processing
- ~ ease of Control from front panel
- ~ LCD Display
- ~ Digital buttons for control/operation

25.7 **Power Amplifier**

- ~ 2ch stereo Power Amplifier – rack mountable
- ~ 2 x 600w Rated input
- ~ Built in protection circuitry
- ~ Selectable stereo, bridge or parallel operation
- ~ Forced air – cooling system with variable speed
- ~ Rotary volume controls

PART 26: TECHNICAL SPECIFICATIONS FOR SOLAR PHOTO VOLTAIC BATTERY BACKED SYSTEM

26.0 There are basically two solar PV systems: stand-alone and grid-connected.

26.0.1 **Stand-alone solar PV systems** work with batteries. The solar energy is stored in the battery and used to feed building loads after conversion from DC to AC power with a stand-alone inverter. These systems are generally used in remote areas without grid supply or with unreliable grid supply.

26.0.2 **Grid-connected solar PV systems** feed solar energy directly into the building loads without battery storage. Surplus energy, if any, is exported to the grid and shortfall, if any, is imported from the grid.

26.1 **Typical Configuration for Solar Power System**

a) Supply 24V, 200 Wp Solar Panels Each 28No.
b) Supply 2V, 1200 Ahr VLRA Battery Blocks Each 60No.
c) Supply Solar Support Structures for ground mounting
d) Supply 60A Solar Charge Controller at 24V 4No.
e) Supply Mains AC/Solar Interface - Control Panel
f) Supply Maintenance Manuals including the Parts Catalogue for each of the units (Solar System, Interface/Control/Monitoring Unit) -
g) Supply Consumable Spares for the system
h) Local training (advisable)
i) Supply of 4KW Solar inverter at 24/240V
j) Submit shop drawings including layouts for array arrangement, solar PV dimensions, one-line diagrams showing functionality.

Panel output (Wp) capacity to be >=90% of design nominal power after 10 years and >=80% of design
nominal power after 25 years.
Module frame Non-corrosive and electrolytically compatible with the mounting structure material Termination box Thermo-plastic, IP 65, UV resistant
Blocking diodes Schottky type
Module minimum rated power. The nominal power of a single PV module shall not be less than 74Wp.

RF Identification tag for each solar module shall be provided inside the module and must be able to withstand environmental conditions and last the lifetime of the solar module.
Power output rating to be given for standard test conditions (STC). I-V curve of the sample module shall be submitted.
Compliance with standards and codes IEC 61215 / IS 14286, IEC 61730 Part 1 and 2, Salt Mist Corrosion Testing As per IEC 61701

PART 26: TECHNICAL SPECIFICATIONS FOR SOLAR PHOTO VOLTAIC BATTERY BACKED SYSTEM

26.2 System components

The solar generator system will consist of the following:

a) PV Solar Modules.
b) Deep Cycling Maintenance free Battery.
c) Charge regulator with programmable low voltage battery disconnect capability, and
d) Voltage/Current Monitoring.
e) Support Structure for PV array.
f) Lightning Surge Protection.
g) Installation materials and accessories.

26.3 PV System Specification

26.3.1 Solar Array

a. The PV Array will be constructed on the basis of 24 V, 200W modules.
b. The offered PV solar array capacity will be 3000Wp.
c. Service life of PV Modules will be 20 years or better.
d. Output Array voltage is 24V positive ground
e. Offered PV Solar Module is defined by the following:
f. Typical Power :TBD
g. Minimum Power :TBD
h. Voltage at peak power :23V
i. Current at peak power :5.8A
j. Open Circuit Voltage :22V
k. Short Circuit Current :6.0A
l. Cell Type :Crystal
m. No. Of Cells in series: :72
n. Dimensions :1618 x 814 x 35mm –to be confirmed by supplier.

26.3.2 Solar Power System

a. Each offered PV module has a factory installed Bypass diode to protect the module against reverse current.
b. Each module will have an indelible serial number inscribed on the module.

c. Additional fringes of solar panels will be welded together as a means of securing them at the time of installation.
d. j. The module will conform to IEC 61215 and its manufacture is ISO 9001 certified.

26.3.3 **Solar Array Support Structure**

a. The support structure, mountings and fixing bolts/nuts are weather proof and corrosion resistant.
b. The structure will be lightweight but strong enough to withstand Wind speeds of 120 km/hr.
c. The supports will allow free air access to module rear

PART 26: TECHNICAL SPECIFICATIONS FOR SOLAR PHOTO VOLTAIC BATTERY BACKED SYSTEM

26.3.3 **Solar Array Support Structure**

d. It will allow tilt angle range adjustable by given steps
e. Provision for cleaning solar panels will be afforded by the installation method.
f. The stands of the structure will be bounded and connected to the building Earth.

The PV modules shall be mounted on fixed metallic structures having adequate strength and appropriate design, which can withstand the load of the modules and high wind velocities. The support structure shall be hot dip galvanized steel or aluminium.
Detailed specifications for the mounting structure are given below:

i. Wind velocity withstanding capacity 150 km / hour
ii. Structure material Hot dip galvanised steel with a minimum galvanisation thickness of 120 microns or aluminium alloy.
iii. Bolts, nuts, fasteners, panel mounting clamps -Stainless steel SS 304

Mounting arrangement for RCC-flat roofs -With removable concrete ballast made of pre-fabricated PCC (1:2:4), M15

Mounting arrangement for metal sheet roofs -Mounting directly on the sheet metal, ensuring stability and wind withstanding capacity, or penetrating the sheet metal and fixing to the substructure, ensuring that the roof remains water proof and ensuring stability and wind withstanding capacity.

Mounting arrangement for elevated structures -The elevated structure has to be securely anchored to the supporting surface. Concrete foundations of appropriate weight and depth for elevated structures mounted directly on the ground; Bolted with anchor bolts of appropriate strength for elevated structures mounted on RCC surfaces.

Mounting arrangement for ground installations -With removable concrete ballast made of pre-fabricated PCC (1:2:4), M15; assuring enough ground clearance to prevent damage of the module through water, animals and other environmental factors.

Installation The structures shall be designed for simple mechanical on-site installation. There shall be no requirement of welding or complex machinery at the installation site.

Minimum distance between roof edge and mounting structure -0.6m

Access for panel cleaning and maintenance -All solar panels must be accessible from the top for cleaning and from the bottom for access to the module junction box.

Panel tilt angle North – south orientation with a fixed tilt angle of 11 – 13 degrees (depending on location), south facing.

PART 26: TECHNICAL SPECIFICATIONS FOR SOLAR PHOTO VOLTAIC BATTERY BACKED SYSTEM

The prospective Installer shall specify installation details of the solar PV modules and the support structures **with lay-out drawings and array connection diagrams**. The work shall be carried out as per the designs approved by the Consultant.

26.3.4 **Battery**

a. European made Deep Cycling Maintenance-free gas recombination sealed valve regulated batteries. Total Battery capacity will 1200 Ah.
a. Operational life at 20°C will be better than 20 years.
b. Self-discharge rate is less than 2%/month at 25°C.
c. Allowable DOD will be 80%.
d. Design DOD is assumed to be 50% in normal circumstances.
b. Offered Battery will conform to IEC 896-2 tests and DIN 40 742 part 1 safety standard. IEC 896-2 cycles shall be stated.
c. A suitable battery rack and container, suitable for indoor installation to be used.

26.3.5 **Charge Controller**

a. A suitable Charge/Discharge controller to be offered to manage the battery charging process, disconnect the battery on a preset low voltage battery as well as affect

26.3.5 **Charge Controller**

b. interfacing functions with the solar panels, Batteries, Load and the Mains Alternating Current.
c. The controller can send a start signal to the Mains AC if the battery voltage falls below a set value and stop the set when the battery voltage rises to a given value

d. The offered Charge Controller shall fulfill all system requirements as laid out in these specifications.
d. The Controller is able to handle up to 60Amps at 24V DC.
e. The Charge controller incorporates a device to monitor the following :

i. Battery Voltage
ii. Battery Current
iii. Load Current
iv. Load Voltage

e. The Controller has programmable functions that allow field setting of charge modes/alarm values:
   i. Low voltage disconnect
   ii. Low Battery Alarm
   iii. High Voltage Alarm

f. The controller has high reliability and is estimated to work without fail for a sufficiently long period which is not less than 10 years.

PART 26: TECHNICAL SPECIFICATIONS FOR SOLAR PHOTO VOLTAIC BATTERY BACKED SYSTEM

26.3.6 **Inverter**
The solar inverter to be rated 4kW at 24VDC/240VAC 1No.

26.3.7 **Alarms**
a) System and individual component failure is monitored by a dry contact alarm with an open/close circuit for the possibility of extending the alarms to a remote Network Maintenance Centre.
b) The Alarm cable is to be laid inside a PVC conduit in the ground to the Rack inside the Equipment Room.
c) The following alarms among others shall be provided:
   i. Low Battery Alarm (the alarm will be initiated before the battery voltage has reached the nominal discharge value)
   ii. High Battery Alarm (the alarm indicates the over-charging of the battery)
   iii. No output from the solar array.

26.4 **Connection to the Building Electrical System**
a. The AC output of the solar grid inverter shall be connected to the building's electrical system after the TANGEDCO service connection meter and main switch on the load side. The solar grid inverter output shall be connected to a dedicated module in the Main Distribution Board (MDB) of the building. It shall not be connected to a nearby load or socket point of the building. The connection to the electrical system of the building shall be done as shown in typical wiring diagram.

26.4 **Connection to the Building Electrical System**

b. For buildings or loads with diesel generator backup, the wiring of the solar grid inverter shall be such that the solar grid inverter cannot run in parallel with the diesel generator. This implies that the solar grid inverter must be connected to a distribution board on the

grid side of the automatic or manual change-over switch as shown in typical wiring diagram.

26.5 **Cables**

a. All cables shall be supplied conforming to IEC 60227/ IS 694 & IEC 60502/ IS 1554. Voltage rating: 1,100V AC, 1,500V DC
b. For the DC cabling, XLPE or XLPO insulated and sheathed, UV stabilized single core flexible copper cables shall be used. Multi-core cables shall not be used.
c. For the AC cabling, PVC or XLPE insulated and PVC sheathed single or multi-core flexible copper cables shall be used. Outdoor AC cables shall have a UV-stabilised outer sheath.
d. The total voltage drop on the cable segments from the solar PV modules to the solar grid inverter shall not exceed 2.0%.

PART 26: TECHNICAL SPECIFICATIONS FOR SOLAR PHOTO VOLTAIC BATTERY BACKED SYSTEM

26.5 **Cables**

e. The total voltage drop on the cable segments from the solar grid inverter to the building distribution board shall not exceed 2.0%
f. The DC cables from the SPV module array shall run through a UV stabilised PVC conduit pipe of adequate diameter with a minimum wall thickness of 1.5mm.
g. Cables and wires used for the interconnection of solar PV modules shall be provided with solar PV connectors (MC4) and couplers.
h. All cables and conduit pipes shall be clamped to the rooftop, walls and ceilings with thermo-plastic clamps at intervals not exceeding 50 cm. The minimum DC cable size shall be 4.0 mm2 copper. The minimum AC cable size shall be 4.0 mm2 copper. In three phase systems, the size of the neutral wire size shall be equal to the size of the phase wires. The following colour coding shall be used for cable wires:
    i. DC positive: red (the outer PVC sheath can be black with a red line
    ii. marking)
    iii. DC negative: black
    iv. AC single phase: Phase: red; neutral: black
    v. AC three phase: Phases: red, yellow, blue; neutral: black
    vi. Earth wires: green

i. Cables and conduits that have to pass through walls or ceilings shall be taken through a PVC pipe sleeve.
j. Cable conductors shall be terminated with tinned copper end-ferrules to prevent fraying and breaking of individual wire strands. The termination of the DC and AC cables at the Solar Grid Inverter shall be done as per instructions of the manufacturer, which in most cases will include the use of special connectors.

26.6 **Earthing**

a. The PV module structure components shall be electrically interconnected and shall be grounded.
b. Earthing shall be done in accordance with IS 3043-1986, provided that earthing conductors shall have a minimum size of 6.0 mm2 copper, 10 mm2 aluminium or 70 mm2 hot dip galvanised steel. Unprotected aluminium or copper-clad aluminium conductors shall not be used for final underground connections to earth electrodes.
c. A minimum of two separate dedicated and interconnected earth electrodes must be used for the earthing of the solar PV system support structure with a total earth resistance not exceeding 5 Ohm.
d. The earth electrodes shall have a precast concrete enclosure with a removable lid for inspection and maintenance. The entire earthing system shall comprise non-corrosive components.

PART 26: TECHNICAL SPECIFICATIONS FOR SOLAR PHOTO VOLTAIC BATTERY BACKED SYSTEM

26.7 **Surge Protection**

a. Surge protection shall be provided on the DC side and the AC side of the solar system.
b. The DC surge protection devices (SPDs) shall be installed in the DC distribution box adjacent to the solar grid inverter.
c. The AC SPDs shall be installed in the AC distribution box adjacent to the solar grid inverter.
d. The SPDs earthing terminal shall be connected to earth through the above mentioned dedicated earthing system. The SPDs shall be of type 2 as per IEC 60364-5-53 Page 13 of 16

26.8 **Junction Boxes**

a. Junction boxes and solar panel terminal boxes shall be of the thermo plastic type with IP 65 protection for outdoor use and IP 54 protection for indoor use.
b. Cable terminations shall be taken through thermo-plastic cable glands. Cable ferrules shall be fitted at the cable termination points for identification.

26.9 **Tools, Tackles and Spares**

a. The Installer shall keep ready stock of tools, tackles and essential spares that will be needed for the day-to-day maintenance of the solar PV system. This shall include but not be limited to, the following:
    i. Screw driver suitable for the junction boxes and combiner boxes;
    ii. Screw driver and / or Allen key suitable for the connectors, power distribution blocks, circuit breaker terminals and surge arrestor terminals;
    iii. Spanners / box spanners suitable for the removal of solar PV modules from the solar PV module support structure;
    iv. Solar panel mounting clamps;

v. Cleaning tools for the cleaning of the solar PV modules;
vi. Spare fuses.

26.10 **Caution Signs**

a. In addition to the standard caution and danger boards or labels as per the Regulations, the AC distribution box near the solar grid inverter, the building distribution board to which the AC output of the solar PV system is connected and the Solar Generation Meter shall be provided with a non-corrosive caution label with the following text: WARNING – DUAL POWER SOURCE EB & SOLAR
b. The size of the caution label shall be 105mm (width) x 20mm (height) with white letters on a red background.
c. Caution labels as may be prescribed by TANGEDCO shall be fixed as per TANGEDCO specifications.

PART 26: TECHNICAL SPECIFICATIONS FOR SOLAR PHOTO VOLTAIC BATTERY BACKED SYSTEM

26.11 **Metering**

a. An energy meter shall be installed in between the solar grid inverter and the building distribution board to measure gross solar AC energy production (the "Solar Generation Meter"). The Solar Generation Meter shall be of the same accuracy class as the TANGEDCO service connection meter or as specified by TNERC.
b. The existing service connection meter needs to be replaced with a bidirectional (import kWh and export kWh) service connection meter (the "Solar Service Connection Meter") for the purpose of net-metering. Installation of the Solar Service Connection Meter will be carried out by TANGEDCO and is not in the scope of the work of the Installer.

26.12 **Documentation**

The Installer shall supply the following documentation:

i. System description with working principles.
ii. System single line diagram.
iii. Solar PV array lay-out.
iv. Routing diagram of cables and wires.
v. Data sheets and user manuals of the solar PV panels and the solar grid inverter.
vi. A system operation and maintenance manual.
vii. Name, address, mobile number and email address of the service centre to be contacted in case of failure or complaint.
viii. Warranty cards.
ix. Maintenance register.

26.13 **Test Certificates and Reports to be Furnished**

Test Certificates / Reports from IECQ / NABL accredited laboratory for relevant IEC / equivalent BIS standard for quoted components shall be furnished. Type Test Certificates shall be provided for the solar modules and the solar grid inverters to provide evidence of compliance with standards as specified in articles 4.0 and 7.0 of this Technical Specification. Customer reserves the right to ask for additional test certificates or (random) tests to establish compliance with the specified standards.

PART 27: TECHNICAL SPECIFICATION OF SOLAR STREET LIGHTING SYSTEMS

27.0 DEFINITION:

A stand alone solar photovoltaic (SPV) street lighting system (SLS) is an outdoor lighting unit used for illuminating a street or an open area. It consists of photovoltaic (PV) module(s), compact fluorescent lamp (CFL), lead acid battery, control electronics, inter-connecting wires/cables, module mounting Pole including hardware and battery box. The CFL is fixed inside a luminaire which is mounted on the pole. The PV module is placed at the top of the pole at an angle to maximize incident solar radiation, and a battery is placed in a box attached to the pole. The module is mounted facing south, so that it receives solar radiation throughout the day, without any shadow falling on it. Electricity generated by the PV module will charge the battery during the day time. This system operates from dusk to dawn.

27.1 TECHNICAL SPECIFICATIONS & GENERAL SPECIFICATIONS:

27.1.1 DUTY CYCLE:

The system should automatically switch is ON at dusk, operate throughout the night and automatically switch is OFF at the dawn.

27.1.2 PV MODULE (S):

a. Both crystalline and thin film technology modules are allowed in the system. The PV module should have a certificate of testing conforming to IEC 61215 Edition II / BIS 14286 or IEC 61646 for crystalline and thin film PV modules respectively.

The manufacturer should produce the certificate for a higher wattage module, in case the certificate is not available for the offered PV module. Further, the manufacturer should

certify that the supplied module is also manufactured using similar material, design and process as that of the certified PV module. The
certificate should be from an NABL or IECQ accredited Laboratory.

b. The power output of the module(s) under STC should be a minimum of 74 Wp. Either two modules of minimum 37 Wp output each or one module of 74 Wp output should be used. In case of thin film technology PV modules, the specified values refer to the stabilized power output after the initial degradation.
The module efficiency should not be less than 12%.

c. The operating voltage corresponding to the power output mentioned above should be 16.4 ± 0.2 V.

d. The open circuit voltage of the PV modules under STC should be at least 21.0 Volts.

e. The terminal box on the module should have a provision for opening for replacing the cable, if required.

PART 27: TECHNICAL SPECIFICATION OF SOLAR STREET LIGHTING SYSTEMS

f. Each PV module must use a RF identification tag (RFID), which must contain the following information:
(i) Name of the manufacturer of PV Module.
(ii) Model or Type Number
(iii) Serial Number

27.1.2 **PV MODULE (S):**
(iv) Month and year of the manufacture
(v) I-V curve for the module
(vi) Peak Wattage of the module at 16.4 volts
(vii) Im, Vm and FF for the module
(viii) Unique Serial No and Model No of the module
Until March 2013, the RFID can be inside or outside the module laminate, but must be able to withstand harsh environmental conditions.

(g) A distinctive serial number starting with NSM will be engraved on the frame of the module. The distinctive number starting NSM will also be screen printed on the tedlar sheet of the module.

27.1.3 **BATTERY**
(i) Lead Acid, tubular positive plate flooded electrolyte or Gel or VRLA Type.
(ii) The battery will have a minimum rating of 12V, 75 Ah (at C/10 discharge rate).

(iii) 75 % of the rated capacity of the battery should be between fully charged and load cut off conditions.

27.1.4 **LAMP**

(i) The lamp should be 11 Watt compact fluorescent lamp (CFL) with 4 pins along with proper pre-heating circuit.

(ii) The light output from the lamps should be around 900±5 % lumens (for 11 W CFL).

(iii) The lamp should be housed in an assembly suitable for outdoor use, with a reflector on its back.

(iv) No blackening or reduction in the lumen output by more than 10%, should be observed after 1000 ON/OFF cycles (two minutes ON followed by four minutes OFF is one cycle).

27.1.5 **ELECTRONICS**

(i) The inverter should be of quasi sine wave/ sine wave type, with frequency in the range of 20 - 30 KHz. Half-wave operation is not acceptable.

(ii) The total electronic efficiency should be not less than 85 %.

(iii) The idle current consumption should not be more than 10 mA.

(iv) The PV module itself should be used to sense the ambient light level for switching ON and OFF the lamp.

PART 27: TECHNICAL SPECIFICATION OF SOLAR STREET LIGHTING SYSTEMS

27.1.6 **ELECTRONIC PROTECTIONS**

(i) Adequate protection is to be incorporated under no load conditions e.g. when the lamp is removed and the system is switched ON.

(ii) The system should have protection against battery overcharge and deep discharge conditions.

(iii) Fuses should be provided to protect against short circuit conditions.

(iv) Protection for reverse flow of current through the PV module(s) should be provided.

(v) Electronics should have temperature compensation for proper charging of the battery throughout the year.

27.1.7 **MECHANICAL HARDWARE**

(i) A metallic frame structure (with corrosion resistance paint) to be fixed on the pole to hold the SPV module(s). The frame structure should have provision to adjust its angle of inclination to the horizontal between 0 and 45, so that the module(s) can be oriented at the specified tilt angle.

(ii) The pole should be made of mild steel pipe with a height of 4 metres above the ground level, after grouting and final installation. The pole should have the provision to hold the weather proof lamp housing. It should be painted with a corrosion resistant paint.

(iii) A vented, acid proof and corrosion resistant painted metallic box for outdoor use should be provided for housing the battery with a provision of lock and Key.

27.1.8 **OTHER FEATURES**

(i) The system should be provided with 2 LED indicators: a green light to indicate charging in progress and a red LED to indicate deep discharge condition of the battery.

(ii) There will be a Name Plate on the system, which will give:
(a) Name of the Manufacturer or Distinctive Logo.
(b) Serial Number.

(iii) Components and parts used in the solar street lighting systems should conform to the latest BIS specifications, wherever such specifications are available and applicable.

(iv) The PV module(s) will be warranted for a minimum period of 25 years from the date of supply and the street lighting system (including the battery) will be warranted for a period of two years from the date of supply. PV modules used in Solar Street Lighting System must be warranted for their output peak watt capacity, which should not be less than 90% at the end of Twelve (12) years and 80% at the end of Twenty five (25) years.
The Warranty Card to be supplied with the system must contain the details of the system**.** The manufacturers can also provide additional information about the system and conditions of warranty as necessary.

PART 27: TECHNICAL SPECIFICATION OF SOLAR STREET LIGHTING SYSTEMS

27.1.8 **OTHER FEATURES**

(v) Necessary lengths of wires/cables and fuses should be provided.

(vi) An Operation, Instruction and Maintenance Manual, in English and the local language, should be provided with the Solar Street Lighting System. The following minimum details must be provided in the Manual:

PART 28: MECHANICAL INSTALLATIONS

28.1 GENERAL MECHANICAL SPECIFICATIONS

28.1.1 General

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

28.1.2 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.

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

Materials and apparatus supplied by others for installation and connection by the Sub-contractor shall be carefully examined on receipt. 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.

28.1.3 **Regulations and Standards**

The Sub-contract Works shall comply with the current editions of the following:

a) The Kenya Government Regulations.
b) The United Kingdom Institution of Electrical Engineers (IEE) Regulations for the Electrical Equipment of Buildings.
c) The United Kingdom Chartered Institute of Building Services Engineers (CIBSE) Guides.
d) British Standard and Codes of Practice as published by the British Standards Institution (BSI)
e) The Local Council By-laws.
f) The Electricity Supply Authority By-laws.
g) Local Authority By-laws.
h) The Kenya Building Code Regulations.
i) The Kenya Bureau of Standards

PART 28: MECHANICAL INSTALLATIONS

28.1 GENERAL MECHANICAL SPECIFICATIONS

28.1.4 **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 and connections to equipment shall form part of this Sub-contract and be the responsibility of the Sub-contractor.

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 the Kenya Power and Lighting Company (KPLC) 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 240Volts, 50Hz, 1-phase.

Any equipment that is not rated for the above voltages and frequencies shall be rejected by the Engineer.

28.1.5 Transport and Storage

All plant and equipment shall, during transportation be suitably packed, crated and protected to minimize 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 Engineer 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.

PART 28: MECHANICAL INSTALLATIONS

28.1 GENERAL MECHANICAL SPECIFICATIONS

28.1.6 Site Supervision

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

28.1.7 Installation

Installation of all special plant and 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.

28.1.8 **Testing**

28.1.8.1**General**

The Sub-contractor's attention is drawn to part 'A' Clause 38 of the "Preliminaries and General Conditions".

28.1.8.2 **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 BS Specification concerned.

For materials where no BS 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 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 specially manufactured for the plant and equipment specified is used, then the Sub-contractor shall submit satisfactory evidence to the Engineer 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.

PART 28: MECHANICAL INSTALLATIONS

28.1 GENERAL MECHANICAL SPECIFICATIONS

28.1.8.3**Manufactured Plant and Equipment – Work Tests**

The rights of the Engineer 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 Engineer of the manufacturer's intention to carry out such tests and inspections.

The Engineer or his representative shall be entitled to witness such tests and inspections. The cost 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 Engineer for his approval as soon as possible after the completion of such tests and inspections.

28.1.8.4**Pressure Testing**

All pipework installations shall be pressure tested in accordance with the requirements of the various sections of this Specification. The installations may be tested in sections to suit the progress of the works but all tests must be carried out before the work is buried or concealed behind building finishes. All tests must be witnessed by the Engineer or his representative and the Sub-contractor shall give 48 hours' notice to the Engineer of his intention to carry out such tests.

Any pipework that is buried or concealed before witnessed pressure 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 Engineer and shall keep a progressive and up-to-date record of the section of the work that has been tested.

28.1.9 **Colour Coding**

Unless stated otherwise in the Particular Specification all pipework shall be colour coded in accordance with the latest edition of BS 1710 and to the approval of the Engineer or Architect.

PART 28: MECHANICAL INSTALLATIONS

28.1 GENERAL MECHANICAL SPECIFICATIONS

28.1.10 **Welding**

28.1.10.1 **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 imperfection due to shearing or flame cutting operation, etc., and shall be free from rust scale, grease and other foreign matter.

28.1.10.2 **Method**

All welding shall be carried out by the electric arc processing using covered electrodes in accordance with BS 639.

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

28.1.10.3 **Welding Code and Construction**

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

a) **Pipe Welding**

All pipe welds shall be carried out in accordance with the requirements of BS 806.

b) **General Welding**

All welding of mild steel components other than pipework shall comply with the general requirements of BS 1856.

PART 28: MECHANICAL INSTALLATIONS

28.1 **GENERAL MECHANICAL SPECIFICATIONS**

28.1.10.4 **Welder's Qualifications**

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

Government of Kenya.

The Engineer may require to see the appropriate certificate obtained by any welder and should

it be proved that the welder does not have the necessary qualifications the Engineer may instruct the Sub-contractor to replace him by a qualified welder.

PART 29: GENERAL SPECIFICATIONS FOR PLUMBING AND DRAINAGE

29.1 MATERIALS AND STANDARDS

29.1.1 **General**

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

29.1.2 **Pipework and Fittings**

Pipework materials to be used are as follows: -

29.1.3 **Cold Water Mains**

Unplasticised PVC or galvanized steel medium or heavy grade, as specified on the drawings.

29.1.4 **Black Steel Pipework**

All black steel pipework up to 65mm nominal bore shall be manufactured in accordance with BS 1387 Medium Grade, with tempered place threads in accordance with BS 21. All fittings shall be malleable iron and manufactured in accordance with BS 143.

Pipe joints shall be screwed and socketed and sufficient coupling unions 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 Engineer

All black steel pipeworks, 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 union and coupling for the joint of pipes to valves 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.

PART 29: GENERAL SPECIFICATIONS FOR PLUMBING AND DRAINAGE

29.1.5 **Galvanized Steel Pipework**

Galvanized Steel pipework shall be manufactured to comply in all respects with the standards described for black Steel pipework in paragraph 3.2 above.

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

29.1.6 **Copper Tubing**

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

Pipe joints shall be made with soldered capillary fittings and connections to equipment shall be with compression fittings manufactured in accordance with BS 864.

Short copper connection tubes between galvanized pipework 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 way than the use
of copper tubing, then a brass straight connector shall be positioned between the galvanized pipe and the copper tube
in order to prevent direct contact.

29.1.7 **Cast Iron Pipework**

a) **Internal Services**

Cast Iron pipework and fittings for use above ground in connection with internal building services, shall be
manufactured with spigot and socket joints of the weight required by the local authority and shall fully comply with the requirements of BS 416.

All joints on Cast Iron spigot and socket pipes shall be made with an approved cold caulking compound and so
installed as to allow for any expansion or contraction, which may take place.

All Cast Iron pipe work, branches, tees bends and other fittings shall be supplied complete with inspection
covers for cleaning purposes. These inspection covers shall be included as parts of the fittings and shall comply
with requirements of BS 416.

b) **External Services**

Cast iron pipe work, which is used in connection with buried external services, shall be manufactured, coated and tested in accordance with the requirements of BS 1211

All buried cast iron bends, elbows swept tees and other fittings, shall comply with the requirements of

BS 1130.

Joining on external cast iron pipes shall be carried out in accordance with one of the methods described in BS Code of Practice 301, Clause 505C (v), to the approval of the Engineer.

29.1.8 **Pitch fibre Pipework**

Pitch Fibre Pipework and fittings for use in connection with external drainage services shall be manufactured in accordance
with the requirements of BS 2760. Pipes shall be connected by means of purpose tapered joints manufactured in accordance
with the requirements of the notes contained under Appendix C of BS 2760.

Until such a 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 BS 2760.

29.1.9 **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 requirements of BS 556,Class 1, except where otherwise stated.

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

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

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

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

PART 29: GENERAL SPECIFICATIONS FOR PLUMBING AND DRAINAGE

29.1.10**Asbestos Cement Pressure Pipe**

Where asbestos cement pressure pipes and fittings are used in connection with external, above ground or buried water
services, they shall be manufactured in accordance with the requirement of BS 486.

The classification of these pipes fall into classes:
A, B, C and D, respectively, and the class to be used shall depend upon the pressure conditions pertaining to site.
Where Cast iron detachable joints are used for connecting pipes, the material shall comply with the BS specification,
then the materials used shall be of quality not less than that required by this standard.

Rubber jointing rings shall be used for sealing purposes and shall comply with requirements of BS 2494, except where
they are likely to be contaminated by oil products, in which case the gasket shall be manufactured in accordance
with BS 3514.

29.1.11**PVC (Hard) Pressure Pipes and Fittings**

All PVC pipes and fittings shall be manufactured in accordance with BS 3505: 1968 or the relevant Kenya Standard.

Jointing

The method of jointing to be employed shall be that of solvent welding, using the pipe and manufacturer's approved
cement. Seal ring joint shall be introduced where it is necessary to accommodate thermal expansion.

Anchoring

The 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.

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

PART 29: GENERAL SPECIFICATIONS FOR PLUMBING AND DRAINAGE

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 a

depth of 6" above
the crown of the pipe and 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.

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 practical after laying and when the
pipeline is adequately 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.

29.1.12**MuPVC Waste Systems**

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

Pipe shall be supplied in plain-ended lengths.

Thickness

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

size(in)	Size (mm)	Pipe and Fittings Wall Thickness (mm)
1…	32	1.8
1	40	1.9
2	50	2.0

PART 29: GENERAL SPECIFICATIONS FOR PLUMBING AND DRAINAGE

Jointing

The method of joining to be employed shall be that of solvent welding, using the pipe and manufacturer's approved cement. Seal rings joints shall be introduced where it is necessary to accommodate thermal expansion.

Anchoring

All bends, valves and hydrant tees etc, in the line of 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.

Workmanship

The installation method of jointing shall be solvent welding; and both jointing and fixing shall comply in all respect to the manufacturer's 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)
1…	1200	32	500
1	1200	40	500
2	2000	50	900
3	2000	80	900
4	2000	100	1000
6	2000	150	1000

PART 29: GENERAL SPECIFICATIONS FOR PLUMBING AND DRAINAGE

Workmanship

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

Pipes passing through wall or floor 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.

Pipe Bed

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

Supports to Fittings

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

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 object be included in the balance of the backfill that might protrude the initial backfill and come into contact with the pipe.

Testing

Pipelines shall be tested in section under an internal water pressure normally one and a half times the maximum allowable working pressure of the class 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 the pipe slowly to avoid risk of damage due to surge.

PART 29: GENERAL SPECIFICATIONS FOR PLUMBING AND DRAINAGE

29.1.12 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 BS 3943, and fixed generally in accordance with manufacturer's instructions and BS 5572: 1978.

Jointing of pipes shall be carried out by means of solvent welding, the manufacturer's instructions and BS 5572: 1978.

Jointing of pipes 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, centres of which shall not exceed one metre.

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

29.1.13**PVC Soil System**

The Sub-contractor shall supply and fix PVC soil pipes and fittings as indicated on the Drawings and Schedules.

Pipes and fittings shall be in accordance with relevant British Standards, including BS 4514 and fixed to the manufacturer's instructions and BS 5572.

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

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

Suitable supporting brackets and pipe clips shall be at maximum of meter centers

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

PART 29: GENERAL SPECIFICATIONS FOR PLUMBING AND DRAINAGE

29.1.14**UPVC Square Rainwater System pipe and Gutter**

Gutter shall be a rectilinear section 116mm or 137mm wide.

Gutters shall be supplied in plain-ended lengths

The minimum acceptable wall thickness of gutter shall be 2.20mm

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 UPVC used for gutter and pipe shall have a minimum softening point of 75^0C when tested by the
vicat method as described in BS 2782.

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

29.1.15**uP.V.C. Rainwater Fittings**

All fittings shall be injection mounted and shall be compatible with pipe and gutters and shall conform to BS 456 or the appropriate Kenya Standard.

All gutters pipe and fittings shall be Colour Grey to British Standard 5252, 12.A. 07 0r 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

Rain water pipes shall be circular in section, 65mm nominal diameter complying in al 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 UPVC used for gutter and pipe shall have a minimum softening point of 75^0 C when tested by the
Vicat method as described in BS 2782.
The pipe and gutter shall be Colour Grey, to BS 5252, 10.A.07. black, white or rustic.

PART 29: GENERAL SPECIFICATIONS FOR PLUMBING AND DRAINAGE

29.1.16**UPVC Underground Drainage System**

(a) Pipes and fitting

The pipes and fittings shall comply in all respects to British Standard 46600 & 581 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:

110mm pipe	3.0mm	
160mm pipe	3.9mm	
110mm junction only	3.50mm socket	3.80mm body
All other fittings	3.20mm socket	3.40mm body
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 UPVC used for the pipes shall have a minimum softening point of 82^0 C when tested by the 'Vicat' method 102D as described in British Standard 2494: 1976.

Holderbats shall be made of Mild Steel protected from corrosion by galvanizing or such coating for optimum fit. To fit pipe supports a special purpose made PVC packing piece 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 lines radius of 250mm.

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

PART 29: GENERAL SPECIFICATIONS FOR PLUMBING AND DRAINAGE

(b) Excavation of Trenches

The installation, method of joining shall confirm 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. Trenches width shall be not less than the outlet diameter of the plus 300mm and not wider than necessary.

(c) Trench Invert

The base of the trench shall be such that even support is given to the pipe for it's 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.

(d) Pipe bed

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

(e) Laying and jointing

Pipes and fitting shall be laid true to gradient in straight lines and joined 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.

PART 29: GENERAL SPECIFICATIONS FOR PLUMBING AND DRAINAGE

(f) 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.

(g) 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 fillings 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.

(h) Granular Material for Bed and Side Fill

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

All material for bed and site fill shall be hard and granular passing 20mm sieve and shall contain not more than 5 per cent fines passing 3mm sieve.

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

PART 29: GENERAL SPECIFICATIONS FOR PLUMBING AND DRAINAGE

29.1.17 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 the requirements of BS 1010.

b) Gate Valves

All gate valves 80mm nominal bore and above, other than those required for fitting to buried water mains shall be of Cast Iron construction, in accordance with the requirements of BS 3464. All gate valves required for fitting to buried water mains shall be of Cast Iron construction in accordance with the requirements of BS 1218.

All gate valves up to and including 65mm nominal bore shall be of Bronze construction in accordance with the requirements of BS 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 65mm nominal bore shall be of Bronze construction in accordance with the requirements of BS 3061.

The pressure classification of all globe valves shall depend upon the pressure conditions pertaining to the site of works.

PART 29: GENERAL SPECIFICATIONS FOR PLUMBING AND DRAINAGE

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 globe valves shall depend upon the pressure conditions pertaining to the Site of 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 follows: -

(i)	Low pressure	-	3.58 b maximum
(ii)	Medium pressure	-	7.72 b maximum
(iii)	High pressure	-	12.62 b maximum

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 BS 1415 from Bronze or other corrosion resistant materials.

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29.1.18 **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 BS 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 BS 1291.

b) Anti-Syphon Traps

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

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

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29.1.19 **Pipe Supports**

a) General

This sub-clause deals with pipe supports 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 damage to builders work associated with the pipe support installation.

The Sub-contractor shall submit all his proposals for pipe supports to the Engineer for approval before any erection works commence.

b) Steel and Copper Pipes and Tubes

Pipe runs shall be secured by 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 supports spacing in metres for Steel and Copper pipe and tube is given in the following table for horizontal runs.

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b) Steel and Copper Pipes and Tubes

Size Nominal Bore	**Copper Tube To BS 659**	**Steel Tube To BS 1387**
15mm	2.0m	1.25m

20mm	2.5m	2.0m
25mm	2.5m	2.0m
32mm	3.0m	2.5m
40mm	3.0m	2.5m
50mm	3.0m	2.5m
65mm	3.5m	3.0m
80mm	3.5m	3.0m
100mm	4.0m	3.0m
125mm	4.5m	3.0m
150mm	4.5m	3.5m

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

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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 Holderbats secured rigidly to the structure, or purpose made scrapes for attachments to rigid steel support brackets.

When Holderbats are used, they shall conform to the requirements of BS 416. Suitable anchors shall be provided at all changes of pipe directions, junctions and tees to counteract the effect of end thrust loads.

(d) **Asbestos Cement Pressure Pipe**

Asbestos Cements pressure pipe with either cast iron detached joints or asbestos cement screw joints shall be supported and anchored on either side of the joints. The joints 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 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 counteract the effect of end thrust loads.

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(e) **Concrete and Pitch Pipes**

These pipes shall not be used for above ground application.

f) **Expansion Joints and Anchors**

Where practicable, cold pipework 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 BS specification.

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 Engineer 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.

29.1.20**Sanitary Appliances**

All sanitary appliances supplied and installed as part of the Sub-contract works shall comply with the general requirements of BS Code of Practice 305 and the particular requirements of the latest BS Specifications.

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29.1.21**Pipe Sleeves**

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

29.2 INSTALLATION

29.2.1 General

Installation of all pipework, 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.

29.2.2 Above Ground Installation

a) Water Services

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

Where falls are not shown on the Contract Drawings or stated elsewhere in the Specification, pipework shall be installed parallel to the lines 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 user 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 reach from a small stepladder, extension spindles with floor or wall pedestals shall be provided.

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a) Water Services

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

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

All screwed joints to piping and fittings shall be made with P.T.F.E. tape.

The test pressure shall be maintained by the pump 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 4.5 litres per 25mm of diameter, per 1.6 kilometre per 24 hours per 30 metres head, may be considered reasonable but any visible individual leak shall be repaired.

b) Sanitary Services

Soil, waste and vent pipe system shall be installed in accordance with the best standard of modern practice as described in BS 5572 to the approval of the Engineer.

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

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

Where a branch requires rodding facilities in a position to which normal access is 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 galvanized steel wire guard.

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

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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 C.P. 305 to the approval of the Engineer.

29.2.3 **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

(i) Setting Out

As described in BS code of practice 301 Clause 502

(ii) **Breaking Up Surface (If in Roads)**

As described in BS code of practice 301 Clause 503

(iii) Excavation and Timbering

As described in BS code of practice 301 and 503 and the following:-

Excavation shall be made to such depths and dimensions as may be required by the Engineer to obtain prior falls and firm foundations. No permanent constructions shall be commenced on any bottom until the excavation has been examined and approved by the Engineer.

Should the Sub-Contractor in error or without the instructions of the Engineer make any excavation below the required level of the pipe or bed, as the case may be, then he shall be required to refill such excavation to the correct levels with concrete 1: 4 : 8 to 38mm maximum aggregate size.

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(iii) Excavation and Timbering

The Sub-Contractor's prices 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 excavations 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 discharge into the sewage system without written permission of the Engineer.

(iv) Laying of Concrete Beds or other Supports for Pipes

As described in BS code of practise 301 Clause 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.

(v) Pipe Laying and Jointing

Drain pipes shall be laid and jointed as described under BS code of practise 301 clause 505.

Water pipes shall be laid and jointed as described under BS code of practice 310, Clause 401, 402, 403 and 404

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(vi) Manholes

(a) General

All manholes provided under the Sub-Contract works shall be constructed

of approved materials and in an approved manner, by the Main Contractor.

All manholes shall be watertight and if constructed of brickwork, solid block work or stone work, they shall be rendered internally with a cement mortar of at least 12mm thickness and finished with a smooth surface.

The sides of all channels in every manhole shall be ought 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 surface with a coat of 1:1 cement mortar.

In all other respects, manhole shall be constructed in accordance with BS code of practice 301

(b) Rectangular and Square Manholes

Rectangular and square straight through manholes shall be constructed from brickwork, solid blockwork, stone and concrete to comply with the following minimum internal dimensions (millimetres)

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Depth below internal Ground of Access Outgoing shaft Invert	Size of Main Shaft Diameter	Internal Chamber Dimension SLXW	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 to 1800	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 dimension of the chamber shall be increased as follows:-

c) Length

Branch Diameter

100mm 300mm/branch on the side with most branches

150mm 380mm/branch on the side with most branches

230and 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

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(c) Precast Concrete Circular Manholes

Where specified straight through precast concrete manholes shall be manufactured and constructed to comply with BS 556 and the following dimensional requirements, (Dimension: Millimetres)

Depth Ground of Outgoing	Internal Access Shaft	Size Main Channel	Chamber Diameter	Height Chamber Above

Invert	Diameter	Diameter		Benching
Up to 740	-	100 to 460	910	-
760 to 2410	-	100 to 460	1070	-
2440 to 4550	-	100 to 460	1220	1370
4570 & over	760	100 to 460	1370	2680

When branches are connected into manhole the internal diameter of the chamber shall be increased as necessary up to maximum chamber diameter 1830.

(d) Steps Iron and Covers

Access shaft to manhole of depth greater than 760mm shall be provided with approved steps iron at 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 into the system.

Cast manhole covers and frames shall be manufactured in accordance with the requirements of BS 497 and shall generally be classified into the following categories:

Heavy Duty : For Carriageway

Medium Duty : For Footpaths

Light Duty : For domestic premises or other places where they do not have to carry wheeled Traffic.

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(e) 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

Connection.

(f) 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.

(g) Testing of Pipelines

After pipelines are connected up and joints have been sealed, the pipeline shall be tested before pipes are, if required haunched or surrounded in concrete

Methods of testing and inspection shall be in accordance with Clause 4 of the Specification.

(h) Concrete Bedding Hunching and Surround

Concrete 3 bedding, hunching and surrounding shall be provided as necessary o where called for by the Engineer in accordance with the requirements laid down in BS code of practice 301, Clause 310

(i) Backfilling

Backfilling of trenches, headings and around manholes shall be carried out in accordance with the methods described in BS code of practice 301, clause 508.

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(j) 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 concerned.

No Claims for extra in this respect will be accepted.

(k) Sewer Connection

Sewer Sub-contractor shall pay all charges associated with the connection by the local Authority of the drainage to the main sewer, including necessary reinstatements

29.3 TESTING AND INSPECTION

29.3.1 Site Tests – Pipework Systems

a) 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 times to design working pressure.

If preferred, the Sub-contractor may test the pipelines in sections. 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 Engineer.

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.

b) Underground Water Mains

After laying, jointing 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 sections 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 used 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 supports to withstand the end thrust of the water pressure in the main.

c) 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 BS 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 respects, tests shall comply with the requirements of BS 5572.

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d) 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.

Water tests shall be carried out in accordance with the methods described under BS 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 10,360 head at any point it 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, drain pipe 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 BS code of practice 301, clause 601 (e).

Testing of manholes shall be carried out in accordance with the methods described under BS code of Practice 301, clause 602 (f)

(e) 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 BS 5572 1972

Smoke tests on above ground soil, waste and ventilation 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, testes shall comply with the requirements of BS 5572.

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29.4 **SITE TEST PERFORMANCE**

Following satisfactory pressure test on the pipework system, operational tests shall be carried out in accordance with the relevant BS 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 pipework shall be installed with pre-formed fibre glass 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 "sweating", 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 painting as follows:

i) Apply a coating of suitable filler until the canvas weave disappears and allow to dry.

ii) Apply two coats of an approved paint and finish in suitable gloss enamel to colours approved by the Engineer.

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 banded in colours to be approved by the Engineer.

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 as 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 of 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 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 BS specification designates a maximum test pressure.

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29.5 STERILIZATION OF HOT AND COLD WATER SYSTEM

All underground and above ground water distribution systems cisterns, tanks, pumps etc shall be thoroughly sterilized and flushed out after the completion 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 BS Code of Practice 301, Clause 409 and to the approval of the Engineer.

29.6 WATER MAINS

29.6.1 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 BS 534- Galvanised steel pipes for distribution system shall comply with BS Galvanized steel pipes for distribution system shall comply with BS 1387-1967 medium tubes and be supplied with flanges on pipes 75mm diameter and over.
All pipes less than 75mm diameter shall be screwed and socketed, unless otherwise stated.

29.6.2 U.P.V.C Pipes

UPVC piping shall be in accordance with BS 3505: 1968.

The maximum sustained working pressure to which the pipes and fittings will be subjected is based on water at a temperature of 20^0 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 BS 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 joints shall sustain the end thrust to which the pipe shall be submitted. The contractor shall supply sufficient quality
of the cleaner and adhesive which shall be required to make the joints with the pipes.
The pipes of 75mm diameter and over shall consist 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.

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29.6.2 **U.P.V.C Pipes**

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 the outside of the socket area as by 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 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 the stress points 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 lined deflection up to 30^{o}.

The sealing ring shall supply be of the first grade natural rubber and the physical properties of the mix shall meet
the requirement of BS 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 and or the pipes to be used. The contractor shall submit full lists 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 strictly in accordance with the manufacturer's instructions.

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29.6.3 **Manufacturer's Instructions**

The contractor shall be responsible for obtaining copies of any manufacturer's instructions for pipe joining
and shall familiarize himself and his employees with these instructions.

All necessary tools and equipment required for laying, jointing and testing of pipes and joints shall be provided by the contractor at no extra cost.

29.6.4 **Fittings and Specials for Galvanized Steel Pipes**

All specials shall be of such dimensions as will meet with piping supplied. Screw down stop valves shall comply with BS 1010. Specials shall comply with BS 1740.

29.6.5 **Flanged Adaptors and Flanges**

Flanged adaptors shall be piece suitable for connecting a flanged sluice valve to the type of piping supplied. All flanged or special shall conform to BS 10 part 1 and shall be drill to Table 'C' and machined across the faces. The flanged adaptors shall comply with BS 78 and BS 3961. All PVC flanged shall be supplied with metal backing rings jointing of flanges shall be carried out using the joint rings, bolts and washers as necessary.

29.6.6 **Tees**

The spigot ends of all tees shall be suitable for connection to the pipework supplied using the aforementioned flexible mechanical joints and branches shall be flanges drilled to BS 10 table 'C'.

29.6.7 **Hydrants**

Hydrants shall comprise a 75mm sluice valve and a 75mm Duckfoot bend with gunmetal screw connection to detailed drawings. These specials shall comply with the requirements of BS 750: 1964.

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29.6.8 **Gate Valves**

All gate valves 80mm nominal bore and above, other than those required for fitting to buried water mains shall be of cast iron construction, in accordance with the requirements of BS 3464.
All gate valves required for fitting to buried water mains shall be of cast iron construction in accordance with the requirements of BS1218.

All gate valves up to and including 65mm nominal bore shall be of bronze construction in accordance with the requirements of BS 1952.
The pressure classification of all valves shall depend upon the pressure conditions pertaining to the site of works.

29.6.9 **Air Valves**

Air valves shall be of cast iron conforming to BS 14 52 Grade 14. They shall not be suitable for working pressure nor less than that specified for the class of pipe to which they are connected.

29.6.10 **Ball Float Valves**

Ball float valves shall be to BS 1212 parts 1 and 2 shall be suitable for working pressure not less than the working pressure for the class of pipe specified for connection to the ball float valve.

29.6.11 **Non-Return Valves**

Non-return valves shall be of cast iron with flanges and shall conform to BS 4090: 1966.

29.6.12 **Stop Cocks**

Stopcock up to 50mm diameter shall be brass and shall conform to BS 1010 part 1: 1959 part 2;1973.

29.6.13**Rubber and Insertion Jointing**

Rubber and insertion jointing for flange jointed shall comply with BS 2494 part 1 and no jointing rings shall be used in the contract, which have not been supplied by manufacturers approved by the Engineer.

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29.6.14 **Bituminous 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.

29.6.15 **Steel Pipe and Fittings for Rising Main**

All piping shall be plain ended and suitable for use with flexible mechanical couplings (e.g. Viking Johnson, dresser) The grade of steel used shall comply with the requirements of BS 3601: 1964. Pipes shall be welded or seamless and shall conform to BS 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 BS 534: 1966.

The external protection shall be reinforced with oven glass, cloth glass, tissue wrapping 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.

29.6.16 **Drain-Off Taps, Stops Valves for Water Services**

Fittings for mains of size 50mm or under shall comply with BS 1010. Samples must be submitted to the Engineer for approval prior to installation of fittings.

29.6.17 **Storage of Plants and Material**

The contractor shall, at his own expenses, make arrangements for dumps along the route of the pipe line for a storage of pipes, his plant and materials to suit his own convenience, but such arrangements shall be subjected to the Engineer's approval.

29.6.18 **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 laying. The stocking of pipes and specials on site, loading and unloading etc. shall be carried out to the satisfaction of the Engineer.

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29.6.19 **Interferences with Fences, Drains, Pipes, Property etc.**

The contractor shall ensure the proper reinstatement of fences, drains, telephone lines, KP&LC. Cables etc where affected by his work. All service shall be adequately protected and propped to the satisfaction of the Engineer. The contractor shall be liable for any damage caused to the service due to his failure to provide adequate protection.

29.6.20 **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 indicated by the Engineer, it is intended that the trench shall be excavated to such a depth as will allow of a minimum cover of 5000mm 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 trenches passes through grassland, arable land or garden, whether enclosed or otherwise, the turf, if any shall be pared off and stalked, 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.

29.6.20 **Method of Excavation**

c) The bottom of the trench shall be property trimmed off, and all low places or irregularities shall be 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 dimension as to allow the joints to be well and properly jointed.

e) The pipe trench shall be kept clear of water at all times.

PART 29: GENERAL SPECIFICATIONS FOR PLUMBING AND DRAINAGE

29.6.20 **Method of Excavation**

f) The contractor shall whenever 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 rate for excavation. Incase the Contractor is instructed by the Engineer to leave any portion of such timber in position, he will be paid for it accordingly.

g) The cleared width inside the timbering in the case of single pipes shall be at least 320mm in excess of the external diameter of the pipe be 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 excesses of the combined external diameters of the pipes.

i) Should the excavations 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 damages that in the opinion of the Engineer, may be caused by the use 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.

PART 29: GENERAL SPECIFICATIONS FOR PLUMBING AND DRAINAGE

29.6.21 **Main 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 slug and sounded with hammer for flaws before they are lowered into 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 is a continuous rise from each washout to air valve.

29.6.22 **Temporary Bench Marks and Sight Rails.**

The contractor shall fix rails for use with boning rods at intervals of not more than 65 meters and temporary Bench mark related to the survey of Kenya Datum shall be provided at intervals as directed by the Engineer.

29.6.23 **Curves and Bends**

Large diameter curves of main shall wherever possible be formed by giving a set not exceeding 30 to each joint, bends being used only where large diameter curves are not possible.

29.6.24 **Cutting 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 while the axis cuts should be made with an approved cutter from rotary cutting machine, engineer may approve cutting by oxyacetylene cutters.

29.6.25 **Flanged 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 full flange width ring.

The bolts shall be tightened up gradually and equally in customary manner in order to distribute the stress evenly over the flange.

PART 29: GENERAL SPECIFICATIONS FOR PLUMBING AND DRAINAGE

29.6.26 **Surface 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.

29.6.27 **Fixing of Valves, Air Valves and Washouts Pipes**

The contractor shall fix the sluice valves, air valves, washout pipes 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.

29.6.28 **Support and Anchor Blocks**

Concrete mix 1:3:6 shall be placed around and against bends and other specials in trenches.

29.6.29 **Colour 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 pipework above ground and valves in valve chambers and pits are to be painted in similar colours.

29.6.30 **Lettering**

The lettering for sluice valves, fire hydrants, air valve and washout abbreviated SV FH and WO respectively shall be in accordance with the detail shown on the Drawings colour as detailed hereafter: -

Untreated water:	White lettering on green background
Drinking water:	White on blue background

Fire Hydrant: White lettering on yellow background

PART 29: GENERAL SPECIFICATIONS FOR PLUMBING AND DRAINAGE

29.6.31**Testing**

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 BS specification designates a maximum test pressure should not exceed 120,180 and 240 meters/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 mains has been jointed, the ends shall be closed with caps, plugs or flanges, which must be strongly strutted against a solid backfilled rammed as hereinafter and as shown on the Drawing, for its whole length so as to cover the mains to a depth of not less than 500mm, except at the joint holes which shall be kept clear of all backfiring, if necessary by the use of timbering, so that each joint is left fully exposed for inspection. No backfililng 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 Engineer 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 Engineer 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 Engineer.

PART 29: GENERAL SPECIFICATIONS FOR PLUMBING AND DRAINAGE

29.6.31 **Testing**

c) After the section to be tested has been charged and all air liberated it shall standing underrate moderate pressure for several days' final airing. The leakage from the mains and connections from each section tested shall not exceed 4 litres per 25mm diameter of main, per 2Km. Length each 24 hours, every 30 meters head of pressure, and any visible individual shall be repaired.

To determine the rate of leakage, the contractor shall furnish a suitable hydraulic test pump, pressure gauge, connection 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 coupling 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 waiter tightness only the Engineer shall authorize the operation of all valves, but the contractor shall provide all the necessary labour to assists in the opening and closing of the valves to the Engineer's instructions and he shall allow in his price for all his expenses in connection with testing on completion.

The Engineer shall be the sole judge of water tightness.

PART 29: GENERAL SPECIFICATIONS FOR PLUMBING AND DRAINAGE

29.6.32 **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 20p.p.m. of free available chorine or such other Sterilizing agent as the Engineer 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 to damage the trench or cause due flooding of 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 mains is put into use, bacteriological samples will be taken by the Engineer's representatives and only on the 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 taking of samples shall be included in the contractor's tendered rates and Engineer will specify and shall be sole judge as to the number of sample required and 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.

PART 29: GENERAL SPECIFICATIONS FOR PLUMBING AND DRAINAGE

29.6.33 Clearance of Site

The contractor shall remove all surplus pipes, special and other fittings from the site 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.

29.6.34 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 Engineer 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 fittings are to be removed with utmost 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 Architects. Where not required to be removed, seal off with concrete or grout solid as directed. Seal o connection to manholes, demolish wall to 50mm below surrounding ground level and fill remainder of manhole with consolidated approved rubber and cover to level of surrounding ground as directed.

PART 29: GENERAL SPECIFICATIONS FOR PLUMBING AND DRAINAGE

29.7 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 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 the sub-contractor shall use the paints, which will not be toxic.

The tanks shall be manufactured to the following British Standards: -

(a) Galvanized 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.

29.8 WATER HEATERS

Electricity Heated

Non-pressure and low-pressure types domestic electric water heaters shall comply with BS 843:1964. High-pressure types shall be of a standard not less than the appropriate BS

Domestic heaters shall, if nothing else is pacified 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 BS 3456 section A8:1963 and C.P. 324. 202:1948.

Purpose made storage water heaters of the specified size shall comply with BS 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. Installation

shall, if nothing else is specified, be fiberglass to the specified thickness with finish suitable for painting.

Domestic heaters for floors 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 galvanizing, wall mounted heaters shall be supplied with all necessary brackets.

PART 29: GENERAL SPECIFICATIONS FOR PLUMBING AND DRAINAGE

29.9 ELECTRICAL SERVICES

Suitably rated control panels shall be supplied and installed as part of this section of the Contract to meet the starting and operating characteristics of the fan, and motors.

The panels shall be either wall or floor mounted to suit the specific area and requirements. Power supplies to these panels shall be extended from adjacent isolating switches to be provided under the electrical services section of this Contract. Complete co-ordination shall be maintained with the electrical services to ensure supply and termination details are satisfactorily carried out to suit the plant and installation requirements.

29.9.1 Motor Control Panels

All starters, control equipment and the like shall be enclosed in purpose made sheet panels. The panels shall be installed within the plant rooms to suit the dimensions of the actual panels. All details of the panels and layouts within the plant shall be to the approval of the Engineer and shall include:

- Triple pole isolating switch removable neutral link and HRC fuses.
- Control circuit fuses of the HR cartridge type
- Under voltage release, adjustable and complete tower to allow for voltage associated with the electrical supply and motor starting.
- Over voltage protection, details to be agreed.
- Ammeter of the moving iron mounted on panel with selector switch.
- Pilot lamp, green.
- Rotary switch for HAND/OFF/AUTO operation, where required. Removable neutral link of heavy section copper.

- Motor winding over-temperature release. The Contractor shall provide this feature in conjunction with the specified thermistor protection
- Duty selection switches.
- Manual stop-start button units to operate in conjunction with rotary switch.
- Hours run meter/counter.

PART 29: GENERAL SPECIFICATIONS FOR PLUMBING AND DRAINAGE

29.9.1 Motor Control Panels

The Contractor shall allow at present for the contractors to re-close automatically on the restoration of the mains voltage. This requirement shall be subject to further discussions with the Employer to suit the Diesel plant and the mode of operation of electrical supplies.

All starter panels shall include sufficient miniature circuit breakers, with neutral bar, to supply auxiliary or associated equipment. One 30TP and one spare 15TP MCBs shall be included as spares.

All starter panels, motor starters and controllers shall comply with BS 587. Enclosures shall be rigid, at least 1.6mm thick, with rolled corners stiffened as necessary, dust-proof, vermin-proof, damp and corrosion protected with a grey colour stone enamel or other approved finish, fully tropicalised, with washable air filters. Instruments, gauges, ammeters, indicator lamps, etc shall be flush mounted. Panel doors shall include isolating switches to prevent them being opened unless the switches are in the off position. Each door shall be provided with a lock, and three sets of keys for all panel door locks shall be handed over to the Engineer.

Terminals for all outgoing main and control cables shall be marked and positioned so that the cables may be carried to the outlet from the panel without crossing or being carried round the panel. Terminal numbers and markings shall correspond to those used on connected equipment and wiring diagrams. All internal interconnecting wiring between individual units and the terminal chamber shall be carried out by the panel manufacturer.

Each panel shall be provided with a main isolator so that the whole panel may be completely isolated.

The Contractor shall determine all motor starter requirements and associated auxiliaries and controls prior to manufacture and shall submit the design and circuit diagrams to the Engineer for approval.

Contractors shall determine all motor starter requirements and associated auxiliaries and controls prior to manufacture and shall submit the design and circuit diagrams to the Engineer for approval.

PART 29: GENERAL SPECIFICATIONS FOR PLUMBING AND DRAINAGE

29.9.1 **Motor Control Panels**

Contractors shall be of air-break type BS 5424 Part 1 and/or BS 587, and shall be provided as follows:

- Magnetic blow-outs and air chutes on each pole.
  - Renewable hard drawn copper contacts.
  - Auxiliary contacts for remote control.
- Continuously rated operating coils, (Max 240V)
- Thermal overload protection device incorporating single phasing protection.

Starters shall be rated as follows:

Ordinary duty - For motors which will run continuously for periods in excess of two hours.

Intermediate duty - For motors under automatic control other than time controls. When the intervals of operation are greater than two hours.

Starters shall be of the following type:

- Up to and including 4KW motor: Single phase on/off with overload protection (D.O.L.).

- Over 4 kW and up to 15 kW: Star Delta starter.

- For starters incorporating reduced voltage starting the changeover of voltage shall be automatic.

PART 29: GENERAL SPECIFICATIONS FOR PLUMBING AND DRAINAGE

29.9.1 Motor Control Panels

Terminals shall be accessible and shall be provided with adequate clearance between phases and between phases and earth. Where starters are not enclosed in a composite panel, an integral isolating switch as specified for control panels shall be provided. Where electric motors are either not visible from the control panel or are located more than 10m distance they shall be provided with a local lock-off stop control circuit switch, or a main circuit isolator where there is no control circuit. A weatherproof lock-off stop control circuit switch shall be provided for motors located externally or otherwise exposed to the weather.

29.9.2 Motors

Motors shall comply with BS 816 Part 1 and shall be arranged for conduit entry.

Motors shall be fitted with locating type bearings and/or heavy thrust bearings at the non-driven and collar type at the drive end. Motors shall be of the totally enclosed fan cooled type, tropicalised to BS 5000 Part 99 suitably finished to resist corrosion by fluids or fumes. The rating of all motors shall be chosen to provide continuously the maximum power requirements of the plant. The motors shall be of the standard induction type. They may be of the squirrel cage, horizontal or vertical spindle type of all to the approval of the Engineer.

Vertical spindle type motors shall be provided with substantial canopies of approved design.

The locked rotor current shall be stated on the name plate of each motor and shall be not more than six times the full load current.

Thermistors shall be fitted to all motors above 5 kW. They shall be fitted during manufacture and their ends shall be brought out to additional terminals on the connector block of the motor.

All motors shall be rated 3 phases. 415 volt or single phase, 240 volt. high power factor continuous maximum rating complying with BS 5000 Part 99 and Class F insulation complying with BS 2757 unless otherwise specified. All motors larger than 4 kW shall be three phase.

All three phase motors shall be supplied with six stud terminals with each end of the stator phase windings connected, terminals shall be of suitable size to accept the cable lugs of the feeding cables. Terminal blocks shall be mounted on the side of the motor case in an approved box complete with lid, gasket and tapped ET entry hole.

PART 29: GENERAL SPECIFICATIONS FOR PLUMBING AND DRAINAGE

29.9.2 Motors

Rubber installation shall not be used on coil connections. Each motor shall be fitted with cable terminals and glands to accept the specified types of cable.

No motor shall run at a speed higher than 1500 rpm unless otherwise specified. Motors driving through Vee-belts shall be fitted with slide rails. The power factor shall not be less than 0.9 lagging. All motors shall be from the same manufacturer as far as possible.

29.9.3 Cabling and Wiring

The Contractor shall carry out all power and control wiring including LV and ELV or any other voltage for the control equipment and alarm systems and interconnecting wiring between starter panels, remote control items, and motor units as required.

Cabling shall be carried out in PVC insulated, PVC sheathed, single wire armoured and PVC sheathed overall cable, using compression type glands provided with means of securing armoured wires within the body of the gland, under armour moisture seal and outer sheath seal.

Each core termination shall be fitted with a plastic ferrule engraved with an identification corresponding to the wiring diagrams.

Multicore control cables to the remote stop, start allow water cut-out/ alarms shall be 0.62mm^2 PVCSWAPVC where external to the pump station and PVC/PVC or similar, where internal. All cables, whether internal or external being suitably protected.

All conductors shall be copper and the installations, both internal and external being carried out in accordance with the regulations and by-laws previously stated. Trenching and the fixing of cables shall be in accordance with locally specified standards details of which have been specified within the subcontract documents for the electrical services. These details can be made available upon request should the Contractor not be familiar with these requirements.

Details of the ratings, types and methods for all cables and wiring to be supplied under this sub-contract shall be submitted with the tenders, wiring, PVC single core shall be run in either galvanised conduit or galvanised trunking of suitable sizes where surface in plant rooms and heavy gauge PVC were cast into walls, slabs etc.

PART 30: PARTICULAR SPECIFICATIONS FOR PLUMBING AND DRAINAGE INSTALLATIONS

30.1 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 contractor in conjunction with the sub-contract.

30.2 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:-

- Cold water supply pipework and fittings to the water storage tanks from the existing water mains.

- 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.

- The water supply pipework to the functional and sanitary as shown on the drawing plus the necessary fixing support and jointing materials from the water storage tanks.

- The sanitary and operational fittings together with the fixing supports and jointing of the supply and discharge pipes.

- The waste and soil pipework from the sanitary and operational fittings to the first manhole including all fixing, supports and jointing materials.

- 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.

PART 29: GENERAL SPECIFICATIONS FOR PLUMBING AND DRAINAGE

30.2 Included in the Sub-Contract

- The sub-contractor shall also be responsible for ensuring that runs for floor or wall chases, holes ton be cut or left will be marked out at the appropriate stage of structural work.

- 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.

- The sub-contractor shall as part of his tender supply all necessary information such as manufacture, catalogue or type numbers, bronchures or copies of catalogue pages, weight and all other relevant information which are necessary to classify the equipment tendered for.

- All other material labour, tools instruments, scaffolding, etc, which are necessary for completion in a first class manner of the plants to the Engineer satisfaction. Excluded are only materials and workmanship especially mentioned herein as " Excluded from this Sub-contractor"

- The sub-contractor shall include for cables, pipes etc from central facilities to working area.

- Provide the Engineer for his approval complete working and manufacturing drawing as

specified.

- Commissioning and testing of the plants as specified.

- Supply of complete operation and maintenance manuals as specified as well as adequate instruction of the client's maintenance personnel as specified.

- The sub-contractor shall include for full maintenance during initial maintenance period as specified.

30.3 **Excluded from the Sub-Contract**

- All concrete works, inclusive of necessary holes, plinths etc

- All block work inclusive of necessary holes (to be marked by the Sub-contractor) etc

- All electrical wiring up to and inclusive of isolators and switchboards.

- The main contractor will provide central located facilities for supply of water and power during the construction period.

PART 29: GENERAL SPECIFICATIONS FOR PLUMBING AND DRAINAGE

30.4 **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 Architects and/or the Engineer. 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.

30.4 **Extent of the Sub-Contractor's Duties**

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 Architect or the Engineer, 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.

PART 30: PARTICULAR SPECIFICATIONS FOR PORTABLE FIRE EXTINGUISHERS

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 and Architects 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 fulfillment of time schedules.

30.5 **Finish Painting**

When all the installations have been set to work, tested and commissioned, the sub-contractor shall prime the pipework with an undercoat and paint 2 No. coats of paints in accordance to BS 1710 Colour coding and to the satisfaction of the Engineer and the Architect.

30.1 **General**

The particular specifications details the requirements for the supply, installation and commissioning of the portable fire extinguishers which shall conform to BS 5423:19 77. The sub-contractor drawings but which are necessary for the completion and satisfactory function of the equipment.

30.2 **Scope of works**

The sub-contractor shall supply, deliver, erect, test and commission all the portable fire extinguishers which are called for in this specification and shown on the contract Drawings and listed in the Bills of Quantities.

PART 30: PARTICULAR SPECIFICATIONS FOR PORTABLE FIRE EXTINGUISHERS

30.3 **Water/CO_2 Fire Extinguishers**

The portable 9-litre water filled CO_2 cartridge operated portable fire extinguishers shall comply with BS 1382: 1977.Unless manufactured with stainless Steel, bodies shall all have internal surfaces completely coated with either a less tin, lead alloy, or zinc applied by hot dipping. There shall be no visibly unallocated areas.

The extinguishers shall be clearly marked with the following: -

a) Method of operation

b) The words '**WATER TYPE' (GAS PRESSURE)** in prominent letters

c) Name and address of the manufacturer or responsible vendor.

d) The nominal charge of the liquid in imperial gallons and litres

e) The liquid level to which the extinguisher is to be charged

f) The year of manufacture

g) A declaration to the effect that the extinguisher has been tested to a pressure of 350 lb/sq in (24.1 bar).

h) A declaration to the effect that the extinguisher has been tested to a pressure of 350 lb/sq in 24.1 Bar)

i) The number of the British Standard "BS 1382" or "BS 5423"

30.4 **Portable Carbon Dioxide Fire Extinguishers**

The portable carbon dioxide fire extinguishers shall comply with BS 3326: 1960 and BS 5423: 1977

The body of the extinguishers shall be a seamless steel cylinder manufactured to one of the following British Standards, BS 1287 or BS 1288.

The filling ratio shall comply with BS 5355 with Valves fittings for compressed gas cylinder to BS 341. Where a hose is fitted it shall be flexible and have a minimum working pressure of 300 lb/sq in (206.85 bar), the hose is not to be under internal pressure until the extinguisher is operated.

The nozzle shall be manufactured of brass gunmetal, Aluminium or Stainless Steel and may be fitted with a suitable valve for temporarily stopping the discharge if such means are not incorporated in the operation head.

PART 30: PARTICULAR SPECIFICATIONS FOR PORTABLE FIRE EXTINGUISHERS

30.4 **Portable Carbon Dioxide Fire Extinguishers**

The discharging horn shall be designed and constructed so as to direct the discharge and limit the entertainment for air. It shall be constructed of electrically non-conductive material.

The extinguishers shall be clearly marked with the following:

a) The words; 5kg carbon dioxide fire extinguishers and to include the appropriate nominal gas content.

b) Method of operation

c) The word "Re-charge immediately after use"

d) Instruction for periodical checking

e) The number of the British Standard BS 3326: 1960

f) The manufacturer's name or identification markings.

30.5 **Dry Powder Portable Fire Extinguishers**

The portable dry powder fire extinguishers shall comply with BS 3465: 1962 and BS 1449 or aluminium to BS 1470: 1972 and shall be suitably protected against corrosion.

The dry powder charge shall be non-toxic and retain it's free flowing properties under normal storage conditions. Any pressuring agent used as an expelling shall be in dry state; in particular compressed air.

The discharge tube and gas tube if either is fitted shall be made of steel, brass, copper or other not less suitable materials. Where a hose is provided it shall not exceed 1.060m and shall be acid and alkali resistant. Provision shall be made for securing the nozzle when not in use.

The extinguisher shall be clearly marked with the following information: -

a) The words "Foam Spray Fire Extinguisher"

b) Method of operation in prominent letters

c) The working pressure and the capacity of the foam charge in litres

PART 30: PARTICULAR SPECIFICATIONS FOR PORTABLE FIRE EXTINGUISHERS

30.5 **Dry Powder Portable Fire Extinguishers**

d) Manufacturer's name or identification mark

e) The words "**RECHARGE AFTER USE**" if rechargeable type

f) Instructions to regularly check the weight of the pressure container or inspect the pressure indicator on stored pressure type when fitted, and remedy any loss indicated by either.

g) The year of manufacture

h) The pressure to which the extinguisher was tested.

i) The number of this British Standard BS 3465 or BS 5423: 1977.

j) When appropriate complete instructions for recharging the extinguisher shall be clearly marked on the extinguisher or otherwise be supplied with the refill.

30.6 **Foam Spray Portable Fire Extinguishers**

The portable foam spray fire extinguishers shall comply with BS 3465: 1962 and BS 5423. The body shall be constructed of Steel not less than the requirements of BS 1449 or Aluminium to BS 1470: 1972 and shall be suitably protected against corrosion.

The foam spray charge shall be non-toxic and retain its free flowing properties under normal storage conditions. Any pressurizing agent used as an expelling shall be in dry state; in particular compressed air.

The discharge nozzle and gas tube if either is fitted shall be made of Steel, Brass, Copper or other not less suitable material. Provision shall be made for securing the nozzle when not in use.
The extinguisher shall be clearly marked with the following information:-

- The words ‘ Foam Spray Fire Extinguisher’
- Method of operation in prominent letters
- The working pressure and the capacity of the foam charge in letters
- Manufacturer’s name or identification mark

PART 30: PARTICULAR SPECIFICATIONS FOR PORTABLE FIRE EXTINGUISHERS

30.6 Foam Spray Portable Fire Extinguishers

- The words ‘**RECHARGE AFTER USE’** if rechargeable type
- Instructions to regularly check the weight of the pressure container or inspect the pressure indicator on stored pressure types when fitted, and remedy any loss indicated by either.
- The year of manufacture
- The pressure to which the extinguisher was tested
- The number of this British Standard BS 3465 or BS 5423:1977
- Appropriate complete instructions for recharging the extinguisher shall be clearly marked on the extinguisher or otherwise be supplied with the refill.

30.7 Fire Blanket

The fire blanket shall be made from cloth woven with pre-asbestos yarn or any other fire proof material and to measure 1210 x 1800mm and shall be fitted with specialties folded so as to offer instantaneous single action release blanket from storing jacket.

PART 31: PARTICULAR SPECIFICATIONS FOR FIRE HYDRANTS

31.1 General

This particular specification details the requirement for the supply, installation and commissioning of the Fire Hydrants. The hydrants installation shall comply in all respects to the requirements of BS 750: 1977 or the latest version of it.

31.2 Scope of Works

The Sub-Contractor shall supply, deliver, erect, test and commission underground screw-down type fire hydrants.

31.3 Fire Hydrant Details

(a) Hydrant body

The body of the hydrant shall be made of Grey Cast Iron complying with the requirements of BS 1452 having a tensile strength not less than that given for grade 14.

(b) Hydrant Valve

The valve shall be faced with suitable resilient material. The threaded part of the valve, which engages with the spindle, shall be of bronze.

Body seating for the valves shall be of copper alloy complying with the requirements of BS 1400, or high tensile brass complying with the requirements of BS 2872 or BS 2874.

Valves shall be closed by turning the spindle cap in a clockwise direction when viewed from above and the direction of opening shall be permanently marked on the gland.

(c) Spindle & Spindle Cap

The spindle note shall be either of the same material as the spindle, or of copper alloy complying with the requirements of BS/1400 either type LG 2 or type LG 4. It shall have a squared top formed to receive either a cast iron spindle cap.

The spindle shall be made of copper alloy complying with the requirements of BS 2874, either type CZ114 or type CZ115, and it shall have a threaded machined of trapezoidal form.

The spindle cap shall be of Cast Iron secured to the spindle by an M12 hexagon socket set screw conforming to BS 4168.

PART 31: PARTICULAR SPECIFICATIONS FOR FIRE HYDRANTS

31.3 **Fire Hydrant Details**

(d) Hydrant outlet

The outlet flange of the hydrant shall have above nominal diameter 65mm, and shall be fitted with a screwed outlet – Both flanges shall be 50 mm conforming to BS 4504: Part 1: 1969

The screwed outlet shall be provided with a cap of Cast Iron or other suitable material. The cap shall cover the outlet thread completely and shall be attached to the hydrant by a chain

The distance between the axis of the outlet and the nearest point on the spindle fitting shall be not less than 100 mm.

The screwed outlet shall be made of: -

Copper alloy to BS 1400, type LG2G or DC BIC or

Copper alloy to BS 2872, type CZ114 or CZ115, or

Suitable spheroidal graphite iron to BS 2789 protected against corrosion accordance with CP 2008.

(e) **Drain Boss**

Each shall be provided with a suitable drain boss on the outlet side. This shall be located at the lowest practical point which will permit the filling of self-operating a drilled drip plug.

(f) **Jointing**

The hydrants shall have machined joint faces throughout and the fitting of adjoining parts shall be such as to make sound joints, corresponding parts of hydrants of the same design and manufacture shall be interchangeable.

(g) **Hydrant coating**

The hydrant shall be coated in accordance to BS. 4164.

(h) **Surface Box**.

The clear opening of hydrant surface boxes at ground level shall not be less than 250mm x 380mm

PART 31: PARTICULAR SPECIFICATIONS FOR FIRE HYDRANTS

(h) **Surface Box**.

The depth of frame shall normally be

a) for boxes located on footpaths: 100mm

b) for boxes located in roads: 125mm

(i) **Markings**

Surface box covers shall be clearly marked by having the words ‘FIRE-HYDRANT’ in letter not less than 30mm high, or the initials ‘F.H.’ in letters not less than 75mm high cost into the cover.

(j) **Surface Box Covers & Frames.**

The surface box frames and covers shall be graded in accordance with 2.1. of BS 497:1967 and shall meet the loading test requirement also given in BS 497

(k) **Testing**

The hydrants shall be deemed to have undergone the necessary hydrostatic and flow test at time of manufacture Necessary test certificates from the manufacturer shall be needed. The test, to conform to BS 750: 1977: Appendix a.1

31.4 **Stand Pipes**

One end of these shall have internal threads to couple with the 80mm diameter external threads of the screw down type fire Hydrant (BS 750 type 2 hydrants) outlet. The other shall have 65mm diameter internal threads to couple with the interconnector hose of the pumpset.

31.5 **Hose Pipe**

Each cotton synthetic fibre rubberised fire hosepipe to be 25mm metres long with 65mm diameter female instantaneous type connector.

PART 32: PARTICULAR SPECIFICATIONS FOR AIR-CONDITIONING & MECHANICAL VENTILATION INSTALLATIONS

32.1 **General**

This section covers the supply and installation of ventilation and air-conditioning equipment and fittings.

The following specification is the General Specification for the Mechanical Ventilation sub-contract, and shall be read in conjunction with the Bills of Quantities, and the Drawings.

Where proprietary materials are specified, the sub-contractor may propose alternatives for the consideration of the Engineer, but the written approval of the Engineer must be obtained prior to the use of such an alternative.

The centrifugal fan type shall have blades of die-cast aluminium.

32.2 Supply Centrifugal Fan Unit

The Contractor shall supply, install, test and commission In-line centrifugal supply fan unit as set out in the equipment schedules shown in the end of this Specification.

The unit shall be selected to suit the type of roof structure on which it will be mounted all to the approval of the Engineer.

The unit shall be fully tropicalised for temperatures up to 50^{o}C and relative humidity up to 100%.

A flat square wire guard shall be supplied to close off the opening in the gable where this is required.

PART 32: PARTICULAR SPECIFICATIONS FOR AIR-CONDITIONING & MECHANICAL VENTILATION INSTALLATIONS

Birds guards shall be provided to prevent entry of birds via air discharge openings.

Motor and fan, and housing shall all be suitably isolated with respect to vibration.

The motor shall be the totally enclosed type, single phase. It shall be metric, ball bearing, squirrel cage indication type, for direct on-line starting. All motors shall have Class F insulation, the motor ratings shall comply generally with B.S. 5000:1973 and IEC 34.1, with protection to IEC 34.5 Group IP54. The motors shall be provided with overheat protection. The motor bearings shall be prefabricated for 30000 hours running or five years' intermittent use. Where lubricators are fitted, the motors shall be re-lubricated after two years.

32.3 Filtration

The extract fan shall be fitted, on its upstream side, suitable filter complete with housing.

Panel or unit filters shall only be used up to air flow of 6m3/sec. Dry replaceable media types shall be used, and shall be sized according to the manufacturers' instructions. Advancement of the media shall be controlled by a pressure differential switch. Sizing of the unit shall be such that the media requires replacement approximately every six months.

PART 32: PARTICULAR SPECIFICATIONS FOR AIR-CONDITIONING & MECHANICAL VENTILATION INSTALLATIONS

32.4 DUCTWORK

32.4.1 General Requirements

The general Contractor shall prepare and submit detailed ductwork drawings to the Engineer for approval in accordance with Clause 1B.6 of this Specification.

All duct sizes indicated on the Drawings refer to inside dimensions.

Ductwork joints shall be square with all sharp edges removed.

Sheet metal shall be rigidly supported and braced to prevent vibration.

Ducts and hangers shall be installed straight, plumb and level.

Ductwork shall be routed directly with a minimum of directional changes and abrupt transition.

Adequate space shall be provided around ducts to ensure proper support and to allow the installation of the specified insulation.

Diverting vanes shall be installed at branches connected into the main duct without a neck.

Fairings shall be provided where pipes or structures penetrate ducts. When the fairing is longer than 500mm the original velocity shall be maintained. When the fairing is shorter than 500mm the velocity may be increased by not more than 10 percent.

PART 32: PARTICULAR SPECIFICATIONS FOR AIR-CONDITIONING & MECHANICAL VENTILATION INSTALLATIONS

32.4 DUCTWORK

32.4.1 General Requirements

Turning vanes shall be provided in elbows whose center lines radius is less than 150 percent of the duct width, or where indicated on the Drawings.

Duct bracing and supports indicated are the minimum acceptable.

Additional bracing or supports shall be installed to eliminate any distortion or vibration when the systems are either in operational or under test.

All connections between ductwork, including flexible connections, fittings and equipment, shall be made with gradually tapered transition fittings.

32.4.2 **Ductwork**

In general all HVAC ductwork, stack heads, register boots, supply air transitions, plenums etc., shall be galvanized steel metal of the gauges and construction hereinafter specified.

All ductwork shall be installed in compliance with the most recent editions of NFPA 90 and 90A and all relevant codes and ordinances. Transitions shall be fabricated with a combined angle not greater than 2.12.1.5 degrees.

Branch take-off fittings (top, bottom and side) shall be fabricated with a throat area equal to 1.5 times the cross sectional area of the branch duct.

All angular turns shall be made with a duct centre lines radius equal to 1.5 times the cross sectional area of the branch duct.

All angular turns shall be made with a duct centre line radius equal to 1.5 times the width of the duct. Were, due to space limitations, it becomes necessary to make turns with a shorter radius, air foil type turning vanes shall be used.

PART 32: PARTICULAR SPECIFICATIONS FOR AIR-CONDITIONING & MECHANICAL VENTILATION INSTALLATIONS

32.4.3 **Galvanized Sheet Metal Ductwork**

Where construction methods, sheet metal gauges, duct fabrication and installation techniques etc., are not specifically detailed herein or indicated on the drawings, such work shall be fabricated in strict accordance with the latest recommendation methods, gauges, procedures, etc., described in the most recent editions of the ASHRAE Guide and Handbook, the SMACNA Standards of Low/High pressure Ductwork and the DW/142.1 standard of HVACA 1982.1.

32.4.4 **Specification**

Duct shall be installed in accordance with the Drawings and the following HVAC, ASHRAE and SMACNA Specification.

REFERENCE	TITLE	SCOPE
HVAC Ref. No.	Specification for sheet	Galvanized steel

	metal and black medium and high pressure/velocity air systems.	
DW/161	Code of practice for Recommendations for identification of air distribution systems	Methods of identification of source and destination of air, direction of flows classification by means of standard symbols.
DW/143	Practical guide to ductwork leakage testing	Leakage testing procedure
SMACNA	Low/and high pressure duct	Construction Specification
ASHRAE	1983 Equipment Volume Duct Chapter 1-Duct Contraction.	construction

PART 32: PARTICULAR SPECIFICATIONS FOR AIR-CONDITIONING & MECHANICAL VENTILATION INSTALLATIONS

32.4.5 **Materials:**

Galvanized ductwork shall comprise strip mill cold-reduced sheet, continuously hot-dipped galvanized to BS 2.1989: Grade Z2.1 or Z3.

32.4.6 **Protection:**

Galvanized ductwork shall be protected by one coat of mordant solution or calcium plumbate primer followed by two coats of bituminous paint.

Galvanized ductwork in contact with aluminium sections (grilles etc), shall, before fastening to ducts, be protected with one coat of primer and two coats of zinc chromate paint.

All aluminium sections shall be anodized to BS 1615. Mild steel shall be protected by one coat of red oxide paint followed by two coats of bituminous paint.

Ductwork: Thickness, stiffening and spacing of supports.

The stiffening of ducts shall be provided by the types of cross joints indicated in the tables plus intermediate stiffeners where necessary to comply with the spacing requirements.

An approved type of sealant shall be used on all cross joints.

Sheet thickness requirements are given in the following tables. In all cases the larger dimension determines the sheet thickness and stiffening. For plant connections, apparatus, casing and special applications (fire dampers etc), the next thickness of sheet up shall be used and additional stiffening shall be provided.

PART 32: PARTICULAR SPECIFICATIONS FOR AIR-CONDITIONING & MECHANICAL VENTILATION INSTALLATIONS

Rectangular - Low Velocity - Steel Duct Work

Maximum spacing between joints/stiffeners.

Minimum angle section for Intermediate Stiffeners	Length (mm)	Nominal (mm) Without	With Beading or cross-breaking (mm)	(mm) beading or cross-breaking
Up to 400	0.6	Unlimited	Unlimited	None
400-600	0.6	1500	Unlimited	2.15 x 2.15 x 3
601-800	0.8	1500	Unlimited	2.15 x 2.15 x 3
801-1000	0.8	12.100	1500	2.15 x 2.15 x 3
1001-1500	1.0	800	12.100	40 x 40 x 4

1501-2000	1.0	800		800	40 x 40 x 4
2001 – 3000	1.2.	600			50 x 50 x 5
For ducts galvanized after manufacture					
Upto 300			1.2		As equivalent sizes above
301 and over			1.6		As equivalent sizes above

32.4.7 **Air Leakage:**

The air leakage rate shall not exceed 1.53 litters per second per square metro of surface area for Class A positive, and leaks shall not be audible. The air leakage from a chosen test section shall be the proportion of the length of section under test to the total length of all ducts in the distribution system.

PART 32: PARTICULAR SPECIFICATIONS FOR AIR-CONDITIONING & MECHANICAL VENTILATION INSTALLATIONS

32.4.8 **Air Leakage Test Procedure:**

The HVAC Specification DW/143 sets out a method for testing which shall be employed by the Engineer. The Contractor shall be familiar with the testing method employed.

32.4.9 **Protection and Cleaning**

During construction all open ends of ductwork shall be covered with one layer of canvas.

All foreign materials shall be removed from the ducts and ductwork shall be cleaned inside and outside.

Ducts shall be cleaned before operating fans and filters. Fans shall not be operated unless filters are installed. After testing all cleanable filters shall be washed and renewable media shall be replaced.

32.4.10**Testing**

After completion of the duct systems and before insulation is installed, the entire system shall be tested under operating conditions for performance and leakage.

Testing shall be carried out in the presence of the Engineer.

32.4.11**Volume Dampers**

Volume control dampers shall be supplied and installed with locking levers and quadrants, indicating their position in main ducts and in all branch ducts supplying three or more air outlets and all fresh air intakes, and where shown on the Drawings.

Volume Control dampers shall be of the splitter, butterfly, or lourve type. Damper blades shall be not less than eighteen gauge thick, reinforced with 2.15mm angles 3.2.1mm thick along unsupported sides longer than 300mm. Angles shall not interfere with the

32.4.11**Volume Dampers**

operation of the damper nor cause additional turbulence. Stops shall be angles of equal dimensions to the reinforcing angles. The maximum dimension of any damper blade shall be 800mm . Duct shall be stiffened at damper locations as necessary.

Door shall be supplied for access to all damper quadrants installed in ducts located in suspended ceilings etc. Location and detailed installation drawings shall be supplied for all access doors. Doors shall be attached to frames with concealed hinges. Locks shall be of the flush type, screw driver operated with bronze cams.

Upon completion of the ductwork, dampers shall be adjusted and set to deliver the amounts of air indicated on the Drawings.

32.4.12**Fire Dampers**

Fire dampers shall be provided and fixed within the thickness of all fire barrier walls with a fire rating equivalent to the barrier. Each fire damper shall be operated by a fusible link set at 72.1 degrees C and fitted with an access door for inspection and replacement.

Details of the construction and operation of all fire dampers shall be submitted to the Engineer for approval before manufacture commences. Operation of all fire dampers shall be tested on Site after installation.

All fire dampers arranged to close by gravity shall be suitable weighted, arranged in the direction of the air flow and provided with an effective stop.

Fire dampers of the fire/shield curtain type, spring operated, shall also be permitted. The damper casing shall be completely airtight and of not less than 1.2.15mm thick galvanized sheet steel. The continuous series of ribbed interlocking blades shall be formed from not less than 0.8mm stainless steel and the spring shall be of not less than 0.2.15mm stainless steel.

The fire dampers shall comply with the Standards for safety UL555:1970, issued by the Underwrite's Laboratories inc., of the U.S.A.

PART 32: PARTICULAR SPECIFICATIONS FOR AIR-CONDITIONING & MECHANICAL VENTILATION INSTALLATIONS

32.4.13 Fusible Link Attachment

This shall consist of an adjustable, accessible, fusible link designed to melt at 72.1 degrees C, and attached to an opposed blade damper assembly, spring-controlled to close fully when the link melts. The link shall not interfere with normal damper operation.

32.1.14 Turning Vanes

Turning vanes shall be fabricated of the same material as the ducts in which they are installed.

Turning vanes for low and medium pressure systems shall comprise 1mm (2.10 gauge) galvanized steel.

Turning vanes shall be either double vanes or shop fabricated turning vanes constructed to the same standard. Samples of shop fabricated units shall be submitted to the Engineer for approval.

32.4.15 Dissimilar Metals

Connections between dissimilar metals shall be avoided by dielectric insulation. Joints between dissimilar metal duct sections shall be formed with companion flanges separated by a compressed asbestos gasket.

All units, bolts, screws and other hardware used in the sheet metal construction shall be fabricated of materials identical or similar to the duct construction, to prevent galvanic corrosion.

32.4.16 **Flexible Ducts**

Flexible ducts connecting the low pressure duct system to the linear slot diffusers, shall consist of a continuous vinyl-coated, spring steel wire helix fused to, and supporting, a continuous layer of vinyl-coated fibreglass mesh. A 13mm thick insulating and sound attenuating blanket of fibreglass wool shall encase the duct, and be sheathed with a moisture barrier consisting of vinyl impregnated and coated fibreglass fabric. The materials shall be incombustible.

Flexible duct connections shall be effected in one continuous length, with a double ply cuff at each end secured to ductwork spigots by a worm drive screw clamp, as supplied by the manufacture to the flexible ducts.

PART 32: PARTICULAR SPECIFICATIONS FOR AIR-CONDITIONING & MECHANICAL VENTILATION INSTALLATIONS

32.4.17 **Plenum Boxes**

Plenum boxes shall be constructed from rigid 50mm by 5mm steel angle and 1.2.1mm thick galvanized sheet steel.

A hinged access door, at least 450mm, with quick-release fasteners, shall be provided in the side of each plenum box.

The sides, top and bottom of the plenum box shall be lined with 2.15mm thick rock wool or fibreglass insulation, neoprene coated and suitable for velocities up to 12.1m/sec. The lining shall be secured with an approved adhesive and pinned into place by means of nylon hangers, or similar, at 2.100mm centres.

32.4.18 **Air Outlets**

a) General Requirements.

All outlets shall be sealed around the edges to prevent air leakages.

Supply air with a velocity in excess of 0.2.15m or less above finished floor level. Room air shall be mixed with the primary air by induction to effect subsequent equalisation of the room temperature without stratification.

Where supply or return outlets are installed in a continuous line, intermediate frames and margins shall be omitted. Guides shall be provided for each element to ensure that adjoining lengths shall be mitred for full alignment.

With outlets used with fan coil units, the Contractor shall co-ordinate the outlet dimensions, arranged and pressure drop with the fan coil unit, to ensure that they will be compatible.

Unless shown otherwise on the Drawings air outlets in ceiling shall be provided with a finish to match the colour of the adjacent false ceiling; other air outlets shall be provided with a natural anodized aluminum finish, all to the approval of the Engineer.

PART 32: PARTICULAR SPECIFICATIONS FOR AIR-CONDITIONING & MECHANICAL VENTILATION INSTALLATIONS

b) Ceiling Mounted Supply/Return Linear Diffusers

The Contractor shall supply and install, in the location shown on the drawings, multi-slot supply and return linear diffusers.

These shall be similar to those manufactured by Martingale Technical Systems Limited, 2.10, St. John's Road, Penn, Bucks, HP10 8HW, England.

Tel. 0494813843/9, Tlx. 837012.1 MARGAL, Fax 0494815150. The slot diffusers shall be suitable for horizontal discharge by the adjustment of the blades. The diffusers shall be constructed of extruded aluminum with the from necessary fixings such as splice plates, hugging clips and suspension brackets and care shall be taken to ensure the cross joins between the supply and return air diffusers. The supply diffusers shall be supplied with galvanized mild steel plenum boxes for connection to the ductwork system by way of side entry spigots.

c) Ceiling Mounted Supply/Return Linear Diffusers

Diffusers shall be of streamlined design, with a complete absence of abstraction in the air stream resulting in a low sound level rating. Diffusers shall be designed such that they may be balanced without the use of dampers, deflectors or return vanes.

The diffusers deflectors shall be fabricated from thermosetting plastic which is nonflammable. directionally stable and has a high resistance to cracking and blemishing.

A metal back plate shall be provided for each diffuser.
The inlet spigot sizes shall be as shown on the drawings. The diffusers shall be provided with a hit and miss volume control, grid pattern air straightener and air deflection blades.

The diffusers shall be connected to the ductwork system by flexible ducting sized to suit the diameter of the entry spigots.

The selection shown on the drawings is for quotation purposes only and the Contractor shall check the air performance of the diffusers prior to placing any orders. The selection shall be based on the ceiling heights shown on the drawings and an air temperature differential (room minus air supply) of 11^{o}c.

PART 32: PARTICULAR SPECIFICATIONS FOR AIR-CONDITIONING & MECHANICAL VENTILATION INSTALLATIONS

c) Ceiling Mounted Supply/Return Linear Diffusers

The noise rating in NC for a horizontal projection supply linear. Diffusers of one slot and 1800mm long shall not exceed 2.12.1NC when supplying 33 litters per second active metro.

The pressure drop with the damper in the 100 percent open position shall not exceed 15 Pa for the supply air.

d) Supply and Extract Air Registers

Each supply air register shall have two sets of separately adjustable louvres, (one set horizontal, the other vertical) and shall be complete with an opposed blade multi-leaf damper. The louvres and the volume dampers shall be constructed from extruded aluminium sections with a metallic aluminium finish to the approval of the Engineer.

Extract air registers shall be supplied and fitted as shown on the drawings and shall be similar to the supply air registers except that the rear set of blades shall be omitted.

Registers shall be as manufactured by “WOODS” OF ENGLAND

d) Transfer Grilles

Transfer grilles shall be supplied and fitted as shown on the drawings. Grilles shall be fabricated from aluminium alloy inverted "V" louvre extrusions. They shall be of the non-vision type and of appearance to match the surrounding finishes, all to the satisfaction of the Engineer. The grilles shall be supplied with a telescopic frame permitting installation from 2.18 to 60mm thick. Transfer grilles installed on walls shall be double faced. These shall be manufactured by Trax.

e) Discharge Louvres

Exhaust louvres shall be white anodized aluminium unless indicated otherwise on the Drawings. Louvres shall be weatherproof, with fixed blades set at 30 degrees, and shall have a free area of 85 percent. These shall also be manufactures by Trax.

PART 32: PARTICULAR SPECIFICATIONS FOR AIR-CONDITIONING & MECHANICAL VENTILATION INSTALLATIONS

f) Intakes

Sand trap louvres shall be provided on all air intakes. The sand shall have an efficiency of 80 percent on the 2.10 to 2.100 micron test (AC coarse) dust distribution and 50 percent on the 1 to 70 micron test (AC fine) dust distribution. Louvres shall be of mill finish aluminum with 1.5mm thick lades and 2.1.0mm thick casing. Self emptying sand drain holes shall be provided. The air pressure drop through the louvres shall not exceed 30 Pa. Galvanized wire bird screens shall be provided on all intakes.

g) Accessories - Regulation and Distribution

At each supply diffuser, register and grille, the Contractor shall provide accessories to ensure a positive regulation of the air volume and a uniform distribution of the air flow over the entire outlet. The following shall be supplied as a minimum:

-Supply diffusers

-For distribution : an adjustable frame and blades.

-For regulation : an adjustable splitter or louvre blades

-Supply Grilles and Registers

The Contractor shall provide either lever-operated radium blades attached to a pivoting frame and mounting bracket, or individually adjustable blades in a gasketed frame mounted at the outlet, for each outlet, all to the approval of the Engineer.

h) Supply/Extract Square Ceiling Diffusers

The square supply diffusers shall be aluminum louvre-faced surface mounted, suitable for 4-way blow with integral opposed blade volume damper.

The Contractor shall check and make sure that the diffusers will fit in with the ceiling construction, particularly as to the edge flanged detail and overall size. They shall be as manufactured by Koolair.

PART 32: PARTICULAR SPECIFICATIONS FOR AIR-CONDITIONING & MECHANICAL VENTILATION INSTALLATIONS

32.4.19 **Thermometers and Pressure Gauge.**

32.4.19.1 **General**

Pressure gauges shall be mounted at the sensing point unless otherwise indicated.

The instrument shall be selected such that the normal range of operating temperatures and pressures falls within the middle-third of the instrument range. Compound gauges shall be employed when operating pressure in near or below atmospheric.

32.4.19 **Thermometers and Pressure Gauge.**

32.4.19.1 **General**

Temperature sensing devices shall be located in a portion of the fluid stream where it is possible to measure the average fluid temperature without obstructing the flow. Pipes of 42.1mm diameter and less shall be increased by at least one pipe size at the point of insertion.

Extension necks shall be provided where thermometers and pressure gauges are located in insulated piping, vessels, ductwork, casing and equipment.

32.4.19.2 **Thermometers**

Mercury-in-steel type thermometers, with a 100mm dial and a length of copper covered steel capillary tubing to connect the dial with the bulb, shall be supplied and installed as specified. Each thermometer shall be provided with a back flange or arranged for flush mounting.

Mercury-in-glass type thermometers with metal guard shall be supplied and installed as specified and as approved by the Engineer.

Unless otherwise specified, thermometer bulbs shall be of steel type, screwed 2.10mm NB British Standard pipe and supplied with stainless steel separable sockets suitable for screwing, brazing or welding into the pipe carrying the medium to the measured.

A red mark on each thermometer scale shall indicate the working temperature at the point of measurement.

PART 32: PARTICULAR SPECIFICATIONS FOR AIR-CONDITIONING & MECHANICAL VENTILATION INSTALLATIONS

32.4.19.3 **Pressure gauge**

Gauges shall be of the Bourdon tube type with a 115mm diameter cast iron, cast aluminum or steel case with moisture-proof and dustproof blowout discs. Panel mounted gauges shall have steel or aluminum hinged rings; direct mounted gauges shall have black numerals on a white background.

Bourdon Tube: Phosphor bronze, beryllium copper or stainless steel.

Socket : Stainless Steel.

Accuracy : Not less than 1% of scale range.

Gauges for combined pressure and vacuum services shall have a compound seal.

32.4.19.4 **Sound Attenuation and Vibration Isolation Materials**

32.4.19.5 **Sound Attenuation**

Where required by the Specification the supply and return air sheet metal ductwork each air handling unit and all plenum supply and return ducts, shall be lined internally on all four sides with 2.15mm thick glass fibre of density not less than 48kg/cu.m up to the walls of sound attenuation to reduce the noise emitted by the fans. The interlay clear dimensions of the duct complete with linear shall not less than the sizes indicated on the Drawings. The glass fibre lining shall be fixed to the sides of the duct using an approved adhesive and shall be secured by means of a galvanized perforated plate liner.

The ductwork shall also be thermally insulated on the outside.

The inside surface of the lined sections of ductwork shall be as smooth as possible so that the resistance to air flow is not appreciably greater than the unlined duct. All lined sections of ductwork shall be inspected and approved by the Engineer before erection on Site.

PART 32: PARTICULAR SPECIFICATIONS FOR AIR-CONDITIONING & MECHANICAL VENTILATION INSTALLATIONS

32.4.19.5 **Sound Attenuation**

Where attenuation are fitted on the return supply sides of the units acoustic insulation may be omitted, provided that the noise transmitted by the plant does not exceed the space noise levels specified.

The attenuators indicated in the schedules are for quotation purpose only and the Contractor shall check and provide a detailed acoustic design for approval by the Engineer prior to the or ordering of any attenuator. The Contractor shall submit an acoustic analysis of the air-conditioning systems based on the proposed equipment and shall make any adjustments to the specified parameters. i.e. systems external resistance etc as may be required.

32.4.19.6 **Equipment Isolation**

All mechanical equipment, piping, duct, etc shall be mounted on or suspended from approved foundations or supports. All floor mounted equipment shall be erected on either a 100mm high reinforced concrete plinth or on steel beams. Where vibration isolation equipment is used the plinths or beams shall be extended to support the isolation system.

Vibration isolation systems shall limit the static deflections as required and indicated on the Drawings with a minimum isolation efficiency of 0.96. The vibration isolation system shall be installed in accordance with the manufacture's instructions. All vibration isolation systems exposed in the following manner; All steel parts shall be hot dipped galvanized; all bolt shall be cadmium plated and springs shall be cadmium plated and neoprene coated.

All of the above equipment, including mounting, hangers, structural steel bases, concrete formwork and flexible pipe connectors, shall be furnished by a single manufacturers of vibration isolation equipment.

PART 32: PARTICULAR SPECIFICATIONS FOR AIR-CONDITIONING & MECHANICAL VENTILATION INSTALLATIONS

32.4.19.7 Piping Isolation

All ceiling-suspended and floor-supported piping that is connected to mechanical equipment shall be isolated from the building structure for a distance of 15 metros from the equipment, in the following manner.

Ceiling-suspended piping shall be isolated by a combination of spring and neoprene-in-shear hangers. The first four hangers located adjacent to mechanical equipment, shall be capable of supporting the piping at a fixed elevation during installation irrespective of load changes.

Floor-supported piping shall be located on concrete plinths and shall be isolated by a heavy duty neoprene pad as indicated on the Drawings. Base elbows used to support piping risers shall be isolated by means of heavy duty neoprene pads.

32.4.19.8 Duct Isolation

All duct runs shall be isolated from the building structure for a distance of 16 metros from the mechanical equipment in the following manner. Ceiling-suspended duct work shall be isolated by double deflection neoprene-in-shear hangers. Floor-supported ductwork shall be isolated by double deflection neoprene-in-shear mountings. Thrust restraints which are similar to spring shall be installed to resist thrust caused by air pressure. The spring shall be selected for the same deflection as the equipment. All air handling equipment with a total static pressure of 750 Pa and above shall be isolated with flexible canvas or rubber duct connections together with thrust restraints.

32.4.19.9 Flexible Connectors

Flexible connectors shall be installed at the suction and discharge ends of all rotating mechanical equipment, including pumps, water chillers, and air handling units. The connectors shall be installed horizontally unless otherwise shown on the Drawings or approved by the Engineer. The pipe connectors shall be of the rubber hose or metal hose type with flanges suitable for the working pressure and temperatures of the respective systems.

PART 32: PARTICULAR SPECIFICATIONS FOR AIR-CONDITIONING & MECHANICAL VENTILATION INSTALLATIONS

32.4.19.10 Piping and Duct Penetrations

All piping and ducts which penetrate floor, walls and shafts shall have the gap between sleeves or timber frames sealed with fibrous materials and caulking to the approval of the Engineer, to prevent the transmission of airborne noise.

32.4.19.11 Attenuators

Each attenuator shall provide an insertion loss, under operating conditions, of not less than that indicated in the final acoustic design analysis, which is to be produced by the Contractor. Manufacturers shall specify the insertion losses expected from the attenuators offered. Under the operating conditions, and this information shall be derived from tests carried out in accordance with BS 4718:19971.

Each attenuator shall have a pressure loss at the design flow and temperature of not less greater than that shown in the Schedules. The manufacture's quoted pressure losses shall be derived from tests carried out in accordance with BS 4718:1971.

Each attenuator shall have a pressure loss at the design flow and temperature of not greater than that shown in the Schedules. The manufacturer's quoted pressure losses shall be derived from tests carried out in accordance with BS 4718:1971. Where the attenuator is known the supplier shall indicate the expected effect of turbulence due to adjacent duct elements on the quoted pressure losses.

Suppliers of attenuators shall provide, with the certified insertion loss data, information relating to the attenuator generated octave band sound power levels (12.15 kHz) at the operating conditions. The outer casing of all duct attenuators shall be constructed in accordance with the current HVCA

ductwork specification. Unless otherwise indicated in the Schedule. the casing shall conform to the Medium & Low" pressure code in terms of its thickness, seams and materials.

All attenuators shall be fitted with drilled angle flange connections, unless alternative connections are specified in the Schedules or instructed by the Engineer. Flanges shall conform to the relevant HVCA code or its equivalent.

PART 32: PARTICULAR SPECIFICATIONS FOR AIR-CONDITIONING & MECHANICAL VENTILATION INSTALLATIONS

32.4.19.11 **Attenuators**

Account elements in rectangular attenuators of height greater than or equal to 900mm shall incorporate fair leading and trailing edges (not square ends), and the inert, rot-proof and non-combustible mineral wool or glass fibre acoustic medium shall be packed to a density of not less than 48kg/m^3 and retained by a perforated steel sheet facing. The manufacturer shall note any particular requirements, e.g. painting, special materials, etc., that are indicated on the schedules of Drawings. Splitter shall be constructed such that no ingress of acoustic medium shall occur into the gas stream under the operating conditions.

Where acoustic elements from splitters within the attenuator, the usual arrangements shall be with the splitters vertical and half-width splitter fixed to each side wall of the casing. However, it is the responsibility of the supplier to ensure that the parallel splitter elements in the attenuator are located near bends, bifurcations, etc. Horizontal splitters shall be suitable stuffed to prevent flexing and restriction of the airways.

For circular attenuators, all internal acoustic elements shall comprise mineral or glass fibre as the acoustic medium, as specified above for rectangular attenuators, retained by a perforated metal facing.

When attenuators are manufactured in modules, each unit shall be shop assembled and this Specification together with the manufacturer's own guarantee and performance rating, shall apply to the unit as a whole. Attenuator units shall be delivered to site with blocked ends to prevent ingress of rubble, etc. prior to installation, and to reduce the risk of damage the direction of airflow through the attenuator shall be clearly marked on the casing.

Attenuators for high temperature application (e.g. diesel or turbine exhausts, boiler flues, etc) shall have their casing manufactured from an approved gauge of sheet steel, and adequate precautions taken to cater for expansion and thermal shock. The internal elements and non-combustible mineral or glass fibre cloth behind the perforated metal facing. For every high temperatures, steel wool or equivalent materials shall be used as the acoustic medium.

Acoustic and aerodynamic requirements of the Specification re met. It is the Contractor's responsibility to ensure that the Engineer is advised of the actual sizes being offered where these differ from the Schedule.

PART 32: PARTICULAR SPECIFICATIONS FOR AIR-CONDITIONING & MECHANICAL VENTILATION INSTALLATIONS

32.4.19.12 **Acoustic Weather Louvre**

All acoustic weather louvres shall provide an insertion loss, under the operating conditions, of not less than that indicated in the relevant acoustic hardware schedules. In addition, the static pressure loss, under maximum operating duty, shall not exceed that shown in the Schedules.

The louvres shall be constructed from an appropriate gauge of galvanized mild steel, or aluminium, supporting louvre blades of like materials. The acoustic material in the blades shall have a density of 60-100kg/m3 and be inert, rot and vermin proof, non-hydroscope and incombustible mineral fibre, faced with mineral fibre tissue and retained on the lower blade face by perforated galvanized mild steel or aluminium. When the louvres are manufactured in sections, each unit shall be shop assembled as a whole unit and this specification, together with the manufacture's own guarantee and performance ratings, shall apply to the unit as a whole.

Acoustic weather louvres shall be supplied with an integral bird screen of galvanized mild steel or aluminium mesh, fixed to its internal face. The mesh pitch shall be a maximum of 25mm.

The louvres between the outside of the louvre frame and the wall or duct shall be made good and sealed with a heavy duct ground and/or a non-hardening, dense mastic.

Electrical Services

Suitably rated control panels shall be supplied and installed as part of this sub-contract to meet the starting and operating characteristics of the fan units.

The panels shall be either wall or floor mounted to suit the specific area and requirements. Power supplies to these panels shall be extended from adjacent isolating switches to be provided under the electrical services sub-contract. Complete co-ordination shall be maintained with the electrical services sub-contractor to ensure supply and termination details are satisfactorily carried out to suit the plant and installation requirements.

PART 32: PARTICULAR SPECIFICATIONS FOR AIR-CONDITIONING & MECHANICAL VENTILATION INSTALLATIONS

32.4.20 Motor Control Panels

All starters, control equipment and the like shall be enclosed in purpose made sheet panels. The panels shall be installed within the plant rooms to suit the dimensions of the actual panels. All details of the panels and layouts within the plant shall be to the approval of the Engineer and shall include:

- Triple pole isolating switch removable neutral link and HRC fuses.
- Control circuits fuses of the HR cartridge type.
- Under voltage release, adjustable and complete tower to allow for voltage associated with the KP & LC supply and motor starting.
- Over voltage protection, details to be agreed.

- Ammeter of the moving iron mounted on panel with selector switch.
- Pilot lamp, green.
- Rotary switch for HAND/OFF/AUTO operation, where required.

  Removable neutral link of heavy section copper.
- Motor winding over-temperature release. The Contractor shall provide this feature in conjunction with the specified thermistor protection.
- Duty selection switches.
- Manual stop-start button units to operate in conjunction with rotary switch.
- Hours run meter/counter.

PART 32: PARTICULAR SPECIFICATIONS FOR AIR-CONDITIONING & MECHANICAL VENTILATION INSTALLATIONS

32.4.20 Motor Control Panels

The sub-contractor shall allow me to present for the contractor to reclose automatically on the restoration of the mains voltage. This requirement shall be subject to further

discussion with the Employer to suit the standby Diesel plant and the mode of operation of essential and non-essential supplies.

All starter panels shall include sufficient miniature circuit breaker, with neutral bar, to supply auxiliary or associated equipment. One 30TP and one spare 155P MCBs shall be included as spares.

All starter panels, motor starters and controllers shall comply with BS 587. Enclosures shall be rigid, at least 1.6mm thick, with rolled corners stiffened as necessary, dust-proof, vermin-proof, damp and corrosion protected with a grey colour stone enamel or other approved finish, fully tropicalised, with washable air filters. Instruments, gauge, ammeters, indicator lamps, etc shall be flush mounted. Panel doors shall include isolating switches to prevent them being opened unless the switches are in the off

position. Each door shall be provided with a lock, and three sets of keys for all panel door locks shall be handed over to the Engineer.

Terminal for all outgoing main and control cables shall be marked and positioned so that the cables may be carried to the outlet from the panel without crossing or being carried round the panel. Terminal numbers and markings shall correspond to those used on connected equipment and wiring diagrams. All internal interconnecting wiring between individual units and the terminal chamber shall be carried out by the panel manufacturer.

Each panel shall be provided with a main isolator so that the whole panel may be completely isolated.

The sub-contractor shall determine all motor starter requirements and associated auxiliaries and controls prior to manufacture and shall submit the design and circuit diagrams to the Engineer for approval.

PART 32: PARTICULAR SPECIFICATIONS FOR AIR-CONDITIONING & MECHANICAL VENTILATION INSTALLATIONS

32.4.20 Motor Control Panels

Contractor shall determine all motor starter requirements and associated and controls prior to manufacture and shall submit the design and circuit diagrams to the Engineer for approval.

Contractors shall be of air-break type BS 5424 part 1 and/or BS 587, and shall be provided as follows:

- Magnetic blow-outs and air chutes on each pole.

- Renewable hard drawn copper contacts.

- Auxiliary contacts for remote control

- Continuously rated operating coils (Max 240V)

- Thermal overload protection device incorporating single phasing protection.

Starters shall be rated as follows.

Ordinary duty - For motors which will run continuously for periods in excess of two hours.

Intermediate duty - For motors under automatic control other than time control. When the intervals of operation are greater than two hours.

PART 32: PARTICULAR SPECIFICATIONS FOR AIR-CONDITIONING & MECHANICAL VENTILATION INSTALLATIONS

Starters shall be of the following types:-

- Up to and including 400W motor: Single phase on/off with overload protection.

- Over 3.75 kW and upto 15kW: Star Delta starter.

- For starters incorporating reduced voltages starting the changeover of voltage shall be automatic.

Terminals shall be accessible and shall be provided with adequate clearance between phases and between phases and earth. Where starters are not enclosed in a composite panel, an integral isolating switch as specified for control panels shall be provided.

Where electric motors are either not visible from the control panel or are located more than 10m distance they shall be provided with a local lock-off stop control circuit switch, or a main circuit isolator where there is no control circuit. A weatherproof lock-off stop control circuit switch shall be provided for motors located externally or otherwise exposed to the weather.

32.4.21 **Motors**

Motors shall comply with BS 816 Part 1 and shall be arranged for conduit entry.

Motors shall be fitted with locating type bearings and/or heavy thrust bearings at the non-drive end and collar type at the drive end. Motors shall be of the totally enclosed fan cooled type, tropicalised to BS 5000 Part 99 suitably finished to resist corrosion by fluid or fumes. The rating of all motors shall be chosen to provide continuously the maximum power requirements of the plant. The motors shall be of the standard induction type. They may be of the squirrel cage, horizontal or vertical spindle type of all to the approval of the Engineer.

Vertical spindle type motors shall be provided with substantial canopies of approved design.

PART 32: PARTICULAR SPECIFICATIONS FOR AIR-CONDITIONING & MECHANICAL VENTILATION INSTALLATIONS

32.4.21 **Motors**

The locked motor currents shall be stated on the name plate of each motor and shall be not more than six times the full load current.

Thermistors shall be fitted to all motors above 5kw. They shall be fitted during manufacture and their ends shall be brought out at additional terminals on the connector block of the motor.

All motors shall be rated 3 phases. 415 volt or single phase, 240 volt, high power factor continuous maximum rating complying with BS 5000 Part 99 and Class F insulating complying with BS 2757 unless otherwise specified. All motors larger than 400kw shall be three phase.

All three phase motors shall be supplied with six stud terminals with each end of the stator phase windings connected, terminals shall be of suitable size to accept the cable lugs of the feeding cables. Terminal blocks shall be mounted on the side of the motor case in an approved box complete with lid, gasket and tapped ET entry hole.

Rubber installation shall not be used on coil connections. Each motor shall be fitted with cable terminals and glands to accept the specified types of cable.

No motor shall run at a speed higher than 1500 rmp unless otherwise specified. Motors driving through Vee-belts shall be fitted with slide rails. The power factor shall be less than 0.9 lagging. All motors shall be from the same manufacturer as far as possible.

32.4.22 **Cabling and Wiring**

The Contractor shall carry out all power and control wiring including LV and ELV or any other voltage for the control equipment and alarm systems and interconnecting wiring between starter panels, remote control items, and motor units are required.

PART 32: PARTICULAR SPECIFICATIONS FOR AIR-CONDITIONING & MECHANICAL VENTILATION INSTALLATIONS

32.4.22 **Cabling and Wiring**

Cabling shall be carried out in PVC insulated, PVC sheathed, single wire armoured and PVC sheathed overall cable, using compression type glands provided with means of securing armoured wires within the body of the gland, under armour moisture seal and outer sheath seal.

Each core termination shall be fitted with a plastic ferrule engraved with an identification corresponding to the wiring diagrams.

Multicore control cables to the remote stop, start allow water cut-out/alarms shall be 0.62mm2 PVCSWAPVC where external to the pump station and PVC/PVC or similar, where internal. All cables, whether internal or external being suitably protected.

All conductors shall be copper and the installations, both internal and external being carried out in accordance with the regulations and by-laws previously stated. Trenching and the fixing of cables shall be in accordance with locally specified standards details of which have been specified within the sub-contract documents for the electrical services. These details can be made available upon request should the sub-contractor not be familiar with these requirements.

Details of the rating, types and methods for all cables and wiring to be supplied under this sub-contract shall be submitted with the tenders, wiring, PVC single core shall be run in either galvanized conduit or galvanized trunking of suitable sizes where surface in plant rooms and heavy gauge PVC were cast into walls, slabs etc.

PART 32: PARTICULAR SPECIFICATIONS FOR AIR-CONDITIONING & MECHANICAL VENTILATION INSTALLATIONS

32.4.23 Testing and Commissioning

The sub-contractor shall be responsible for testing and commissioning the air conditioning mechanical ventilation systems to ensure they are in proper working order to the satisfaction of the Engineer, all in accordance with the requirements set out below. A full test shall be carried out, and the following taken.

(a) Volumes is all major ducts and for all extract diffusers and diffusers and supply grilles.

(b) Noise rating in the above rooms, and from all mechanical ventilation fans.

(c) Total flow rates for every mechanical ventilation system installed under this sub-contract.

(d) Running current for each electric motor in amperes (recorded against the manufacturer's full load current).

(e) Air static pressure differential across each fan, filter, coil etc.

The operation of all controls, safety devices, alarms and standby equipment shall be demonstrated in liaison with the electrical services sub-contractor.

PART 33: PARTICULAR SPECIFICATIONS FOR AIR CONDITIONING UNITS

33.0 General

This part of the sub-contract comprises the supply, delivery and complete installation of single split direct expansion units and a modular multi-system as outlined in the Bills of quantities.

The design data for the lift motor room is as follows:-

Mean ambient temperature	:	28^{o}c
Altitude	:	1750m above sea level
Room Temperature	:	22 ± 1^{o}C

33.1 Indoor Units

The indoor units shall incorporate a quiet centrifugal fan, liquid crystal display wired remote controller, air purifying filter employing static electricity to remove particles and Airflow direction lourves. All the controls shall be by use of microprocessor,

The unit shall have the following parameters:-

Cooling capacity:- as specified in the bills of quantities

Air Flow rate (High Speed): - as specified in the bills of quantities

Fan speed:- 3 speeds and Auto

Limiting Noise level 41 dB(A) at high speed.

The units shall be mounted as shown as per tender drawings. Condensate removed from the air shall drain into the drip pan and then drain by an integrated pump through condensate drainpipe to the ground.

All units shall be as specified in the bills of quantities

PART 33: PARTICULAR SPECIFICATIONS FOR AIR CONDITIONING UNITS

33.2 Outdoor Unit

The unit shall comprise of several modules(compressors and inverters) interconnected together and shall be running sequentially depending on the cooling load demands from the conditioned space. The modules and their arrangement shall be as specified in the bills of quantities and shall be sized to match the indoor units.

The outdoor units shall have the following parameters: -

Sound level (limit) - 49 dB(A) at 1 meter

The modules shall be complete with integral isolator, compressors, condenser fans, LP/HP cut-outs, auto restart after power failure and weather proof.

33.3 Components

a) **Compressors**

These shall be rotary with three-phase motors having internal current/thermal overload device and pressure relief valve.

b) **Condenser**

These shall be forced-draught type with acrylic-dipped copper tubes mechanically expanded into aluminium fins spaced at approximately. 10 per 25mm.

c) **Fans**

These shall be of the forward curved centrifugal type and shall be made of aluminium, reinforced fibre or rigid plastic material.. The fan shall have variable speeds to enable the user to reduce both air volume and noise levels.

d**)** **Operating Controls**

These shall comprise an ON/Off switch, combined with fan speed controller and a compressor selector to give a range of options such as: off; fan only; fan & low cool, fan 7 high cool.

There shall be a bimetallic, single-pole single-throw (SPST) thermostat with sensing phial clipped in the return air stream behind the air filter. This shall cycle the compressor but the evaporator fan shall be unaffected as long as the unit is switched "ON".

PART 33: PARTICULAR SPECIFICATIONS FOR AIR CONDITIONING UNITS

33.3 **Components**

e) **Safety Controls**

These shall comprise either externally or internally mounted compressor motor overloads, to safeguard against thermal or electrical overloads.

f) **Central Remote Controller.**

The controller shall be connected to the outdoor unit. The remote shall control the entire indoor units installed and shall be connected to the outdoor unit.

g) **Noise Level**

Fan and motor assemblies shall be complete with anti-vibration mountings and shall operate quietly, with the noise level at 1 metre not exceeding noise curve NR 49dB(A).

h) **Refrigerant piping**

The refrigerant piping shall be neatly installed and clipped on the wall. The pipes shall also be neatly boxed or put in a trunking to the approval of the engineer.

i) **Installation Requirements**

Suitable aperture and supporting frame to be fitted in a wall shall be made. The unit shall be properly balanced and supported in a manner that prevents noise or "drumming" regardless of the type of structure in which it is supported.

PART 33: PARTICULAR SPECIFICATIONS FOR AIR CONDITIONING UNITS

33.3 **Components**

j) **Mounting Brackets**

The air-conditioners shall be held in position by two mounting brackets, fixed to the wall. The sub-contractor shall ensure that any damage to the wall is made good-inside and out around the frame, and repaint as necessary. The sub-contractor shall ensure that the unit is perfectly level from side to side and that from to back it is sloping slightly to the rear of the baseplate.

k) **Power Supply**

The power point serving the system shall be as close as possible to the modules and slightly lower to the side on which the power cable enters the front of the chassis and of the fused switch type.

With the indoor air filters in place, the power supply shall be switched on to start the unit working steadily through the full operating sequence permitted by the controls. The sub-contractor shall ensure that the control switch operates in every position which can be selected.

l) **Testing and Commissioning**

The sub-contractor shall test and commission the unit to the entire satisfaction of the Engineer and the Employer. In particular he shall check the full load amperage drawn using a clip-on ammeter to confirm that this does not exceed values shown on the nameplate. The sub-contractor shall adjust the supply air grille to produce effective distribution throughout the room, free from draughts and pockets of stagnant air. Control knobs shall be checked and confirmed to be tight. The differential between the temperatures of the air entering the return grille and that leaving the discharge grille shall be ascertained to be what the manufacturer recommends.

The sub-contractor shall produce operation and maintenance manuals to be given to the Engineer for onward transmission to the Employer.

PART 33: PARTICULAR SPECIFICATIONS FOR AIR CONDITIONING UNITS

33.3 **Components**

m) **Maintenance Contract**

The contractor shall provide all necessary technical brochures and operation manuals to the Client upon completion of works. He shall also quote for maintenance of these units after the 6 months liability period is over.

The scope of maintenance works shall include but not be restricted to all normal servicing of he unit which shall be carried out as stipulated in the maintenance contract agreement to be entered between the Client and the Sub-contractor.

PART 34: PARTICULAR SPECIFICATIONS FOR HOSEREEL SYSTEM

34.1 General

The following details the particular requirements for the supply, installation and commissioning of the hosereel installation. The hosereel installation shall comply in all respects to the requirements set out in B.S. 5306 Part I, B.S. 5041 and B.S. 5274.

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 specification and the Contract Drawings, he shall clarify these differences with the Engineer before tendering.

34.2 Scope of Work

The Sub-contractor shall supply, deliver, erect, test and commission all the automatic fire fighting hosereel installation which is called for in this specification and shown on the Contract Drawings listed in the drawing schedule.

Hose reels pumpsets consisting of control panel and 2 No. vertical multistage pumps are to be installed in the underground pumproom and arranged as shown on the drawings. A double pole pressure switch shall activate the pumps in case of pressure drop in the mains.

All the hosereels are to be supplied from the dedicated hose reel main serving the building as shown on the drawings.

34.3 Pipework

The pipework for the hosereel installation shall be galvanized wrought steel tubing "Heavy Grade Class `C' to B.S. 1387: 1967 with pipe threads to B.S. 21.

PART 34: PARTICULAR SPECIFICATIONS FOR HOSEREEL SYSTEM

34.4 Pipe Fittings

The pipe fittings shall be galvanized wrought steel fittings conforming to B.S. 1740 Part 1, or galvanized malleable iron fittings to B.S. 143.

The hosereels to the installation shall consist of manually operated swinging wall hosereel as Thorn Norsen (Type B).

The hosereels shall be supplied and installed complete with first-aid non-kinking 20mm diameter hose 30 metre long, with nylon spray/jet/shut-off nozzle fitted. A screw down chrome plated globe valve to B.S. 1010 to the inlet to the reel is to be supplied.

The orifice to the nozzle is to be not less than 6.35mm to maintain a minimum flow of 0.5L/S to the jet.

The hosereels shall be installed at 1.5m centre above the finished floor level in locations shown on Contract Drawings.

34.5 Finish Painting

Upon completion of testing and commissioning of the hosereel installation the pipework shall be primed and finish painted with 2 No. coats of paint to the Engineers requirements.

34.6 Testing and Commissioning

The installation is to be tested to one and a half times the working pressure of the installation all to the approval of the Engineer. The Sub-contractor shall arrange at his own expense for acceptance and approval.

SPECIFICATIONS: SITE CLEARANCE

PART 35: SITE CLEARANCE

35.1 **CLEARING SITE**

The Contractor shall remove buildings, walls, gates, fences, advertisement and other structures and obstructions, grub up and remove trees, hedges bushes and shrubs and clear the site of the works at such time and to the extent required by the Engineer, but not otherwise, the materials so obtained shall so far as suitable be reserved and stacked for further use; all rubbish and material unsuitable for use shall be destroyed or removed from the site.

Where top soil has to be excavated, this shall be removed and stacked on site. After completion of construction, it shall be spread over the disturbed ground, any surplus being disposed of as directed by the Engineer.

35.2 **VEGETATION**

No allowance will be made for the cutting and removal of crops, grass weeds and similar vegetation. The cost of all such work will be held to be included in the rates entered in the Bills of Quantities for excavation.

35.3 **BUSHES AND SMALL TREES**

All bushes and small trees, the main stem of which is less than 300 mm girth at 1 metre above ground level shall be uprooted (unless otherwise directed by the Engineer) and burnt or otherwise disposed of as directed by the Engineer.

35.4 **HEDGES**

Where directed by the Engineer, hedges shall be uprooted and disposed of by burning.

35.5 **FELLING TREES**

Where shown on the drawings or directed by the Engineer, trees shall be uprooted or cut down as near to ground level as is possible. No trees shall be cut down without the express permission of the Engineer.

SPECIFICATIONS: SITE CLEARANCE

35.6 GRUBBING UP ROOTS

Stumps and tree roots shall, unless otherwise directed, be grubbed up, blasted, burnt or removed and disposed of in approved dumps to be provided by the Contractor. Where directed by the Engineer, the holes resulting from grubbing up shall be filled with approved materials, which shall be deposited and compacted in layers not exceeding 225 mm loose depth, to the same dry density as that of the adjoining soil.

35.7 UNDERGROUND CHAMBERS, ETC. TO BE CLEANED

Demolition of pits, septic tanks, walls and cesspools shall be to a depth of 1 metre below formation level and the remainder shall be properly cleaned out and filled with approved materials, which shall be deposited and compacted in layers not exceeding 225 mm loose depth to the same dry density as that of the adjoining soil. Soil and surface water drains, lying within the site of the works, shall, where directed by the Engineer, be sealed off and all other services satisfactorily severed and sealed to the satisfaction of the appropriate authorities and/or owners. Disused soil and surface water drains within 1 metre of formation level shall be required by the Engineer to be removed and trenches shall be backfilled.

35.8 WEED CONTROL

The Contractor shall take all necessary precautions against the growth on the site of weeds and remove them as necessary throughout the period of works and maintenance.

The formation level and finished surface of base of all footways and elsewhere as directed shall be sprayed with an approved persistent total herbicide at the rate recommended by the manufacturer. The application shall be by an even spray in a high volume of water at about 0.07 to 0.11 litres per sq.m. After this application the footways shall receive at least two further waterings before the surface is sealed.

SPECIFICATIONS: SITE CLEARANCE

35.9 REMOVING EXISTING FENCING AND GATES

Where instructed by the Engineer, the Contractor shall carefully remove existing fences and gates, dismantle the components and stack them in separate heaps where directed. All wires shall be neatly coiled and tied. Materials which in the opinion of the Engineer, are not suitable for re-use shall be destroyed or removed to a tip to be provided by the Contractor.

35.10 STOCKPROOF FENCING

Where stockproof fencing is called for in the Bills of Quantities or ordered by the Engineer it shall comprise 150 mm sawn Cedar posts painted with two coats of cresote, firmly fixed into the ground and placed at 2 m centres together with 200 mm diameter posts suitably strutted at all changes of direction and having four six-gauge wires equally spaced throughout its height of 1.5 m. The Contractor's rate for stockproof fencing shall include for its provision, erection, maintenance during the period of the Contract. The fence shall remain the property of the Employer.

35.11 TEMPORARY FENCING

Where temporary fencing is called for in the Bills of Quantities or ordered by the Engineer, it shall comprise 100 mm diameter sawn Cedar posts firmly fixed into the ground and placed at 2 m centres together with 150 mm diameter posts suitably strutted at all changes of direction and having four wires equally spaced throughout its height. The Contractor's rate for temporary fencing shall include for its provision, erection, maintenance during the period of the works and removal on completion of the Contract. The fence shall remain the property of the Contractor.

35.12 PROTECTIVE FENCING OF TREES

Where ordered the Contractor shall supply and erect around specified single trees or groups of trees to protect them from damage, split bamboo fencing of approved construction, 1.2 m high above ground rough posts, firmly fixed in the ground. The posts shall be at 2 m centres or where required for change of direction. The Contractor shall include in his rate for the satisfactory maintenance of this fencing for the period of the Contract.

SPECIFICATIONS: EARTHWORK

PART 36: EARTHWORKS

ROADWORKS

36.1 **FORMATION LEVEL**

Formation level on embankments and in cuttings shall be the surface of the ground obtained after completion of the earthworks, i.e. the underside of the sub-base, or where no sub-base is specified, the underside of the base. Any excess depth unnecessarily excavated below formation level shall be backfilled with material acceptable for construction and compacted as directed by the Engineer and no payment shall be made for the excess excavation or for the filling and compacting.

36.2 **SURFACE SOIL**

Unless otherwise directed by the Engineer, all surface soil shall be removed from the area to be used for cuttings and embankments and stockpiled for re-use for any purpose such as the soiling of slopes of cuttings and embankments, berms, verges, open spaces, central reserve and the preparation of beds for the cultivation of trees and shrubs.

Surface soil shall be regarded as soil which on visual examination can be seen to have been broken down by agricultural cultivation and/or is seen to be capable of supporting vegetable growth.

Surface soil shall be regarded as soil which on visual examination can be seen to have been broken down by agricultural cultivation and/or is seen to be capable of supporting vegetable growth.

Surface soil shall be removed to an average depth as shown on the drawings or specified in the Bills of Quantities.

The Contractor shall make his own arrangements for temporary storage sites for heaps of surface soil either inside or outside the site of the works to suit his convenience. The cost of all operations needed in excavating, loading, carting, depositing and stacking, together with arranging for the storage sites, the hire or purchase of land therefor and all necessary access roads for this purpose is to be included in the item in the Bills of Quantities for stripping surface soil and is to be quoted whatever the nature of the underlying sub-soil.

All unsuitable soil comprising or underlying surface soils shall be excavated and run to spoil in accordance with this Specification.

SPECIFICATIONS: EARTHWORK

ROADWORKS

36.3 SOILING OF SIDE SLOPES AND VERGES

Soiling and compacting of the side slopes of cuttings and embankments shall be carried out to an even surface with a thickness within the range 100 mm - 200 mm or in the case of verges as stated in the Bills of Quantities with surface soil as previously set aside or from an approved source.

Grass planting shall be carried out as specified.

36.4 STORAGE AND HANDLING OF EXPLOSIVES AND BLASTING

The removal of hard materials by use of explosives will normally be permitted subject to compliance by the Contractor in all respects with the Explosive Laws of Kenya.

The Contractor shall provide proper buildings or magazines in suitable positions for the storage of explosives in a manner and quantities to be approved; he shall also be responsible for the prevention of any unauthorized issue or improper use of any explosive brought on to the works and shall employ only experienced and responsible men to handle explosives for the purpose of the works.

The shots shall be properly loaded and tamped and where necessary, the Contractor shall use heavy mesh blasting nets. Blasting shall be restricted to such periods and such parts of the works as the Engineer may prescribe. If, in the opinion of the Engineer, blasting would be dangerous to persons or property or to any finished work or is being carried on in a reckless manner, he may prohibit it and order the rock to be excavated by other means and payment will be made at the rate for rock excavation where blasting is permitted. The use of explosives by the Contractor in large blasts, as in seams, drifts, shafts, pits, or large holes is prohibited unless authorized in writing by the Engineer. In the event of wasting of rock through any such blasting, the Contractor shall if required by the Engineer, furnish an equivalent amount of approved materials for embankments 1 cu. m. rock in-situ being taken to equal 1.5 cu. m. of material in embankment.

SPECIFICATIONS: EARTHWORKS

36.5 **EXCAVATION OF CUTTINGS**

The Contractors shall carry out the excavation of cuttings in accordance with the drawings and shall adhere to the slopes, levels, depths and height shown thereon.

The sloping sides of all cuttings shall be cleared of all rock fragments which move when pressed with a crowbar and are therefore liable to cause injury or damage through falling.

Where excavation reveals a combination of suitable and unsuitable materials, the Contractor shall, wherever the Engineer considers is practicable, carry out the excavation in such a manner that the suitable materials are excavated separately for use in the works without contamination by the unsuitable materials.

If any suitable material excavated from within the site, is, with the agreement of the Engineer, taken by the Contractor for his use (i.e. as material for pavement courses) and not in consequence for the forming of embankments, or soiling of slopes of cuttings and embankments or verges, sufficient suitable filling material to occupy, after full compaction, a volume corresponding to that which the excavated material occupied, shall unless otherwise directed by the Engineer, be provided by the Contractor from his own resources.

No excavated material shall be dumped or run to spoil except on the direction or with the permission of the Engineer, who may require material which is unsuitable to be retained on site. Material used for haul roads shall not be re-used in embankments, or elsewhere without the permission of the Engineer.

The completion of cuttings shall, unless otherwise permitted by the Engineer, be undertaken in two stages. First the area between the extremities of the carriageway(s), including verges shall be excavated to a level 300 mm above formation level whereupon constructional traffic may continue to be allowed to use the surface so formed.

Second, when it is necessary to complete to formation level, this excess of material shall be trimmed off as a single operation and disposed of either elsewhere in the works if regarded by the Engineer as suitable material or if not run to spoil. When the height above formation level has been reduced below 300 mm the movement and use of constructional plant other than that used to complete this operation shall be in accordance with the requirements as specified later in this Appendix. This trimming operation shall be regarded as the commencement of construction of the pavements.

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ROADWORKS

36.6 FORMING OF EMBANKMENTS

The Contractor shall carry out the forming of embankments in accordance with the drawings and shall adhere to the slopes, levels, depths and heights shown thereon.

Unless otherwise directed or permitted by the Engineer, all suitable excavated materials shall be used to form embankments. Any such excavated material which is surplus to this requirement shall be disposed as described in the Bills of Quantities.

All filling material other than rock in embankments or below formation level in cuttings shall be deposited in layers not exceeding 225 mm loose depth unless as a result of compaction trials the Engineer approves spreading to a greater depth up to a maximum of 375 mm loose depth. Each layer shall extend over the full width of embankment and shall be compacted as specified.

Rock used in rock-filled embankments shall be of such size that it can be deposited in horizontal layers each not exceeding 450 mm loose depth and extending over full width of the embankment except for any specified external cover to slopes or new formation level. The materials shall be spread and levelled by a crawler tractor weighing not less than 15 tonnes. Each layer shall consist of reasonably well graded rock and all large voids shall be filled with broken fragments before the next layer is placed. The top surface with side slopes of embankments so formed shall be thoroughly blinded with approved fine graded material to seal the surface. Such material may be surface soil on side slopes.

Isolated boulders each within the range of 0.05 cu. m. in size may be incorporated more than 600 mm below formation level in embankments not of rock-fill at the discretion of the Engineer, provided that the specified compaction requirements are met. No stone exceeding 0.05 cu. m. should be placed less than 600 mm below formation level of carriageways and verges.

During construction of embankments, the Contractor shall control and direct constructional traffic uniformly over their full width.

Fill material shall not be stock-piled on embankments, unless this is permitted by the Engineer.

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ROADWORKS

36.6 FORMING OF EMBANKMENTS

Should the quantity of excavation from the works, including that from any widened cuttings, be insufficient to make up the embankments, the deficiency shall be made good by approved imported suitable material and the Contractor shall be responsible for locating the obtaining such material.

Where materials of different characteristics are readily available, those of relatively high bearing capacity shall be placed in the topmost 600 mm below formation level. The completion of embankments shall unless otherwise permitted by the Engineer be undertaken in two stages. First the area between the extremities of the carriageway(s), including verges shall be brought up to a level 150 mm above formation level whereupon constructional traffic may continue to be allowed to use the surface so formed.

Second, when it is necessary to complete to formation level the excess of material shall be trimmed off as a single operation and disposed of either elsewhere in the works if regarded by the Engineer as suitable material or if not, run to spoil.

When the height above formation level has been reduced below 150 mm the movement and use of construction plant, other than that used to complete this operation, shall be in accordance with the requirements specified later in this Specification.

This trimming operation shall be regarded as the commencement of construction of the pavement.

36.7 SIDE SLOPES

Should the slopes of any cutting be excavated beyond the widths shown on the drawings or directed by the Engineer, the Contractor shall make good each affected area in a manner satisfactory to the Engineer.

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ROADWORKS

36.8 SURFACE TREATMENT OF FORMATION

If required, after final preparation of the sub-grade, the surface of the formation, shall within 24 hours of such final preparation or as soon as practicable thereafter be surface dressed with bitumen, as stated in the Bills of Quantities. The surface dressing shall be carried out as specified in BENCHING and shall include blinding with 5 mm down crushed rock at the rate of 6 Kg. per sq.m. Where a particular area of formation is to be covered with a compacted and sealed sub-base within 24 hours of its preparation, the surface dressing of the formation may be omitted. If, in spite of such sealing membrane for the formation or the sub-base having been ordered promptly by the Engineer, the Contractor allows the moisture content of accepted compacted materials to increase to a value above that which would have been acceptable for compaction, the Contractor shall allow the material to revert to such an acceptable moisture content and if so directed by the Engineer re-compact the surface before sealing.

36.9 COMPACTION OF EARTHWORKS

All filling material used in earthworks shall be compacted to specification by plant approved by the Engineer for that purpose. The Contractor shall submit to the Engineer for approval his proposals for the compaction of each main type of material to be used in the embankments, including those in relation to the types of plant, the number of passes and the loose depth of layer. The Contractor shall carry out compaction trials supplemented by any necessary laboratory investigations, as required by the Engineer, using the procedure proposed by the Contractor for the earthworks, and shall satisfy the Engineer that all the specified requirements regarding compaction can be achieved. Compaction trials with the main types of material likely to be encountered shall be completed before the works with the corresponding materials will be allowed to commence.

For the purpose of selection for use in earthworks all common excavation shall be classified as either plastic or non-plastic. Non-plastic materials shall be defined as those on which it is impossible to carry out a plasticity index test and shall include coarse grained, non-cohesive materials included in Table 1 of British Standard Code of Practice CP 2001: Site Investigations, and such shales, silts and other materials which in the opinion of the Engineer are readily self draining. Plastic materials shall be defined as all other materials included in the above mentioned Table as fine grained cohesive materials, as defined in CP 2001.

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ROADWORKS

36.9 COMPACTION OF EARTHWORKS

Work on the compaction of plastic materials in embankments shall proceed as soon as practicable after excavation and shall be carried out only when the moisture content is not greater than 2 percent above the plastic limit for that material. Where the moisture content of plastic material as excavated is higher than this value the material shall, unless otherwise directed by the Engineer, be run to spoil. If the Contractor allows the moisture content of suitable plastic materials to increase to a value which is unacceptable for compaction he shall, unless he prefers at his own expense to wait until the material has dried sufficiently for acceptance again as suitable material, run such material to spoil and provide an equal volume of material suitable for filling, both without extra charge.

Work on the compaction of non-plastic materials in embankments shall be carried out only when the material has such a moisture content as is within the range from 1 per cent wetter to 2 percent drier than the moisture content of the material in cuttings or borrow pits when measured on samples obtained from at least 300 mm above the level of the water table as indicated by the presence of free water in the excavation. Nevertheless, should the Engineer doubt whether satisfactory compaction will be obtained within the above moisture limits, he may require compaction to proceed only when the limits of moisture content for the compaction of non-plastic materials are within the range of the optimum moisture content and 3 percent below the optimum moisture content as determined by the laboratory compaction test method described in British Standard 1377: Methods of Test for Soil Classification and Compaction.

If any such non-plastic material on excavation is too wet to satisfactory compaction and the Engineer orders the moisture content to be lowered or raised, such work shall be treated as included in the rates. All adjustment of moisture content shall be carried out in such a way that the specified moisture content remains uniform throughout compaction.

If the Contractor allows the moisture content of suitable non-plastic materials to change after excavation to a value unsuitable for compaction, he shall raise or lower the moisture content as required above, or the Contractor shall, if so directed by the Engineer, run the material to spoil and replace it with an equal quantity of material suitable for compaction.

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ROADWORKS

36.9 COMPACTION OF EARTHWORKS

Work shall be continued until a state of compaction is reached throughout the embankments, including especially, the slopes of embankments and the immediate approaches to bridge abutments such that at least 9 out of every 10 consecutive samples taken of the compacted material have a relative compaction determined according to B.S. 1377 of at least the following percentage of the maximum density at optimum moisture content;

a) for the topmost 600 mm below formation level a maximum density of 100 percent, and

b) for the remainder below formation a maximum density of 95 percent.

If with non-plastic materials the compacted material has become drier in the interval between the completion of compaction and the measurement of the state of compaction, then the moisture content to be used for the calculation of the air content shall be the mean moisture content for the completion of such materials as specified above.

Each layer of rock used as rock-fill in embankments shall be systematically compacted by at least 8 passes of a towed vibrating roller weighing not less than 3 tonnes or a grid roller weighing not less than 13 tonnes dead weight or other approved plant. Where however, it is established that rock can be compacted to the requirements for common excavation, the rock shall be compacted to such latter requirements.

36.10 EXCAVATION BELOW EMBANKMENT IN MATERIALS UNSUITABLE

Before forming the embankment, any suitable material naturally occurring on the site shall be removed to such depths and over such area as may be directed by the Engineer and shall be run to spoil. The resultant excavation shall be backfilled with suitable material deposited and compacted as specified for the forming of embankments. Nevertheless, where in these circumstances such backfill has to be deposited below standing water, compaction may be omitted provided that the material used is completely free draining.

If ordered by the Engineer as an alternative method of construction, approved rock-fill material shall be placed directly on the naturally occurring unsuitable material to such total depth that on completion of compaction negligible deflection of the surface occurs due to the passage of vehicles hauling in the rock. The rock-fill material shall be deposited in accordance with the requirements previously specified and compacted so as to comply with the requirements as previously specified for the compaction of rock. Such work will be dealt with as a Variation of the works.

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36.11 BENCHING

Where an embankment is to be placed on appreciably sloping ground, the surface of the ground shall be benched in steps or trenches, as shown on the drawings or directed by the Engineer including, if necessary, any under-draining of the site.

36.12 EXCAVATION BELOW FORMATION IN CUTTINGS IN MATERIALS UNSUITABLE FOR CONSTRUCTION

Where suitable material is encountered in the subgrade, it shall be excavated to such depth and over such area as the Engineer shall direct and be run to spoil. The resultant excavation shall be backfilled with suitable material deposited in layers each not exceeding 225 mm loose depth and compacted in the manner specified for the forming of embankments. Nevertheless, where in these circumstances such backfill has to be deposited below standing water, compaction may be omitted provided that the material used is completely free draining.

If ordered by the Engineer as an alternative method of construction, approved backfill material shall be placed directly on the naturally occurring unsuitable material to such total depth that on completion of compaction negligible deflection of the surface occurs due to the passage of vehicles hauling in the rock. The rockfill material shall be deposited in accordance with the requirements as previously specified and compacted so as to comply with the requirements as previously specified for the compaction of rock. Such work will be dealt with as a variation of the works.

36.13 EMBANKMENTS AT APPROACHES TO BRIDGES

To avoid interference with the construction of bridge abutments and wing walls, the Contractor shall, at points to be determined by the Engineer, suspend work on embankments and/or cuttings forming the approaches to any such structures until such time as the construction of the latter is sufficiently advanced to permit the completion of the approaches without the risk of interference or damage to the bridge works. The cost of such suspension of work shall be included in the prices entered in the Bills of Quantities for excavation from which embankments are formed.

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36.14 EMBANKMENTS OVER BRIDGES, CULVERTS AND DRAINS

In carrying embankments up to or over bridges, culverts or pipe drains, care should be taken by the Contractors to have the embankment brought up equally on both sides and over the top of any such structures. Earth embankments shall be formed and compacted inlayers as previously specified and, in rock embankments, the rock filling shall be carefully packed for such distance back as the Engineer may direct. The fillings adjacent to structures shall be deposited and compacted in accordance with the requirements of clauses `DESCRIPTION' and `METHOD OF FILLING'. The cost of these works shall be included in the prices entered in the Bills of Quantities for the excavations from which embankments are formed.

36.15 SIDE GRIPS

Where directed by the Engineer side grips as shown on the drawings shall be formed through verges for surface water drainage and the excavated material disposed of as directed.

36.16 STONE REVETMENTS

Where shown on the drawings, the slopes of embankments, relivers, streams, watercourses and other surfaces shall be protected against water or other action by hand-set stone facing set on end. The stones - the largest of which shall be used in the bottom or where the current is greatest - shall be roughly dressed on the bed and face and roughly square to the full depth of the joints. No rounded boulder shall be used, or stones less than 225 mm in depth of 0.05 m^3 in volume. The stones shall be laid to break bond and shall be well bedded on to a 75 mm layer of gravel or fine rubble rammed to a uniform surface and the whole work finished to the satisfaction of the Engineer. Where required, a trench shall be excavated at the bottom of the slope, to such a depth as will ensure a safe foundation for the revetment.

36.17 COMPLETION OF EARTHWORK

The formation shall be properly shaped and regulated and compacted as previously specified. When completed, the formation shall be at the required level and generally parallel to the required finished surface of the road.

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36.18 **CURVES**

Where the alignment of the carriageway is curved, the bottoms of cuttings and the tops of embankments shall be formed with the super-elevation and increased widths shown on the drawings or as the Engineer shall direct, to suit the degree of curvature of the alignment.

36.19 **TIPPED REFUSE ON SITE**

Tipped refuse other than artificial deposits of industrial waste or shale found on the site shall be removed and disposed or in a spoil heap to be provided by the Contractor.

36.20 **REMOVAL OF INDUSTRIAL WASTE, ETC.**

Artificial deposits of industrial waste or shale found on the site shall be removed and disposed of as directed by the Engineer. Should any particular deposits consist of or contain

material which in the opinion of the Engineer is suitable for incorporation in embankments, all such material shall be used accordingly and deposited in layers and compacted as previously specified. The prices entered in the Bills of Quantities for the excavation of this material shall include for the excavation of the material and the loading, transportation, disposal and compaction of same as and where directed.

36.21 **LAND SLIPS**

Remedial works and/or the removal of materials in slips, slides or subsidences and overbreaks of rock extending beyond the lines and slopes, or below the levels shown on the drawings or required by the Engineer, will not be paid for unless such occurrences are shown to have been beyond the control of the Contractor and not preventable by the exercise of due care and diligence on his part.

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36.22 CLASSIFICATION OF SLIPS

The classification of material from slips or slides will be in accordance with its condition at the time of removal, regardless of prior condition. Measurement of overbreak in rock excavation shall be that of the space originally occupied by the material before the slide occurred and regardless of its subsequent classification.

36.23 ROAD APPROACHES AND ACCESS ROADS

The excavations and embankments in road approaches, junctions, access roads and fringe lands shall be of such form and dimensions as the Engineer may direct, and in all respects finished as specified for those of the main carriageway. The materials arising from such excavations shall be disposed of as directed by the Engineer.

36.24 STREAMS, WATERCOURSES AND DITCHES

Excavations carried out in the diversion, enlargement, deepening, or straightening of streams, watercourses, or ditches shall be performed as directed the Engineer. The rates for such excavations shall include for the necessary trimming of slopes, grading of beds, disposal of excavated materials and all pumping, timbering, works and materials necessary for dealing with the flow of water.

36.25 FILLING OLD WATERCOURSES

Where watercourses have to be diverted from the sites of embankments or other works, the original channels shall be cleared of all vegetable growths and soft deposits and carefully filled in with approved materials deposited and compacted as previously specified.

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36.26 **OPEN DITCHES**

Open ditches for drainage purposes shall be cut where and of such cross section as the Engineer shall direct and where so required by him they shall be constructed before the cuttings are opened or the embankments begun. The sides shall be dressed fair throughout and the bottoms accurately graded so as to carry off the water to the outlet to be provided. The material excavated from the ditches shall be disposed of as directed by the Engineer.

36.27 **CLEARING EXISTING DITCHES**

Where directed by the Engineer existing ditches shall be cleared by removing vegetable growths and deposits. The sides shall be shaped fair throughout and the bottoms properly graded. Material removed from existing ditches shall be disposed of in tips provided by the Contractor. The rates included in the Bills of Quantities for clearing ditches shall include for maintaining and keeping clean.

36.28 **SIDE SLOPES IN ROCK CUTTINGS**

Where rock is encountered in cuttings the side slopes shall be cut out at least to the lines, levels and slopes shown on the drawings or directed by the Engineer.

36.29 **EXCAVATIONS FOR FOUNDATION PITS AND TRENCHES**

Pits and trenches for foundations for bridges, culverts, walls and other structures, except those covered under clause `EXCAVATIONS FOR PIPELINES, SEWERS AND MANHOLES' shall be taken out to the levels and dimensions shown on the drawings or to such other levels and dimensions as the Engineer may direct. The bottoms of all excavations shall be carefully levelled and if necessary stepped or benched horizontally. Any pockets of soft material or loose rock and fissures in the bottoms of pits and trenches shall be removed and the cavities so formed filled with concrete of the appropriate class. When any excavation has been taken out and trimmed to the levels and dimensions shown on the drawings or directed by the Engineer, the Engineer shall be informed accordingly so that he may inspect the completed pit or trench and no excavation shall be filled in or covered with concrete until it has been so inspected and the Contractor has been authorized to proceed with the work. All surplus excavated materials form such excavations not required for refilling shall be deposited in embankments, or otherwise disposed of, as directed. All excavations shall be kept dry and all baling and pumping, timbering, shoring and supporting of sides that may be required, and any refilling, ramming and disposal of surplus materials necessary in carrying out the excavations for foundation pits and trenches shall be included in the prices for excavation.

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36.30 **EXCAVATION FOR CUT-OFF WALLS**

The rate for excavation of trenches for cut-off walls shall include for cutting one face of the excavation true to receive concrete and for any extra concrete of the appropriate class specified for the cut-off walls which is required to fill up over-excavation on this face.

36.31 **EXCAVATION FOR FOUNDATION BELOW OPEN WATER**

The rates for excavation of foundations below the agreed water level shall include for the cost of all temporary close timbering and shoring, sheet piling, coffee dams, caissons, pumps and other special appliances required.

36.32 **FOUNDATION PITS AND TRENCHES OF GREATER WIDTH AND DEPTH THAN NECESSARY**

The Contractor shall not be entitled to payment in respect of excavation to any greater extent, whether horizontally or vertically, than is necessary to receive any structure for which the excavation is intended, except where a separate item is provided for additional excavation for working space, timbering, or other temporary work. Excavation to a greater depth or width than is directed shall be made good with concrete of the appropriate class as determined by the Engineer who may allow excavation to a greater width than is necessary to be filled and tightly packed with suitable material.

36.33 **EARTHWORKS TO BE KEPT FREE OF WATER.**

The Contractor shall arrange for the rapid dispersal of water shed on or entering the earthworks from any source at any time during construction, or water which is shed on to the completed sub-grade. He shall provide within the site where necessary temporary water-courses, ditches, drains, pumping or other means of maintaining the earthworks free from standing water. Water discharged from the site shall not be run into a road but be carried direct to an approved sewer, ditch or river through troughs, shutes or pipes.

Such provision shall include carrying out the work of forming the cuttings and embankments in such a manner that their surfaces have at all times a sufficient minimum crossfall and where practicable, a sufficient longitudinal gradient to enable them to shed water and prevent ponding.

In pumping out excavations and in any lowering of the water tables, the Contractor shall pay due regard to the stability of all structures.

The cost of compliance with the requirements of the class shall be covered in the rates for earthworks.

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36.34 SUPPORTS FOR FOUNDATION PITS AND TRENCHES

The sides of pits and trenches shall where necessary be adequately supported to the satisfaction of the Engineer by timber or other approved means.

36.35 REFILLING OF FOUNDATION PITS AND TRENCHES AND REMOVAL OF EXCAVATION SUPPORTS

Refilling of foundation pits and trenches shall be carried out only after the foundation and structural works within the excavations have been inspected and approved by the Engineer. Unless otherwise directed by the Engineer, all filling shall consist of approved excavated material which shall be deposited and compacted, using approved plant, in layers not exceeding 225 mm loose depth, to a dry density not less than that of the adjoining soil. Timber sheeting and other excavation supports shall be carefully removed as the filling proceeds except as otherwise specified, but the removal of such supports will not relieve the Contractor of his responsibility for the stability of the works.

Where directed by the Engineer timbering, sheeting or other excavation supports shall be left in foundation pits and trenches and any timber so left in will be measured and paid for at the prices entered in the Bills of Quantities except where in the opinion of the Engineer, the necessity for leaving the timber in has arisen from negligence on the part of the Contractor.

The number of separate layers deposited and compacted at any one time shall be subject to the approval of the Engineer.

36.36 USE OF VIBRATORY COMPACTION PLANT

Where vibratory rollers or other vibratory compaction plant are used, the mechanism for vibration shall be kept working continuously during compaction operations, except during periods when the Engineer permits or directs discontinuance of vibration.

Unless otherwise permitted by the Engineer, the frequency of vibration shall be maintained within the range of amplitude and frequency recommended by the manufacturers of the plant for the material to be compacted. The frequency shall be recorded by a tachometer indicating speed of rotation of any shaft producing vibration.

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36.37 **PROVISION OF SPOIL HEAPS**

The Contractor shall provide spoil heaps at his own expense for the disposal of surplus materials and all rubbish collected when clearing the site and during the construction of the works. The sites for these shall be approved by the Engineer.

CONSTRUCTION OF SUB-BASES, BASES AND VERGES

36.38 **DRAINS TO BE COMPLETED**

Before the construction of the carriageways, footways or verges is begun all drains, sewers, cable ducts or other special formation work shall be completed.

36.39 **COMPACTION OF NON-PLASTIC SOIL IMMEDIATELY BELOW FORMATION LEVEL IN CUTTINGS**

Where shown on the drawings or direct by the Engineer, non-plastic soils shall, for a depth of 150 mm be scarified, pulverized and recompacted in accordance with the requirements previously specified for non-plastic soils. Work shall be continued in such a manner as to produce a maximum density of 100 percent at the optimum moisture content, or such other percentage as may be approved by the Engineer as a result of compaction trials.

Soft areas which may develop during compaction shall be removed and replaced by approved material.

36.40 **MURRAM TO CARRIAGEWAY ON ROCK**

Where the formation is rock, after excavation has been completed and if directed by the Engineer, a murram cushion shall be laid to the proper cross-falls to receive the carriageway base. It is anticipated that the depth of such murram shall not exceed 50 mm and the cost of these works shall be included for in the rates for excavation in rock.

SPECIFICATIONS: CIVIL WORKS

PART 37: CIVIL WORKS

37.1 MATERIALS AND TESTING OF MATERIALS

a) Acceptable Standards of Material

All materials used in or upon the works shall be to the satisfaction of the Engineer and where specified, shall comply with the appropriate Specification named, e.g. British Standards Institution (hereinafter referred to as the "B.S."); American Society for Testing and Materials (ASTM) or American Association of State Highway Officials (AASHO) including any subsequent revisions of such Specifications. Materials complying with Specifications other than those quoted will be accepted in lieu provided the quality is comparable with the Specification named but tenderers should, ascertain before tendering whether or not any such other Specification is acceptable.

Similarly, where a material has been specified by manufacturer's Trade Name, the product of another manufacturer will be accepted provided it is in all respects of equivalent or higher quality.

Samples of all materials proposed to be used shall be submitted to the Engineer, shall be tested where required and receive his approval prior to being delivered in bulk upon the Works. The Contractor shall provide all samples free of charge.

b) Range of Testing

As provided in Clause 36 of the Conditions of Contract and in accordance with the Specification quoted for any material used on the Works of this Contract, tests may be called for by the Engineer to be carried out at the place of manufacture or on the site. The Contractor may assume that tests will be required on all materials including sand, stone, road stone, concrete pipes, proprietary concrete products, reinforcement, welding, bitumen and bitumen products.

Where a sample complies with the Specification, the cost of testing ordered by the Engineer will be borne by the Client, but where a sample fails to comply with the Specification, the cost of testing will be borne by the Contractor who shall make due allowance in his prices for this and rendering any assistance required in carrying out tests.

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b) **Range of Testing**

Loading tests on structure will not generally be called for unless specifically mentioned elsewhere.

All samples shall be obtained and tests are to be carried out in accordance with Specifications quoted. Techniques or tests adopted within the Ministry of Transport and Communications, but which are not explicitly in these standards are as detailed in (c) below.

c) **Sample preparation and test Procedures Peculiar to Ministry of Transport and Communications**.

i) **Preparation of Gravel Samples**:

Materials such as murram or soft rock which are agglomerations of materials and not discrete particles (such as quartz gravel) are first broken (usually by hand hammers) to pass a 20 mm sieve. The material shall not be broken more than necessary to achieve this state.

In testing soils containing discrete hard particles not readily broken in this way, the proportion of size greater than 20 mm is recorded, but is not included in the material used for routine laboratory tests. The material so discarded is not replaced by any other sizes.

ii) **Moisture Content:**

Wherever possible, moisture contents determined by the oven method shall be used. Where for field control purposes, it is necessary to use other methods, the various methods shall not be mixed.

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iii) **Bitumen Affinity of Stone**:

Stone between 20 mm and 13 mm in size and 3.5% bitumen at standard working temperatures are mixed, allowed to stand for 24 hours, then immersed in distilled water and inspected 24 hours later for signs of stripping.

iv) A L D (Average Least Dimensions) of Aggregate:

The average least dimension of a sample of aggregate shall be determined by obtaining and averaging the thickness (least dimension between two parallel planes) of all the pieces in the sample. The sample shall contain at least 100 pieces.

d) **Abbreviations:**

The following abbreviations are used in this Specification:

Aggregate Crushing Value	A C V
Los Angeles Abrasion	L A A
British Standard Compaction Test	B S Compaction Test
5.5 ib. Rammer Method	
California Bearing Ration	C B R
Maximum Dry Density	M D D
Optimum Moisture Content	O M C
Plasticity Index	P I
Liquid Limit	L L
Sodium Sulphate Soundness	S S S
Unconfined Compressive Strength	U C S
Linear Shrinkage	L S

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37.2 **PORTLAND CEMENT**

ORDINARY

All cement used upon the works shall be Ordinary Portland cement, unless otherwise specified or permitted by the Engineer, complying with B.S. 12 in all respects.

The Contractor shall supply with each consignment of cement a copy of the Invoice stating the quantity delivered, the maker's name and also the maker's certificate showing that each consignment has been tested and analyzed and conforms with the B.S. 12. The cement will be subject to such test, in accordance with B.S. 12, as the Engineer may deem necessary and he may reject any cement which proves unsatisfactory notwithstanding the maker's certificate.

All cement shall be stored in a waterproof shed on a wooden floor raised at least 0.15 m above the surrounding ground and any cement injuriously affected by damp or other cause shall be open to inspection by the Engineer at all reasonable times. Each consignment shall be stored separately and used in order of delivery.

RAPID HARDENING

Where the Engineer orders or permits rapid hardening cement to be used in lieu of ordinary Portland cement, it shall comply in all respects with B.S. 12 and all special conditions applicable to its use stipulated by the manufacturers shall be observed.

The conditions specified in Clause 202 for ordinary Portland cement shall apply.

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37.3 HYDRATED LIME

Lime for stabilization shall be Hydrated Calcium Lime (not magnesium) and shall generally comply with B.S. 890, Class B and with a free lime content of 50%.

Locally manufactured limes may be accepted by the Engineer in lieu of Lime to B.S. 890 and Contractors are advised, prior to tendering to ascertain from the Chief Materials Engineer, Ministry of Transport and Communications, what local limes may be suitable. All percentages of lime specified are based upon Hydrated Calcium. Limes complying with B.S. 890 and an adjustment of these percentages may be required for some locally made limes.

The Contractor shall submit with all consignments the manufacturer's certificate that it complies with B.S. 890, or his chemical analysis.

37.4 CONCRETE AGGREGATE

Aggregate shall consist of sharp sand or crusher dust, or a mixture of these and hard durable crushed or knapped locally occurring stone to the approval of the Engineer. All aggregate shall be free from clay, shale, pryrites and all other impurities. The coarse part of the aggregate shall be roughly cubicle in shape and free from excess of flat and/or elongated particles. The grading of the aggregate shall be according to Table 1 Section 17, concrete Works (Excluding Pre-stressed).

In respect of purity and soundness, the aggregate shall, in all respects, comply with B.S. 882.

37.5 CRUSHER RUN MATERIAL

The aggregate shall consist of crushed stone which is tough and durable, roughly cubicle in shape and free from excess of flat, and/or elongated particles, clay, top soil or other deleterious matter and shall be to the approval of the Engineer.

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37.5 **CRUSHER RUN MATERIAL**

The rock from which the stone is to be produced shall comply with the following:

Aggregate Crushing Value : Not greater than 35%

Los Angeles Abrasion Value : Not greater than 50%

Sodium Sulphate Soundness Test: Loss on 5 cycles to be not less than 12%

The grading shall conform to the grading requirements given in the table:

B S SIEVE SIZE	PERCENTAGE PASSING BY WEIGHT
50 mm	100
25 mm	75 - 95
10 mm	40 - 70
5 mm	30 - 60
No. 7	20 - 45
No. 36	15 - 30
No. 200	5 - 15*

* The percentage passing No. 200 sieve shall not be more than one-half of that passing No. 36 sieve.

Added fines: a) Up to 15% may be added

b) P I of Fines shall not be greater than 6, and LL not greater than 20

Sampling of rock and crusher run material shall be in accordance with B.S. 812.

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37.6 HAND PACKED STONE BASE COURSE AND SUB-BASE MATERIAL

a) **General Requirements**:

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

A C V: Not greater than 40%

L A A: Not greater than 60%

S S S: Loss on 5 cycles to be not more than 12%

b) **Stones:**

The stones shall be free from an excess of flat or elongated particles soft and less durable rock, clay, loam, top soil and other deleterious matter and shall be to the approval of the Engineer.

The grading for coarse aggregate shall be as follows:

B S SIEVE SIZE	PERCENTAGE PASSING BY WEIGHT
75 mm (3")	100
63 mm (2.5")	90 - 100
50 mm (2")	35 - 70
25 mm (1")	0 - 15
20 mm (3/4")	0 - 5

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37.6 HAND PACKED STONE BASE COURSE AND SUB-BASE MATERIAL

c) **Binder Material**

Soil binder material, which may, with the Engineer's approval be added to the screenings, or used in lieu of the screenings, shall comply to either of the following requirements:

i) The fraction passing B S Sieve No. 200 shall be less than half that passing No. 36 sieve.

ii) P I not greater than 8 and preferably not greater than 5.

37.7 SURFACE DRESSING CHIPPINGS

a) **General:**

All chippings shall consist of tough durable crushed stone preferably cubicle in shape and absolutely free from visible stone dusts and harmful material such as loam, clay, lime, organic matter or other deleterious substances.

The rock from which the chippings are to be produced, shall comply with the following:

A C V: Not greater than 22%

L A A: Not greater than 28%

S S S: Loss on 5 cycle to be not more than 12%

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37.7 **SURFACE DRESSING CHIPPINGS**

The larger stones shall have a maximum dimension slightly greater than the thickness of the required compacted layer and be of a shape acceptable to the Engineer.

The smaller stones shall have a reasonably uniform grading and be of a nominal size suitable, in the opinion of the Engineer, for filling the surface voids of the as-placed large stones. The nominal size will be of the order of 50 mm (2").

b) **Screenings:**

The screenings shall consist of tough durable crushed rock, free from an excess of flat elongated soft or disintegrated pieces and harmful material, such as loam, clay, organic matter, or other deleterious substances and shall be to the Engineer's approval.

The grading of the screenings shall form a smooth curve and shall be within and approximately parallel to, the following grading limits.

B S SIEVE SIZE	PERCENTAGE BY WEIGHT PASSING B.S. SIEVES
3/8"	100
3/16"	85 - 100
No. 36	30 - 50
No. 100	10 - 30
No. 200	0 - 20

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

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b) **Screenings:**

i) It shall consist mainly of sand sizes and have a reasonable smooth grading.

ii) The fraction passing No. 200 sieve shall be less than the weight passing No. 36 sieve.

iii) P I shall not be greater than 5.

37.8 **WATERBOUND STONE BASE MATERIAL**

a) **General Requirements:**

The rock from which the aggregate is to be produced shall comply with the following:

A C V of stone: Not greater than 35%

L A A of stone: Not greater than 50%

S S S of stone: Loss of 5 cycles to be not more than 12%.

b) **Course Aggregate**:

The coarse aggregate and screenings shall consist of tough, durable crushed stone, free from excess of flat, elongated, soft or disintegrated pieces and harmful material such as loam, clay, organic matter or other deleterious substances and shall be to the Engineer's approval.

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37.8 **WATERBOUND STONE BASE MATERIAL**

c) **Grading:**

Chippings for surface treatment work shall comply with B.S. 63 single sized Roadstone and chippings except that the maximum permissible flakiness index shall not exceed 20%. The following table is appended for information:

Percentage by Weight Passing B.S. Nominal Size

B S Sieve	20 mm (3/4")	13 mm (1/2")	10 mm (3/8")	6.3 mm (1/4")	3 mm (1/8")
(3/4") 20 mm	85 - 100	100			
(1/2") 13 mm	0 - 35	85 - 100			
(3/8") 10 mm	0 - 7	0 - 45	85 - 100		
(1/4") 6.3 mm		0 - 7	0 - 45	100	
(3/16") 5 mm			0 - 10	85 - 100	100
(1/8") 3 mm	0 - 2	0 - 2	0 - 2	0 - 10	85 - 100
No. 7					
No. 10					0 - 35
No. 14					0 - 10
No. 25					0 - 2

Despite the provisions of this B.S., the Engineer may accept chippings which do not comply with the requirements in respect of flakiness index, specified size and oversize fraction of the aggregate. Contractors are advised to submit samples of chippings for test and approval.

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37.8 WATERBOUND STONE BASE MATERIAL

d) **Deleterious Substances:**

The percentage by weight of deleterious substances in the chippings shall not exceed the following:

Soft Fragments	2.0%
Clay Lumps	0.25%
Humus	0.25%
Removal of decantation	1.0%

e) **Other Properties**:

In the event of suitable tests and service records of the chippings, satisfactory to the Engineer, not being available, the chippings shall be subjected to such other tests as are necessary to determine its acceptability for surface treatment such as specific gravity absorption petrographic analysis, alkali aggregate recations, bitumen affinity etc.

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37.9 PREMIX WEARING COURSE AND BASE COURSE AGGREGATE

a) **General Requirements:**

The aggregate for premix wearing course and base course shall consist of tough, durable, crushed stone, and shall be clean, free from visible dust and harmful material, such as loam, salt, lime, organic matter or other deleterious substances and shall be to the approval of the Engineer.

The rock from which the aggregate is to be produced shall comply with the following:

A C V: Not greater than 26% wearing course 30% base course

L A A: Not greater than 30% wearing course 42% base course

S S S: Loss on 5 cycles to be not more than 12%

Bitumen Affinity: To be good

The flakiness Index on the aggregate shall not be greater than 20%.

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37.9 **PREMIX WEARING COURSE AND BASE COURSE AGGREGAT**

The grading of the aggregate shall be as follows:

B S SIEVE SIZE	NOMINAL MAXIMUM SIZE OF AGGREGATE MM.					
	40	25	20	13	10	6
50.8 (2") 38.1 (1/12")	100 85-100	100				
25.4 (1") 19.1 (3/4")	75-90 65-82	85-100 75-95	100 85-100	100		
12.7 (1") 9.5 (3/8")	55-70 45-65	60-80 52-72	75-90 65-80	85-100 75- 95	100 85-100	100
4.8 (3/16") No. 7	30-50 20-40	35-55 20-40	45-65 30-50	50- 70 35- 55	65-80 45-60	70-95 50-70
No. 36 No. 200	7-20 2- 6	8-20 3- 7	10-22 4- 8	12-23 4-8	18-28 5-9	20-35 5-9

37.10 **BITUMEN GROUTED STONE BASE COURSE AGGREGATE**

a) General Requirements:

The rock from which the stone, choke and chippings are to be produced shall comply with the following:

A C V: Not greater than 26%

L A A: Not greater than 36.5%

S S S: Loss on 5 cycles to be not more than 12%

Bitumen Affinity: to be good

The aggregate shall consist of tough, durable crushed stone, preferably cubicle in shape and shall be clean, free from visible dust and harmful material such as loam, clay salt, lime, organic matter or other deleterious substances and shall be to the approval of the Engineer.

The aggregates shall have a Flakiness Index not greater than 20%.

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37.9 **PREMIX WEARING COURSE AND BASE COURSE AGGREGAT**

b) **Penetration Course Stone:**

The grading of stone for a penetration course shall be within the limits given in Table 1 in this clause for material for a course of thickness between 60 - 100 mm or of 40 - 60 mm respectively.

TABLE 1

B S SIEVE SIZE	PERCENTAGE BY WEIGHT PASSING BY SIEVES	
	Course Thickness 60 - 100 mm	Course Thickness 40 - 60 mm
76.2 mm (3")	100	-
63.2 mm (2.5")	90 - 100	100
50.8 mm (2")	35 - 70	90 - 100
38.1 mm (2.5")	0 - 15	20 - 55
25.4 mm (1")	-	0 - 15
19 mm (3/4")	-	-
12.7 mm (1/2")	0 - 5	0 - 5
9.5 mm (3/8")	-	-

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37.9 **PREMIX WEARING COURSE AND BASE COURSE AGGREGAT**

b) **Penetration Course Stone:**

TABLE 2

B S SIEVE SIZE	PERCENTAGE BY WEIGHT PASSING BY SIEVES	
	Course Thickness 60 - 200 mm	Course Thickness 40 - 60 mm
25.4 mm (1")	100	-
19 mm (2.5")	90 – 100	100
12.7 mm (0.5")	-	-
9.5 mm (3/8")	20 - 55	40 - 70
4.8 mm (3/16")	0 - 10	0 - 15
2.4 mm No. 7	0 - 5	0 - 5

c) **Sealing Chippings:**

The grading of sealing chippings shall be within the limits given in Clause 208 of the Specification for surface dressing chippings.

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37.11 **BITUMEN AND BITUMEN EMULSION**

a) **General Requirements**:

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

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

i) Prime Coat:

On stone base course) R C 70 or M C 70

On stabilized base course) (alternatively R C 1 or M C 1

ii) Premix and Surface Dressing:

Above 2,000 m 180/200 Penetration

Below 2,000 m 80/100 Penetration

iii) Grouted stone:

80/100 Penetration

Penetration Grade Bitumen - shall comply with the requirements given in Table 1 in this clause.

Cutback Grades of Penetration Bitumen - shall comply with the requirements given in Table 2 or 3 in this clause for rapid curing (RC) and Table 4 or 5 in this clause for medium curing (MC).

Bitumen Emulsion Additive - shall comply with a B.S. 434. Bitumen Road Emulsion, section 3, clause 10 - 13 and 15.

Bitumen Additive - shall be Erol Asco 66/1 as supplied by:

Joseph Weil & Son Limited Friars House, 39 - 41 New Broad Street, London E C 2 ENGLAND or other similar approved materials.

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37.12 SAMPLING OF BITUMEN AND BITUMEN EMULSIONS

a) **General:**

Every precaution shall be taken to obtain samples that will show the true nature and condition of the material. A sample should not include material other than that to be sampled, and should not be altered, e.g. by evaporation of volatile constituents or by oxidation in the process of sampling.

b) **Penetration Grade Bitumen and Cutback Penetration Grade Bitumen**

Sampling is to be carried out in accordance with Standard methods of sampling bituminous materials given under AASHO Designation T.40. It is required, however, that the load sinker shown in fig. 1 - Bottle sampler for Tank Bars, be fixed externally, since irregularities in the metal may retain material which will contaminate the sample if the weight is fitted in the interior, alternative designs are given in B.S. 3195 and also in publication of Institute of Petroleum `Standard for Testing Petroleum and its Products' under IP 51 Section 35.

It is possible that suitable sampling equipment will be available at the material Branch Ministry of Transport and Communications and application for use of such equipment should be made to the Chief Material Engineer. Suitable friction top tin plated cans are manufactured in Kenya and are referred to as having cushion ring and cap they should have seams soldered only on the outside.

c) Sampling is to be carried out in accordance with Section 2 of B.S. 434 except that where a delivery is made in drums or barrels, the number of samples obtained shall depend upon the number of drums or barrels constituting the delivery concerned and be in accordance with the Table given below:

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37.12 **SAMPLING OF BITUMEN AND BITUMEN EMULSIONS**

b) **Penetration Grade Bitumen and Cutback Penetration Grade Bitumen**

Packages in shipment	**Packages Selected**
2 to 8	2
9 to 27	3
28 to 64	4
65 to 125	5
126 to 216	6
217 to 343	7
344 to 512	8
513 to 729	9
730 to 1000	10

Samples taken shall be placed in wide-mouth glass jars.

d) **Samples sizes (with S1 equivalent)**

A. **Liquid Materials and Materials made liquid by heating:**

i) For routine laboratory examination - Penetration grades and cutback grades, 1 quart or litre Emulsion, 1 gallon or 5 litres.

ii) From bulk storage, during loading or filling distributors, tank cars or trucks - gallon or 5 litres.

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37.12 SAMPLING OF BITUMEN AND BITUMEN EMULSIONS

B. **Semi-solid or Solid Materials:**

i) From barrels, drums or cakes - 2 - 3 pounds or 1 to 1.5 kilogrammes.

ii) From crushed or powdered material in bulk or bags 2 to 3 pounds or 1 to 1.5 kilogrammes.

e) **Leaning of Sample Containers**:

Cans:

Particular care is necessary to ensure that cans are properly cleaned even when new, as this can not be checked by visual examination. Cans shall be washed with solvent and dried with a clean dry cloth before being dried in an oven at 105 degrees centigrade. It is essential that all traces for soldering fluid, rust etc. be removed.

Gas Jars:

It is essential that jars should always be scrupulously clean. For samples for reference tests, jars shall be cleaned by treatment with chromic acid and shall then be well washed with water, followed by rinsing with distilled water and drying in an oven at 105 degrees centigrade. Used jars shall first be cleaned with a suitable hydro-carbon solvent, dried and then treated as above.

Cleaning of glassware with chromic acid should be undertaken only in a laboratory or by persons fully conversant with the hazards entailed.

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37.13 TESTS FOR BITUMEN AND BITUMEN EMULSIONS

a) **Test for Penetration Grade Bitumen**:

Routine:

i) Penetration of Bituminous Materials ASTM D.5.

ii) Softening Point of Asphalts and Tar Pitches (Ring-and-ball Apparatus) (Tentative) ASTM D. 36.

iii) Solubility of Bitumens materials in Organic Solvents ASTM D.4 Procedure No. 1 except that of carbon tetrachloride, shall be used in place of carbon disulphide.

iv) Water in Petroleum and other Bituminous Materials ASTM D.95.

V) Specific Gravity of Road Oils, Road Tars, Asphalt Cements and Soft Tar Pitches ASTM D.70.

As Required:

i) Ductility of Bituminous Materials ASTM D.113.

ii) Flash and Fire Points by Cleveland Open Cup ASTM D.92.

iii) Loss on Heating of Oil and Asphalt Compounds ASTM D.6.

iv) On residue from loss on Heating Test. Penetration of Bituminous Materials ASTM D.

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37.13 **TESTS FOR BITUMEN AND BITUMEN EMULSIONS**

b) **Tests for Cutback Grades of Penetration Bitumen**:

Routine:

i) Distillation of Cutback Asphalt Products ASTM D.402.

ii) Viscosity, kinematic of Asphalts ASTM D.2170 (viscosity), Saybolt, ASTM D.88. Then convert to kinematic value.

iii) Water in Petroleum and other Bituminous Materials ASTM D.95.

As Required:

i) Flash and Fire Points by Cleveland open Cup ASTM D.92. after distillation.

ii) Penetration of Bituminous Materials ASTM D.5.

iii) Softening Point of Asphalts and Tar Pitches (Ring-and-apparatus) (Tentative) ASTM D.36.

iv) Solubility of Bituminous Materials in Organic Solvents ASTM D.4 procedure No. 1, except that of carbon tetrachloride shall be used in place of carbon disulphide.

v) Ductility of Bituminous Materials ASTM D.++/.!!!

c) **Tests for Bitumen Road Emulsion:**

Routine:

i) Residue on No. 22 B.S. Sieve Test A B.S. 434.

ii) Stability to mixing with Coarse Graded Aggregate Test C, B.S. 434.

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37.13 **TESTS FOR BITUMEN AND BITUMEN EMULSIONS**

iii) Water Content, Test E, B.S. 434.

iv) Viscosity Test F, B.S. 434.

As Required:

i) Residue on a No. 100 B.S. Sieve Test B.S. 434.

ii) Stability of Bitumen Emulsion to mixing with Cement Test D. B.S. 434.

ii) Stability of Bitumen Emulsion to mixing with Cement Test D. B.S. 434.

iii) Sedimentation Test H, B.S. 434.

37.14 **TESTING OF CONCRETE**

a) Method of Making Test Cubes:

i) Test cubes shall be made by or under the supervision of the Engineer or his representative from concrete placed in, or about to be placed in the works.

ii) Test cubes shall be made, stored and cured and tested in accordance with B.S. 1881 `Methods of Testing Concrete' except that no 4" cubes will be permitted. The method of compaction (by had or vibrator) will be at the Engineer's discretion.

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37.14 **TESTING OF CONCRETE**

TOLERANCES

37.15 **INTENTION**

This section deals with the range of tolerances that shall apply for different stages in construction. The relevant tolerances are also given in each section, for ease of reference.

The Engineer shall have the right to reject any work which fails to comply with these tolerances and the Contractor shall at his own expense make good any defects as directed by and to the satisfaction of the Engineer.

37.16 **MATERIALS TOLERANCES**

For materials, where B.S. is referred to, the tolerances stated in these B.S. shall apply, unless otherwise specifically mentioned.

PAVEMENT AND SUBGRADE TOLERANCES

NAME	VARIATIONS PERMITTED				
	MM Thickness	MM Level	MM 3 m Straight edge	MM Camber	MM Grade in 30 m
PREMIX WEARING COURSE	+ 6 mm - 0 mm	+ 40 mm - 70 mm	+ - 6 mm	+ 15 mm -	0.1
BASE COURSE	+ 10 mm - 0 mm	+ 35 mm - 70 mm	+ - 6 mm	+ 15 mm -	0.1
SUB-BASE	+ 25 mm - 10 mm	+ 25 mm - 70 mm	+ - 20 mm	+ 15 mm -	0.1
SUBGRADE LAYERS	N/A	+ 0 mm - 60 mm	N/A	+ 0 mm - 30 mm	0.1
GRAVEL WEARING	- 25 mm	+ 0 mm - 60 mm	+ 25 mm -	+ 25 mm -	0.1

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37.16 **MATERIALS TOLERANCES**

The tolerances given in the above table are devised so as to control pavement shape, thickness and qualities. They allow that deficiency in shape and level shall generally be made up in the sub-base layer, though within the tolerances laid down for base courses and wearing course deficiencies can also be made up there.

No tolerance will be permitted at the junction of concrete and bitumen work.

TOLERANCE ON PAVEMENT WIDTHS

NAME	Variation in Half Width mm	Max. Rate of Variation in 30 mm
PREMIX WEARING COURSE	+ 25 mm - 6 mm	50 mm
SURFACE DRESSING WEARING COURSE	+ - 25 mm	50 mm
GRAVEL WEARING COURSE	- 100 mm	N/A
WATERBOUND & HANDPACKED STONE & CRUSHER-RUN BASE COURSE	+ 150 mm - 0 mm	N/A
STABILIZED BASE COURSE	+ 50 mm - 150 mm	N/A
GRAVEL BASE COURSE	- 150 mm	N/A
STABILIZED SUB-BASE	- 50 mm	N/A
GRAVEL SUB-BASE	- 50 mm	N/A

The "half width" shall be measured from the centre-line of the road to the edge of the layer.

The final average width of all kinds of wearing courses, base courses and sub-base measured at seven points over a length of 100 m shall be at least equal to the width specified or ordered.

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37.17 **SLOPE: TOLERANCES**

In the final trimmed slope of cuttings a tolerance of 1/8 will be permitted, i.e., if the slope of 1 in 2 is specified, the acceptable slope shall be not steeper than 1 in 17/8 or slacker than 1 in 21/8 and the rate of change of slope shall not be greater than 1/8 in 50 m subject to the tolerance, on width of the bottom of cuttings being complied with.

In final trimmed slopes of embankments a tolerance of plus 1/2 will be permitted, i.e., if the specified slope is 1 in 2, the acceptable slope shall be not steeper than 1 in 2 or slacker than 1 in 21/2.5 and the rate of change of slope shall not be greater than 1/4 in 30 m.

37.18 **WIDTHS OF CUTTINGS AND EMBANKMENTS: TOLERANCES**

The tolerance permitted in the overall width of the bottom of cuttings shall be 75 mm in the horizontal distance between the centre line of the road and the toe of the cutting slope. The width of embankments measured as the horizontal distance from the centre line of the road to the top of the embankment, shall not be less than the design width.

37.19 **COMPACTION: TOLERANCES**

The compaction, measured as the dry density of the compacted layer, shall in no case be less than specified or ordered by the Engineer.

37.20 **CONCRETE WORKS: TOLERANCES**

a) **Dimension:**

The maximum permitted variation from the dimension as shown upon the drawings, or as ordered by the Engineer, shall be

Least Dimension on Concrete Structure	Variation Permitted
Less than 0.4 M	+ 4% - 2.5%
Greater than 0.4 M	+ 16 mm - 10 mm

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37.20 **CONCRETE WORKS: TOLERANCES**

b) **Cover to Reinforcement**:

The cover to the reinforcement bars in concrete (other than prestressed) shall be as shown upon the drawings, or as ordered by the Engineer, with the following variations permitted.

Least Dimension on Concrete Structure	Variation Permitted
Less than 0.25 m	+ 4% - 2%
Greater than 0.25 m	+ 10 mm - 5 mm

c) Accuracy in Placing Tendons in Prestressed Work:

The permitted variation in placing the tendons shall be:

i) Pre-tensioned work + 1.5 mm

ii) Post-tensioned work + 3.0 mm

37.21 **GRASS**

The area to be planted should be cleared of all rubble, weeds, surplus material and other rubbish. The soil shall then be well dug to a depth of 225 mm and all lumps of soil broken down. If it is necessary to import soil to replace that removed during construction, it shall be rich red soil and sufficient which should be brought to provide a 75 mm layer over the area concerned, or, if mixed with the existing soil, to form 50% of the top 75 mm of the mixed soil.

Unless otherwise specified in the Bills of Quantities, the types of grass which may be planted shall be those known locally as Kikuyu grass. The cuttings shall not be greater than 225 mm in length and should be inserted firmly 25 to 50 mm into the ground at spacings of 225 to 300 mm. All plantings must be done at the beginning of an accepted rainy season just as soon as the ground becomes sufficiently moist.

The grass should be regularly weeded during the maintenance period and be delivered up weed-free at the end of this time.

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KERBS, CHANNELS, QUADRANTS, EDGINGS CUT-OFF WALLS,

PAVING FLAGS AND TRAFFIC SIGNS

37.22 PRECAST CONCRETE KERBS, CHANNELS AND QUADRANTS

Precast concrete kerbs, channels and quadrants shall be as specified. All concrete carriageway slabs, kerbs and quadrants shall, where shown on the drawings, be laid and bedded in a 12 mm layer of cement mortar, as specified. Dowel bars, as specified and of the dimensions shown on the drawings or stated in the Bills of Quantities, shall be driven 50 mm into the green concrete of the slab after it has been finished, at 375 mm centres and concrete of the appropriate class shall be cast over and around the protecting dowel bars as backing to the kerb all as shown on the drawings.

For other than concrete roads, the concrete kerbs, channels and quadrants shall be laid and bedded on the 12 mm layer of cement mortar 3 to 1 on a foundation or haunch of concrete of the appropriate class constructed as shown on the drawings or as directed by the Engineer.

All kerbs channels and quadrants shall be jointed with cement mortar 3 to 1. No joint shall exceed 12 mm in width.

Dowelled kerbs used with cut-off walls shall be laid and bedded on a 12 mm layer of cement mortar 3 to 1. The holes shall be filled with cement mortar in two stages, the last 12 mm of depth being added two days after the bulk.

Specially cast circular kerbs and quadrants shall be used on curves where the radius is 20 metres or less. Expansion joints where shown on the drawings or directed by the Engineer shall be constructed in line with expansion joints in the carriageway.

All kerbs and quadrants shall be laid true to line and level and any unit found to be more than 3 mm out of the line or level at either end shall be lifted and relaid.

17.23 PRE-CAST CONCRETE EDGING

Precast concrete edging shall be as specified and shall be set and jointed as shown on the drawings or as directed by the Engineer. When completed it shall be true to line and level and any found to be more than 3 mm out of line at either end shall be lifted and relaid. The price inserted in the Bills of Quantities shall include for any necessary excavation and refilling required in connection with the setting of the edging and the disposal of surplus material.

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37.24 CONCRETE BEDDING AND CONCRETE HAUNCHING FOR PRECAST KERBS AND QUADRANTS

Concrete bedding and concrete haunching for precast kerbs and quadrants shall be constructed to the dimensions shown on the drawings or as directed by the Engineer and shall consist of the appropriate class. The price included in the Bills of Quantities shall include for all form work, excavation and disposal of surplus material.

37.25 CUT-OFF WALLS

Where required, concrete cut-off walls shall be constructed from concrete of the appropriate class to the dimensions shown on the drawings. The concrete shall be mixed, sampled, transported, placed, compacted and cured as specified in the Structural Section of the Specification.

Kerb dowels 12 mm diameter and 300 mm long shall be accurately set 150 mm into the wall at 450 mm nominal centres and cast in. Kerbs may be cut only adjacent to outlet drains. Construction joints as specified shall be provided where directed. The inner face of the wall shall be cast against the trimmed face of the trench, but formwork will be required, where the wall projects above existing ground level. The outer face shall receive application of bitumen of 85/100 penetration applied by means of an approved handspray distributor at a rate of application of 0.54 lit./sq.m. and at a temperature of 170 degrees centigrade - 180 degrees centigrade. The rates for cut-off walls shall include for all excavation including working space, formwork, all materials, bitumen application including a coating on all pipes and conduits passing through the wall and backfilling with approved excavated materials.

37.26 PRECAST CONCRETE FLAG PAVING

Precast concrete flags shall be as specified and shall be laid over a 75 mm bed of murram as specified. The slabs shall be laid to a regular 150 mm or 300 mm bond as directed, with joints at right angles to the line of the kerb. The prices for laying paving shall include all cutting whether straight or circular, bedding in with fine sand and grouting with mortar 3 to 1.

SPECIFICATIONS: CIVIL WORKS

PART 37: CIVIL WORKS

37.27 MURRAM FOOTWAYS

Murram footways shall consist of a 100 mm of compacted murram as specified laid to the levels and falls shown on the drawings on a well compacted sub-grade.

37.28 PERMANENT TRAFFIC SIGNS

Permanent traffic signs shall be either externally or internally illuminated, reflectorised or non-reflecting and shall conform in quality to British Standard 873. The Construction of Road Traffic Signs and Internally-illuminated Bollards. They shall have the dimensions and legends and be of the material and finish, including any illumination or reflectorisation, shown on the drawings or stated in the Bills of Quantities.

Where illumination is to be provided this shall be tungsten filament or fluorescent type, as shown on the drawings or stated in the Bills of Quantities and complying with the British Standard.

Traffic signs shall be erected with suitable fittings on posts made from tubular steel, reinforced or prestressed concrete or timber, all as shown on the drawings or stated in the Bills of Quantities and complying with the British Standard.

SPECIFICATIONS: CIVIL WORKS

PART 37: CIVIL WORKS

MATERIALS

37.29 MURRAM

Murram shall be from an approved source quarried so as to exclude vegetable matter, loam, top soil or clay. The California Bearing Ratio of the murram, as determined for a sample compacted to maximum density (as defined under B.S. 1377) and allowed to soak in water for four days, shall not be less than 30. This C.B.R. is a guide to quality only and the compaction in the work will be judged by density.

In the event that murram is not readily available in the immediate vicinity of the works, the Contractor will be required to provide it and to pay for all haulage. The source of supply shall be approved by the Engineer before any material is brought to site.

37.30 WATER FOR CEMENT TREATED MATERIALS

If water for the works is not available from the Public Mains, the Engineer's approval must be obtained regarding the source of supply and manner of its use. Water to be used with cement or lime shall be free from salt, oil, alkali, organic matter and other deleterious substance. If the water is required to be tested, this shall be done in accordance with the requirements of British Standard 3148: Tests for Water for Making Concrete.

37.31 SALT-GLAZED WARE SPIGOT AND SOCKET PIPES AND SPECIALS

Salt-glazed ware spigot and socket pipes and specials, shall comply with the requirements of British Standard 65: Salt-glazed Ware Pipes. Unless otherwise stated in the Bills of Quantities, they shall be of British Standard quality as defined therein.

37.32 CONCRETE PIPES AND SPECIALS

Concrete pipes and specials shall comply with the requirements of British Standards 556 or 4101 as appropriate. They shall carry the British Standard Institution Registration Certification trade mark, or test certificates shall be furnished by the manufacturers.

SPECIFICATIONS: CIVIL WORKS

PART 37: CIVIL WORKS

37.33 CONCRETE POROUS PIPES

Concrete porous pipes shall comply with the requirements of British Standard 1194: Concrete Porous Pipes for Under-drainage.

37.34 CONCRETE DRAIN INVERT BLOCKS

Precast concrete invert blocks shall be manufactured to the detailed drawings supplied from concrete class specified using maximum 12 mm size aggregate. If required, cube test certificates shall be supplied by the manufacturer.

37.35 CONCRETE SLABS FOR OPEN DRAINS

Precast concrete slabs for lining open drains shall be manufactured to the detailed drawings supplied from concrete as specified using maximum 12 mm aggregate. If required, cube test certificates shall be supplied by the manufacturers.

37.36 AGRICULTURAL TILES AND PIPES

Agricultural tiles and pipes shall be best well burnt earthware true and circular in bore and with an extremely flat bottom and plain ends suitable for laying with open or butt joints.

37.37 CAST IRON PIPES AND SPECIALS

Cast iron pipes, bends, junctions and fittings shall be provided with spigot and socket joints and shall comply with the requirements of British Standard 78: Cast Iron Pipes (vertically cast) for water, Gas and Sewage. Class B pipes shall be used, and they shall carry the British Standard Institution registered certification trade mark, or test certificates shall be furnished by the manufacturers.

SPECIFICATIONS: CIVIL WORKS

PART 37: CIVIL WORKS

37.38 MANHOLES COVERS AND FRAMES

Manhole covers and frames shall be basically in accordance with the requirements of B.S. 497: Cast Manhole Covers, Road Gulley Gratings and Frames for drainage Purposes except that the manhole covers shall be constructed of mild steel, concrete filled, in accordance with the Council's standard detailed drawings.

Foul water sewer manholes shall have triangular Grade `A' heavy duty covers and frames. Circular manhole covers and frames shall be used on surface water sewer manholes.

37.39 GULLEY GRATINGS AND FRAMES

Gulley gratings and frames shall be basically in accordance with the requirements of B.S. 497, nominal size 500 mm x 350 mm except that the gulley gratings shall be constructed of mild steel, concrete of mild steel, concrete filled in accordance with the councils's standard detailed drawings.

Where indicated as being kerb inlet type, the gullies shall conform to the shape and dimensions given on the detail drawings supplied, but in respect of materials and workmanship conform to B.S. 497.

37.40 PRECAST CONCRETE MANHOLES AND INSPECTION CHAMBERS

Precast concrete manholes and inspection chambers shall comply with the requirements of British Standard 556: Concrete Cylindrical Pipes and Fittings including Manholes Inspection Chambers and Street Gullies and they shall carry the British Standard Institution registered certification trade mark, or test certificates shall be furnished by the manufacturers.

37.41 PRECAST CONCRETE GULLIES

Precast concrete gullies shall be unreinforced and shall comply with the requirements of British Standard 556: Concrete Cylindrical Pipes and Fittings including Manholes, Inspection Chambers and Street Gullies.

SPECIFICATIONS: CIVIL WORKS

PART 37: CIVIL WORKS

37.42 MANHOLE STEP IRONS

Step irons of general purpose type shall comply in all respects with B.S. 1247: Malleable Step Irons.

37.43 TIMBER

Timber shall be sound, well-seasoned and entirely free from worm, beetle, warps, shakes, splits and all forms of rot and deadwood. Where required, all timber shall be treated with creosote, as specified in British Standard 144: Coal Tar Creosote for the Preservation of Timber, or an alternative approved timber preservative.

37.44 PVC PIPES

PVC pipes shall comply with B.S 3505 and shall be of the type and class as specified in the drawings or the Bills of Quantities. The joint shall employ a flexible rubber ring which shall meet the requirements of B.S. 2494. Laying, jointing and testing shall generally be carried out according to the relevant clauses of this Specification and all as per the manufacturer's institutions.

37.45 PITCH FIBRE PIPES

Pitch fibre pipes, bends, junctions and taper joints shall comply with the requirements of British Standard 2760: Pitch-Impregnated Fibre Drain and Sewer Pipes, except that they shall be perforated if so shown on the drawings or required by the

Bills of Quantities. They shall carry the British Standards Institution registered certification trade mark, or test certificates shall be furnished by the manufacturers.

SPECIFICATIONS: LANDSCAPING

PART 38: LANDSCAPING

38.1 SOIL PREPARATION

a) Generally

This section includes the removal of weeds, rocks and debris from the soil surface, cultivation of the soil and addition of manure and fertilizers to the soil in preparation for planting.

b) Job Conditions

Soil preparation is to be carried out after completion of building works in that area. The work is to be co-ordinated by the Contractor with other traders to ensure there will be no subsequent contamination of the prepared soil by building and other debris.

c) Manure

All manure is to be dry, well-rotted and a minimum of 12 months of age. It must be either horse, cow or chicken manure. Compound fertilizers are to be 20-20-20 or equally approved and are to be of dry, granular consistency. Top soil obtained locally must be neutral, free of excess salt, and must be approved by the Architect. Tests may be required by the Architect, at the expense of the Contractor.

d) Installation

Remove all large rocks (over 75 mm diameter), roots and debris from the excavated soil and then prepare soil planting mixture as follows: Mix together 4 parts excavated soil, 2 parts manure, 1 part imported top soil, 1/4 part ammonium sulphate and 1/8 part compound fertilizer. Mix all components of the planting mixture together and place into the planting hole. Fill the hole with the soil mixture to a level above the original to allow for soil settlement. Thoroughly water the planting area until well soaked. After 2 days install the plant materials.

e) Inspection

Areas of soil prepared for planting are to be inspected and approved by the Architect prior to planting.

SPECIFICATIONS: LANDSCAPING

PART 38: LANDSCAPING

38.2 **LANDSCAPING**

a) **Generally**

The term landscaping covers all soil preparation for planting work and all planting of trees, shrubs, grass and other plant materials.

b) **Product Handling**

All plant material is to be supplied to site by the Contractor and maintained on site by the Contractor until the expiry of the defects liability period. The Contractor is to be responsible for all ordering, inspections, importation, duties and handling procedures and expenses which may be incurred through supply of plant materials.

c) **Job Conditions**

Prior to plant material being delivered to the site, the Contractor must construct a shade house for storage of the plants until planting. The shade house is to be constructed with a flat roof covering of split bamboo poles (or equally approved) to allow filtered light through to the plant material to be stored below. the sides of the shade house are to be similarly constructed of split bamboo poles (or equally approved) to protect the plant material from intense solar radiation.

Plant material which is to be supplied to the site "bare-rooted" must be immediately planted into heavy-duty polythene plant bags in good quality top soil approved by the Architect. The plants are then to be stored in the shade house until they have fully recovered from transplantation and have leafed out prior to planting on site.

d) **Acceptable Materials**

All plant materials must be obtained from reputable suppliers. The Contractor must supply a list of his intended suppliers to the Architect for approval prior to ordering.

SPECIFICATIONS: LANDSCAPING

PART 38: LANDSCAPING

e) **Materials**

Plant materials may be obtained locally or imported "bare-rooted" or in soil. At the time of planting, each plant must be the following height in the ground:

Trees - 1.5 metres

Shrubs - 0.5 metres

Each plant must be individually tagged using the full Latin plant name written on to plastic tags in permanent, indelible ink, on immediate arrival on site.

f) **Supervision**

The contractor must employ to the satisfaction of the Architect a qualified landscape contracting expert to supervise all landscaping works. This person must be on site throughout the period of the landscape works from the time of arrival of the plant materials to completion of the maintenance period.

g) **Installation**

No planting of the plant material into the ground is to take place between the months May to October inclusive, unless approved in writing by the Architect. The recommended planting time is between November and March.

h) **Maintenance**

The Contractor is to be responsible for all landscape maintenance in areas of the site where construction work is to take place or is taking place. The Contractor is to submit his maintenance program to the Architect prior to commencement of the building contraction site.

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PART 38: LANDSCAPING

i) **Reinstatement**

The Contractor is responsible for reinstatement of all landscaped areas which are not specifically designated for renovation, to their original condition where construction works take place and damage existing landscape areas.

38.3 **LAWNS**

a) **Generally**

This section includes the planting of grass plugs to create a lawn.

b) **Job Conditions**

Lawn areas are to be properly prepared prior to planting. Soil in this area is to be prepared in accordance with section 15.1 prior to the lawn installation. Planting must take place after 16:00 hours and before 08:00 hours to avoid damage to newly planted grass from daytime heat.

c) **Materials**

Grass "plugs" are to be of the same uniform species as is existing. "Plugs" are to be free of weeds and any other grass species. "Plugs" are to be freshly uprooted no longer than 12 hours prior to replanting in the lawn area. "Plugs" are to be no less than 100 mm in length with both leaves and roots visible.

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d) **Preparation**

The Contractor shall clear the lawn of all debris, and excavate existing soil to a depth of 250 mm and prepare soil in accordance with section 15.1: Replace soil planting mixture and grade and level the soil surface. Fill in any holes and smooth cut any high points. Finally, level soil surface using a wooden plant, and roll lightly before planting.

e) **Installation**

Plant grass "plugs" at a depth of 50 mm, exposing only a small amount of leaf, 100 mm apart. After planting water the lawn area thoroughly using hosepipes with sprinklers connected.

38.4 **TREES AND SHRUBS**

a) **Installation**

The Contractor shall dig a round hole, 600 mm deep and 900 mm wide for each shrub and 1000 mm deep and 1500 mm wide for each tree. Remove soil and prepare soil planting mixture (see Section 15.1). When soil is prepared and the area has been inspected by the Architect, the trees and shrubs may be planted. The Contractor shall dig a hole large enough to accommodate the root ball of the plant, remove the polythene plant bag and place the plant in the hole ensuring that the level of the soil around the plant when in the bag is at the same level when planted in the ground. Replace the soil around the plant in the hole. Gently tamp down the soil. Water the plant thoroughly.

b) **Plant Protection**

All shrubs are to be protected from over exposure to the sun after planting in the ground, when planted during the months of November, March & April. The Contractor shall erect a sun shade over and around each shrub. This is to consist of a "roof" and sides of dried grass on a rigid frame (or equal approved).

The sun shade is to protect the plant after planting for a period of one month after which the grass may slowly be removed, a little each day, until the plant becomes acclimatized to direct sunlight.

SPECIFICATIONS: LANDSCAPING

PART 38: LANDSCAPING

38.5 TREE AND PLANT PROTECTION

a) Generally

This section includes all work involved in the protection of existing trees and shrubs on site from damage during the contract period and includes erection of specified barricades.

b) **Job Conditions**

Plants to be protected are to be identified and tagged on site by the Architect prior to installation of protective barricades.

c) **Preparation**

Remove all existing debris and weeds (if any exist) from around plants to be protected.

d) **Installation**

Erect barricades to the satisfaction of the Architect. Barricades are to coincide with the diameter of the crown of the tree or, in the case of a shrub or small plant, are to be installed at a 1.0 metre radius (minimum) from the edge of the plant.

38.6 GRASS

a) **Generally**

The grass should be mown regularly during the growing season. In the dry season mow to 50 mm in length and in the wet season mow to 25 mm in length. Weed the grass regularly to prevent it being choked with weeds. The edges of the lawn must be trimmed and kept tidy to prevent the grass creeping into shrub beds.

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b) **Fertilization**

Grass must be fertilized regularly for a good lawn to be maintained.

c) **Top Dressing**

Apply in April after the first rains, apply a top dressing of 4 parts red top soil and 1 part dry, well-rotted manure (well mixed together) to the lawn to a depth of 13 mm. Rake top dressing over lawn and use it to fill in any uneven patches. If there is no rain, water heavily after application. Repeat top dressing application in October after the start of the rains.

d) **Compound Fertilization**

In June/July, apply a compound chemical fertilization (20-10-10). This can be done by hand at the rate of 30 grammes per square metre.

e) **Ammonium Sulphate**

Every 2-3 months (in between top dressings and compound fertilization apply Ammonium Sulphate at a rate of 15 grammes per square metre. Water thoroughly after application. Heavy watering after application of fertilizer is essential to prevent "burning".

f) **Aeration**

Apply a layer of course sand 6 mm deep in March to improve aeration. Spike the lawns with a garden fork or a spiked roller to aerate the lawn. Excavations should be spaced 100 mm apart throughout the lawn. Do not spike in very wet weather or in very dry weather.

g) **Watering**

Water very heavily once a week in dry weather.

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PART 38: LANDSCAPING

38.7 **SHRUBS**

a) **Generally**

Weed all shrub beds regularly, every two weeks. Inspect all shrubs every two weeks for pests and diseases. Do not fertilize newly planted shrubs for three months. Remove ground cover plants from around the base of shrubs to avoid strangulation.

b) **Fertilization**

Fertilizer shrubs three times a year starting three months after planting. Alternate major fertilization with manure and compound fertilizer; manure fertilization. In April and in October, apply 6 mm of well rotted manure to all shrub beds. Water well after application.

c) **Compound Fertilization**

In July and January, apply 15 grammes of 2ON-1OP-10K compound chemical fertilizer to each shrub around the stem and 15 grammes of bone meal. Lightly fork the fertilizer into the soil without disturbing the roots. Water well after applications. Minor fertilisation: once a month apply BAYFOL and/or WUXAL forlio feed to all plants. This is applied as a spray and should be done before 9.00 a.m. and after 4.00 p.m. on dry days.

d) **Watering**

All shrubs should be watered very well (soaked) 1-2 times a week in the dry season. Use a sprinkler (not a hose as this can cause soil erosion).

e) **Pruning**

Prune only when necessary. Many shrubs need never be pruned (e.g. Gardenia), others become straggly and need annual pruning (e.g. Poinsettia, Buddleia, Steptoselen, Hydrangea). Some shrubs require light pruning throughout the year to maintain a good shape (e.g. Abulition). Some shrubs can tolerate drastic pruning (e.g. Pride of India, Fibouchina Bougainvillaea).

Lightly prune shrubs to encourage growth and improve shape. Shrubs should never be repeatedly and drastically pruned to "stunted balls" as this not only destroys the natural form of the plant but also discourages flowering.

Arbrex, a pruning compound, must be applied to all cut stems after pruning. This also should be applied to roses, trees and any shrubs which have been pruned.

SPECIFICATIONS: LANDSCAPING

PART 38: LANDSCAPING

f) **Mulching**

Rake up leaves which fall on the lawns and use these as a mulch on all the shrub beds. Make sure that only the leaves are placed in the shrub beds and no branches as this will attract white ants. Apply the dead leaves to the shrub beds to a depth of 100 mm. The leaves will act as a mulch; it will provide humus to the soil, prevent weed and help retain moisture in the soil.

SECTION A

GENERAL RULES

Bills of Quantities A1 Bills of Quantities shall fully describe and accurately represent the works to be executed. Work which cannot be measured accurately shall be described as provisional or give in a bill of approximate quantities.

Measurements A2

(a) Work shall be measured net as fixed in position and each measurement shall be taken to the nearest 10 mm (i.e. 5 millimeters and over shall be regarded as 10 millimeters less than 5 millimeters shall be disregarded). This rule shall not apply to any dimensions stated in descriptions.

(b) Where minimum deductions of voids are dealt with in this document they shall refer only to openings or wants which are wholly within the boundaries of measured areas. Openings or wants which are at the boundaries of measured areas shall always be the subject of deduction irrespective of size.

Description A3

(a) The order of stating dimensions in descriptions shall be consistent and generally in the sequence of length, width and height. Where that sequence is not appropriate or where ambiguity could arise, the dimensions shall be specifically identified.

(i) Labour and all costs in connection therewith

(ii) Materials, goods and all costs in connection therewith (e.g. conveyance, delivery; unloading; storing; returning packings; handling; hoisting; lowering).

(iii) Fitting and fixing materials and goods in position.

(iv) Use of plant

(v) Waste of materials

(vi) Square cutting

(vii) Establishment charges, overhead charges and profit

(c) Junctions between straight and curved work shall in all cases be deemed to be included with the work in which they occur

(d) Notwithstanding the provisions in this document for labours to be given as linear items, such labours may be given in the descriptions of any linear items of work in which they occur.

(e) Notwithstanding the provisions in this document for labours to be enumerated, such labour may be given in the description of any enumerated item of work on which they occur.

(f) Labours on existing work shall be so described.

Grouping of sizes A4 Where this document requires the sizes of pipes and tubes (measured internally) and bars, cables, conduits, standards and the like (measured externally) to be stated in accordance with this clause they shall be grouped and described as follows:-

(i) Small (i.e. not exceeding 55 millimeters diameter)

(ii) Large (i.e. over 55 millimeters but not exceeding 110 millimeters diameter).

(iii) Extra large (i.e. over 110 millimeters diameter).

Small quantities narrow widths Short lengths A5 All small quantities narrow widths and short lengths shall bee deemed to be included with the work in which they occur.

Quantities A6 (a) Where the unit of billing is the meter, quantities shall be billed to the nearest whole unit. Fractions of a unit less than half shall be disregarded and all other fractions shall be regarded as whole units.

(b) Where the unit of billing is the kilogramme, quantities shall be billed to the nearest whole unit. Fractions of a unit less than half shall be disregarded and all other fractions shall be regarded as whole units.

(c) Where application of this Clause would cause an entire item to be eliminated such item shall be enumerated stating the size or weight as appropriate.

Provisional or in prime cost sums A7 Where this document requires provisional or prime cost sums to be given accordance with this Clause, the choice of term shall be made in conformity with the following definitions unless otherwise provided in the conditions of contract:-

(i) The term “provisional sum” shall mean a sum provided for work or services to be executed by a nominated sub-contractor, a statutory authority or a public undertaking or for materials or goods to be obtained from a nominated supplier. Such sum shall be deemed to be exclusive of any profit required by the general contractor and provision shall be made for the addition thereof.

(ii) The term “prime cost sum” shall mean a sum provided for work or services to be executed by a nominated sub-contractor, a statutory authority or a public undertaking or for materials or goods to be obtained from a nominated supplier. Such sum shall be deemed to be exclusive of any profit required by the general contractor and provision shall be made for the addition thereof.

Work under water	A8	Work executed in or under water shall be so described stating whether canal, river or sea water and (where applicable) the levels of high and low water.
Work in compressed	A9	Work executed in compressed air shall be so described stating the pressure and the methods of entry and exit.

SECTION B

PRELIMINARIES

PRELIMINARY PARTICULARS

Name of parties	B1	The names and addresses of the employer, the architect and the quantity surveyor shall be stated.	
Description of site	B2	(a)	The position of the site shall be described stating the mode of access. Attention shall be drawn to any limitations of working space and to any adjacent or abutting buildings.
		(b)	Recommendations as to visiting the site and inspection of any trial holes shall be made stating where the keys may be obtained (if any required) and where the drawing sand other documents may be given.
		(c)	Where any restrictions are imposed on the use or disposal of any sand or gravel found on the site, particulars of the restrictions shall be given.
		(d)	Where possession of the site will be given in sections, particulars shall be given.
Description of the Works	B3	(a)	A general description of the works shall be given.
		(b)	Where drawings are not supplied with the Bills the size of the building, the height above and below ground level and the number of storeys shall be given. Where the works are required to be executed or completed in any specific order or in sections or phases particulars shall be given.

CONTRACT PARTICULARS

Contract particulars	B4	(a)	Particulars of the form and type of contract shall be given.
		(b)	Where the conditions of contract are standard (i.e. printed and published for general use), particulars of the edition to be used shall be given and a schedule of the clause headings shall be set out in the bill.
		(c)	Where any other conditions of contract are used, a copy of the full conditions shall be supplied with the bill and a schedule of the clause headings shall be set out in the bill.
		(d)	Where there is an appendix to the condition of contract requiring insertions to be made, a schedule of the insertions shall be set out in the bill.

GENERAL MATTERS

Items for convenience in pricing

B5 For convenience in pricing, items for the following shall be given where applicable unless they are covered by the schedules given in accordance with Clause B4 hereof.

(i) Plant, tools and vehicles

(ii) Safety, health and welfare of work people

(iii) Notice and fees to local authorities and public undertakings

(iv) Setting out the works

(v) General foreman

(vi) National insurances and pensions for work people

(vii) Holidays for work people

(viii) Transport for work people

(ix) Safeguarding the works, materials and plant against damage and theft

(x) Maintenance of public and private roads

(xi) Police regulations

Obligations imposed by the employer

B6 Any obligation or restriction that may be imposed on the contractor by the employer in respect of any matter not covered by any clause in the conditions of contract shall be given as an item stating the relevant particulars.

Water for the works

B7 Water for the works and temporary arrangements for storing and distributing shall be given as an item. Where water will be supplied free of cost to the contractor, particulars shall be given as to the available capacity, the source (e.g. public main; bore hole) and the location of the point of free supply.

Lighting and power for the works

B8 and for lighting of hoardings and the like shall be given as an item Where lighting and power for the works and temporary arrangements for distribution electric current will be supplied free of cost to the contractor particulars shall be given as to the available capacity for voltage, type of supply (e.g. alternating; direct) and the location of the point of the free supply.

Contractor's liability

B9 (a) The contractor's liability for risk of injury to persons and property and of damage to the works shall be given as an item unless it is covered by the schedules given in accordance with Clause B4 hereof.

(b) Where the employer requires the contractor to effect insurance in respect of the contractor's liability for any such risk, the relevant particulars shall be given unless covered by the schedules given in accordance with Clause B4 hereof.

(c) Where the employer intends to relieve the contractor of liability for any such risk, the relevant particulars shall be given unless covered by the schedules given in accordance with B4 hereof.

Employers liability	B10	Where the cost of insuring any liability of the employer is required to be included in the contract sum such cost shall be given as a provisional or prime cost sum as Clause B4 hereof.

TEMPORARY WORKS

Temporary works generally	B11	Clearing away temporary works and making good after shall be deemed to be included with the items.
Temporary roads	B12	Temporary roads, tracks, hard-standings, crossings and the like shall be given as an item stating the relevant particulars.
Temporary buildings other	B13	(a) Temporary sheds, offices, mess rooms, sanitary accommodation and temporary buildings for the use of the contractor shall be given as an item. Lighting, furniture, equipment and attendance shall be deemed to be included with the item. (b) Temporary offices for the use of the architect, the quantity surveyor, the clerk of works and any other person acting on behalf of the employer shall be given as an item stating the floor area required. Lighting, furniture, equipment and attendance shall be given in the description.
Temporary telephones	B14	Temporary telephone facilities on the site shall be given as an item.
Temporary screens	B15	Temporary screens and the like shall be given as an item stating the area and any requirements regarding construction. Doors and windows in screens shall be given in the description.
Temporary hoardings and gantries	B16	(a) Temporary fencing, hoardings, fans, planked footways, guard-rails, gantries and the like as may be necessary for protecting the public, for the proper execution of the works and for meeting the requirements of any local or other authority shall be given as an item stating any conditions imposed by the employer regarding such matters as construction, access, decoration and advertisement. (b) Such temporary works specifically required by the employer shall be given as items stating all relevant particulars.
General scaffolding	B17	General scaffolding for the works shall be given as an item.

WORKS BY PUBLIC BODIES

Works by public bodies	B18	Works which may only be carried out by a local authority or a public undertaking (e.g. taking up and relaying public roads and footpaths; forming permanent crossings) shall each be given separately as a provisional or prime cost sum as Clause A7 hereof.

WORKS BY NOMINATED SUB-CONTRACTORS

Works by nominated sub-contractors	B19	(a)	Works which are required to be carried out by a nominated sub-contractor shall be given as a provisional or prime cost sum as Clause A7 thereof.
		(b)	Attendance on nominated sub-contractors shall be given as an item in each case and shall be deemed to include only allowing use of standing scaffolding, mess rooms, sanitary accommodation and welfare facilities, providing space for office accommodation and for storage of plant and materials; providing light and water for the work; clearing away rubbish. Special attendance shall be given as an item in each case giving particulars (e.g. unloading; storing; hoisting; placing in position; providing power; providing special scaffolding).
		(c)	Builder's work in connection with works by nominated sub-contractors shall be given in accordance with the appropriate rules in this document. It is desirable for such work to be grouped together under a heading in each appropriate section of the bill.

GOODS AND MATERIALS FROM NOMINATED SUPPLIERS

Goods from nominated suppliers	B20	(a)	Goods and materials which are required to be obtained from a nominated supplier shall be given as a provisional or prime cost sum as Clause A7 hereof.
		(b)	Fixing only goods and materials shall be given in accordance with the appropriate rules in this document. Unloading, storing, hoisting the goods and materials and returning pacing materials to the nominated supplier carriage paid and obtaining credits therefore shall be deemed to be included with the items of fixing only. Where the costs of conveying goods and materials to the site, any special packing or the like are required to be paid by the contractor, particulars shall be given.

PROTECTING AND CLEANING THE WORKS

Protection of the the works	B21	Protection of the works shall be given as an item covering all sections of works
Removing rubbish and cleaning	B22	Removing rubbish and debris and cleaning the works internally and externally shall be given as an item.

CONTINGENCIES

Contingencies	B23	Provision for contingencies shall be given as a provision sum as Clause A7 hereof.

SECTION C

DEMOLITIONS AND ALTERATIONS

GENERALLY TO SECTION C

C1 (a) The location of demolitions and alterations shall be given in the description of the items.

(b) Shoring and scaffolding incidental to demolitions and alterations shall be given in the description of the items. Other shoring (e.g. to old buildings left standing) shall be given in accordance with Clause C10 hereof.

(c) Old materials arising from demolition and alterations shall become the property of the contractor unless otherwise stated. Clearing away such old materials shall be deemed to be included with the items. Provisions shall be made in the bill for credits.

(d) Old materials required to remain the property of the employer shall be so described. Setting aside and storing such old materials on site shall be given in the description of the items.

(e) Old materials permitted to be re-used in work measured as new shall be so described. No adjustment shall be made to the measured quantities of new work in which such old materials are re-used.

DEMOLITIONS

Demolitions C2 (a) Demolishing individual structures (or parts thereof) shall be given as items, except the clearing of the site of all structures may be given as an item. The lowest level of the demolition shall be stated (e.g. down to the top of surface concrete at the lowest floor level).

(b) Leaving parts of old walls temporarily in position to act as buttresses shall be given in the description of demolition items.

ALTERATIONS

Alterations generally C3 Alteration work which would be most conveniently priced on the site shall be grouped together and given under an appropriate heading.

Cutting openings C4 Cutting openings in old structures shall be given as items stating the nominal finished size of the opening, the type and thickness of the old structure and the treatment around the opening (e.g. inserting trimmers, lintels arches, sills and the like; building up jambs). Extending finishing and making good all work disturbed shall be given in the description. New doors, windows and the like shall be measured in detail in accordance with the Appropriate rules.

Blocking up openings C5 Blocking up openings in old structures shall be given as items stating the size of the opening and the nature and thickness of the new work. Taking out thresholds lintels, arches, sills and the like, bonding or otherwise securing the new work to the old structure, extending finishing on the new work and making good all work disturbed shall be given in the description.

Pulling down parts of structure	C6	Pulling down walls, partitions, floors, roofs, staircases and other parts of old structures shall be given as items. Where practicable quantities and dimensions shall be given in the description.
Taking down fittings and fixtures	C7	Taking down fittings and fixtures (e.g. doors; windows; sanitary appliances; counters; cupboards) shall be given as items stating the size. Those required to be set aside for re-fixing shall be so described.
Re-fixing fittings and Fixtures	C8	Repairing, adapting and re-fixing old fittings and fixtures shall be given as items stating the size.

SUNDRIES

Temporary screens and temporary roofs	C9	Temporary screens and temporary roofs shall each be given separately in square meters or enumerated as may be appropriate. Weatherproof and dustproof screens shall be so described. Temporary arrangements for dealing with rainwater, temporary doors, temporary windows and the like in screens shall be given in the description. Clearing away temporary work shall be deemed to be included with the items.
Shoring	C10	Timber shoring (other than that incidental to demolitions and alterations) shall be given in linear meters, stating the nominal size, the position and type of shoring and the nature of the structure to be shored. Erecting, maintaining, clearing away, making good all work disturbed, obtaining licenses, paying fees and providing all necessary nails, wedges and bolts shall be deemed to be included with the items.

SECTION D

EXCAVATION AND EARTHWORK

The Unit of Billing shall be the Meter

GENERALLY TO SECTION D

D1 (a) Any information available concerning the nature of the ground and strata shall be given. Attention shall be drawn to any open trial holes on site.

(b) Work in existing buildings shall be so described. Handling materials and getting them in or out of such buildings shall be deemed to be included with the items.

SITE PREPARATION

Site Preparation Generally

D2 (a) Anti termite treatment to sub-soil or filling shall be given in square meters.

(b) The removal of termites' nests shall be given as an item and the method of destruction of the termites shall be stated. Alternatively, this item may be given in the description of excavations.

Preserving vegetable soil

D3 Excavating vegetable soil which is to be preserved shall be given in square meters stating the average depth. Soil deposited on site in permanent spoil heaps or spread on site shall be so described stating the location of such deposits or the average distances from the excavation in linear meters or kilometers.

Removing trees and hedges

D4 (a) Cutting down trees and grubbing up their roots shall be enumerated. Trees not exceeding 600 millimeters girth (measured at a height of 1 meter above ground) shall be grouped together and described as small trees, those over 600 millimeters girth shall be classified and given in further stages of 300 millimeters

(b) Cutting down hedges and grubbing up their roots shall be given in linear meters stating the nature and height of each hedge or its location.

(c) Clearing site of bushes, scrub, undergrowth and the like and grubbing up their roots shall be given in square meters or hectares. Alternatively, this may be given as an item stating the approximate area. Cutting down trees not exceeding 600 millimeters girth within such areas and grubbing up their roots may be given in the description, but cutting down larger trees shall be dealt with in accordance with paragraph (a) of this clause.

EXCAVATION

Excavation generally

D5 (a) The quantities given for excavating and subsequent disposal shall be deemed to be the bulk before excavating and no allowance shall be made for any subsequent variations in bulk. No allowance shall be made for any extra space required to accommodate planking and strutting.

(b) Getting out excavated materials by any means necessary shall be deemed to be included with the items of excavation. Subsequent disposal of excavated material shall be given in accordance with Clause D15 hereof (except as otherwise provided in Clause D11)

(c) Excavating in running silt or running sand (grouped together) shall be given in cubic meters as extra over all kinds of excavation irrespective of depth.

(d) Excavating in rock shall be given in cubic meters as extra over all kinds of excavation irrespective of depth. Rock defined as any material met with in excavation which is of such size or position that it can only be removed by means of wedges, compressed air plant, other special plant, or explosives.

(e) Where the depths of excavation are required to be stated in accordance with this rule, they shall be grouped and given in successive stages of 1.50 meters (e.g. not exceeding 1.50 meters deep; over 1.50 meters but not exceeding 3 meters deep).

Excavation Generally

(f) Allowances for working space (which shall not be subject to adjustment if more or less space is actually required) shall be made in the measurements of excavations as follows:-

(i) 1 meter from the face of any work which requires formwork over 1 meter high occurring below the starting level of excavation or from the external face of any work which will be covered externally with a damp-proof covering occurring at any depth below the starting level of excavation, or from the external face of any work which requires workers to operate from the outside at any depth below the starting level of excavation

(ii) 0.30 meter from the face of any work which requires formwork not exceeding 1 meter high occurring below the starting level of excavation.

(iii) 2 meters extra length at each end of trenches which are to receive post-tensioned concrete ground-beams.

Surface excavation D6 Excavation surfaces over 300 millimeters deep to reduce levels shall be given in cubic meters. Such work not exceeding 300 millimeters deep shall be given in square meters stating the average depth.

Cuttings D7 Excavating cuttings shall be given in cubic meters.

Basements D8 Excavating basements and the like (measured to the outside of the foundations subject to Clause D5(f) hereof) shall be given in cubic meters stating the starting level and the depth as Clause D5(e) hereof. Existing voids shall be deducted.

Foundation to trenches D9 Excavating trenches to receive foundations (measured the width of foundations subject Clause D5(f) hereof), shall be given in cubic meters stating the starting level and the depth as Clause D5(e) hereof. In the case of trenches over 1 meter deep the minimum width measured shall be 1 meter for the depth of the trench down to the top of the concrete foundation, thereafter the width measured shall be the net width of the concrete foundation therein. Preliminary trenches for basement retaining walls which are constructed before the basements are excavated shall be so described. No distinction

shall be made between surface trenches and basement trenches. For pipe trenches and the like see Clause D11 hereof. .

Pits D10 Excavating pits to receive bases of stanchions, isolated piers and the like (measured the size of the bases therein subject to Clause D5(f) hereof) and grouped together shall be given in cubic meters stating the starting level and the depth as Clause D5(e) hereof. In the case of pits over 1.50 meters deep the minimum size measured on plan shall be 1.50 meters in each direction measured down to the top of the concrete base. Thereafter the net size of the concrete base shall be measured. No distinction shall be made between surface pits and basement pits.

Pipe trenches and the like D11 Excavating trenches to receive service pipes, cables, kerbs and the like shall be given in liner meters stating the starting level and the average depth to the nearest 250 millimeters. Filling in, compacting, grading bottoms and disposing of surplus spoil shall be given in the description of such trenches.

Breaking up concrete and the like D12 Breaking up concrete, reinforced concrete work and the like me t with in excavation shall each be given separately in cubic meters as extra over all kinds of excavation irrespective of depth.

Breaking up paving and the like D13 Breaking up surface concrete, reinforced surface concrete, paving tarmacadam and the like on the surface of the ground shall each be given separately in square meters stating the thickness and the method of disposal. Alternatively, breaking up such hard materials on the surface may each be given in square meters as extra over excavation.

Existing cesspits D14 Clearing out and removing contents of cesspits shall be enumerated stating the method of disposal.

Disposal of excavated Materials D15

(a) Multiple-handling of excavated materials and transporting about the site as necessary shall be deemed to be included with the items of final disposal. Multiple-handling which is specifically required shall be given in the description of disposal items.

(b) Earth fillings shall be measured as equal to the void to be filled. Any thickness stated shall be deemed to be measured after compacting.

(c) Earth backfilling shall be given in cubic meters except as otherwise provided in Clause D11 hereof.

(d) Earth filling in making up levels over 300 millimeters thick shall be given in cubic meters. Such work not exceeding 300 millimeters thick shall be given in square meters stating the average thickness.

(e) Earth filling required to be deposited and compacted in layers shall be so described stating the maximum thickness of the layers.

(f) Surplus spoil shall be given in cubic meters. Spoil deposited on site in permanent spoil heaps or spread on site shall be so described stating the location of such deposits or the average distance from the excavation in linear meters of kilometers. Spoil removed from the site shall be described and the provision of a chute, dump or tip shall be deemed to be included with the items unless otherwise stated.

Surface treatments	D16	(a)	Treating the surface of the ground or the surface of filling or the bottom of excavation (e.g. grading to falls, grading to cambers, blinding) shall be given separately in square meters. Alternatively, such treatment may be given in the description of any superficial item of excavation, earth filling, hardcore filling, concrete or paving. Leveling and normal compacting are deemed to be included.
		(b)	Compacting which is required to be carried out by specific means shall be appropriately described.
		(c)	Any special treatment to bottoms of excavations in rock shall be described
		(d)	Trimming sides of cutting and sides of embankments to slope shall each be given separately in square meters.
		(e)	Trimming sides of excavations in rock to produce fair faces shall be given in square meters.
Soiling seeding planting and turfing	D17	Soiling, seeding, planting, fertilizing and turfing to surfaces shall each be given separately in square meters stating the thickness of soil and the quantity per square meter of the seed, plants or fertilizer.	

DISPOSAL OF WATER

Disposal of water	D18	(a)	Keeping excavations free from water (i.e. all water except spring or running water) shall be given as an item. Alternatively, this item may be given in the description of excavation.
		(b)	Keeping excavations free from spring or running water shall be given as a provisional or prime cost sum as Clause A7 hereof or as a provisional number of actual pumping hours for the different classes of pumps likely to be required.
		(c)	Providing pumps and other equipment, power and attendance for pumping and standing time shall be deemed to be included with the items.

PLANKING AND STRUTTING

Planking and strutting generally	D19	Planking and strutting shall be deemed to mean providing everything requisite to uphold the sides of excavation by whatever means are necessary (other than special shoring or steel sheet piling) and shall be given as an item or shall be included in the description of excavation.

HARDCORE FILLING

Hardcore filling	D20	(a)	Hardcore filling shall be measured as equal to the void to be filled. Any thickness stated shall be deemed to be measured after compacting.

(b) Hardcore filling in making up levels over 300 millimeters thick shall be given in cubic meters. Such work not exceeding 300 millimeters thick shall be given in square meters stating the average thickness.

(c) Hardcore filling required to be deposited and compacted in layers shall be so described stating the maximum thickness of the layers.

(d) Treating the surface of the hardcore shall be given in accordance with Clause D16(a) and (b) hereof.

(e) Hand-packing hardcore to form vertical or battering face over 300 millimeters wide shall be given in square meters. Such work not exceeding 300 millimeters wide shall be given in linear meters stating the width.

(f) Forming sinkings in hardcore shall be given in linear meters stating the size.

SECTION E

PILING

The Unit of Billing be the Meter

GENERALLY TO SECTION E

E1 (a) Any information available concerning the nature of the ground and strata shall be given stating whether the surface is level or irregular. Attention shall be drawn to any available records of bores on the site.

(b) Work near rivers or tidal waters shall be so described stating the level of the ground in relation to high-water mark, low-water mark and the Ordnance datum. Attention shall be drawn to any available records of the highest flood-water level in the locality.

(c) Providing and assembling the piling equipment on the site and its subsequent removal shall be given as an item. Moving the piling frames about the site, raising and lowering them and providing any necessary staging or barges to support them shall be deemed to be included with the item.

(d) A general description of the piling operations shall be given as an item stating the approximate level or levels at which the piling frames will operate (e.g. ground level; reduced level; basement level).

(e) Extra excavation (where necessary in order to place the hammer over any pile situated in an angle or similar position), together with any necessary filling and ramming afterwards, shall be given in detail or as provisional items.

WOOD OR CONCRETE PILES

Wood or concrete piles Generally

E2 Designs for piles shall be deemed to be provided by the employer. Piles required to be designed by the contractor shall be given in accordance with Clause E7 hereof.

Wood piles

E3 (a) Supplying wood piles shall be given in linear meters stating the nominal size. Those over 10 meters long shall be so described stating the length in further stages for 3 meters.

(b) Pointed ends of piles shall be enumerated as extra over the piles on which they occur. Where shoes are fitted they shall be given in the description stating the weight.

(c) Handling, transporting and pitching piles shall be enumerated stating the size the length and whether single or in clusters.

(d) Driving piles (measured from the shoe point in contract the ground when pitched to the shoe point when driven) shall be given in linear meters stating the set required and any limitation on the method of driving. Driving piles on rake and driving piles in water shall each be so described.

		(e)	Cutting off the tops of piles to required levels and ringing with steel bands shall be enumerated as extra over the piles concerned stating the size of the cross-section of the band. Cutting under water shall be so described stating the depth below the water level.
Cast concrete piles	E4	(a)	Supplying cast concrete piles shall be given in linear meters stating the nominal size and the number. Moulds shall be deemed to be included with the items. Piles required to be cast other than on the site and subsequently transported to the site shall be so described.
		(b)	Bar reinforcement shall be given in accordance with the rules for reinforced concrete in Section F hereof.
		(c)	Heads and shoes shall each be enumerated as extra over the piles to which they are fitted stating the weight. Rock-shoes shall be so described.
		(d)	Handling, transporting and pitching the piles shall be enumerated stating the size, the length and whether single or in clusters.
		(e)	Driving piles shall be given in accordance with Clause E3(d) hereof.
		(f)	Cutting off the tops of piles to required levels and preparing the reinforcement shall be enumerated as extra over the piles concerned. Cutting under water shall be so described stating the depth below water level.
		(g)	Lengthening piles in position shall be given in detail. Connections shall be enumerated. Re-driving lengthened piles shall be given in linear meters stating the number.
Bored piles	E5	(a)	Boring pile holes and filling bores with concrete (measured as one item) shall be given in linear meters stating the size and number of bores and the mix of concrete filling.
		(b)	Where bored piles are required to finish below the formation level of the ground, an additional item of blind boring shall be given in linear meters stating the size of the bore.
		(c)	Bar reinforcement shall be given in accordance with the rules for reinforced concrete in Section F hereof.
		(d)	Disposal of spoil from the bores shall be given in accordance with the rules for disposal of excavated materials in Section D hereof.
Trial piles	E6	(a)	Trial piles shall be enumerated stating the location, length and nominal size of the pile, the length of driving and the method of testing. Any necessary pointed ends, shoes, heads and reinforcement shall be given in the description.

CONTRACTOR-DESIGNED CONCRETE PILES

Contractor-designed Concrete piles	E7	(a)	Contractor-designed concrete piles shall be enumerated stating the actual length, the superimposed load to be carried and the method of disposing of any spoil. Particulars shall be given of any restrictions regarding the type of pile or the method of driving. Any necessary reinforcement in piles shall be deemed to be included.
		(b)	Where the tops of piles are required to finish below the formation level of the ground, the piles shall be so described stating the depth of the top below such level.

STEEL SHEET PILING

Steel sheet	E8	(a)	Steel sheet piling (measured the area as placed in position taken on the centre line of the piling) shall be given in square meters stating the nominal size of such unit and the thickness or substance of the metal. Sheet piling over 10 meters long shall be so described stating the length in further stages of 3 meters. Handling, transporting, pitching, strutting and waling shall be given in the description.
		(b)	Driving steel sheet piling (measured from the formation level of the ground to the bottom edge of the sheet when driven) not exceeding 6 meters deep shall be given in square meters. Driving over 6 meters deep shall be given in square meters stating the depth in further stages of 3 meters. Driving in water shall be so described. Withdrawing steel sheet piling shall be given in the description of driving.
		(c)	Corner piles and junction piles shall each be given in linear meters as extra over the sheet piling in which they occur.
		(d)	Cutting or burning through steel sheet piling shall be given in linear meters as extra over the piling concerned. Cutting under water shall be so described stating the depth below water level.

SECTION F

CONCRETE WORK

The Unit of Billing shall be the Meter except where the Unit is required to be the Kilogramme

GENERALLY TO SECTION F

F1 (a) Particulars of the following shall be given:

i. Kind and quality of materials for concrete

ii. Any tests of the materials

iii. Any tests of the finished work

iv. Composition and mix (or strength requirements) of the concrete

(b) Concrete required to be placed by a particular method (e.g. poured at a stated speed shall be so described.)

(c) Concrete required to be consolidated by a particular method (e.g. mechanically tamped; vibrated) shall be so described.

(d) Concrete required to be cured by a particular method shall be so described.

(e) Curved labours on concrete shall be described irrespective of radius

(f) Labours on existing concrete shall be so described

(g) Concrete shall be measured as executed but no deduction shall be made for the following:-

i. Volume of any steel embedded in the concrete

ii. Voids not exceeding 0.10 square meters in work given in square meters

iii. Voids not exceeding 0.05 cubic meters in work given in cubic meters

PLAIN CONCRETE AND REINFORCED CONCRETE

Plain and reinforced concrete generally

F2 (a) Plain in-situ concrete shall be given under an appropriate heading.

(b) Reinforced in-situ concrete shall be given under an appropriate heading.

Foundations

F3 (a) Foundations to trenches shall be given in cubic meters (irrespective of thickness)

(b) Foundations to stanchions, columns and piers which are combined with foundations in trenches shall be classified as foundations in trenches.

(c) Foundations to stanchions, columns and piers which are isolated shall be grouped together and given in cubic meters.

(e) Ground beams and casings to steel ground beams shall each be given separately in cubic meters.

(f) Grouting under steel stanchion-bases and under steel grillages shall each be given separately in square meters stating the mix of the grout and the number of bases or grillages.

(g) Building in and grouting anchor bolts and the like shall be enumerated stating the length of the bolt in stages of 150 millimeters and the mix of the grout.

Machine bases F4 Machine bases shall be given in cubic meters.

Beds F5

(a) Beds over 300 millimeters thick shall be given in cubic meters. Those not exceeding 300 millimeters thick shall be given in square meters stating the thickness.

(b) Beds laid to slopes not exceeding 15 degrees from horizontal and those laid to slopes over 15 degrees from horizontal shall be so described.

(c) Beds laid in bays shall be so described stating the size of bays. Formwork between the bays shall be given in the description.

Roads, foot paths & pavings F6 Roads, footpaths and pavings shall each be so described and given in accordance with the rules for beds in Clause F5 hereof.

Floors, roofs F7

(a) Suspended floors, roofs and the like (measured over all bearings and grouped and the like together) shall be given in square meters stating the thickness. Those laid around or between steel filler joists (measured over the fillers) shall be so described. Classification shall be as follows:-

i. Horizontal

ii. Sloping not exceeding 15 degrees from horizontal

iii. Sloping over 15 degrees from horizontal

iv. Vertical

(b) Curved roofs, conical roofs, spherical roofs and elliptical roofs shall each be so described irrespective of radius. Haunchings shall be given in cubic meters.

(c) Tops and cheeks of dormers (grouped together) shall be given in square meters stating the thickness.

Walls F8

(a) Measurements of walls shall be taken between attached piers or pilasters. The thickness of attached piers or pilasters shall be taken as the combined thickness of the wall and the pier or pilaster. Attached or isolated piers, pilasters and the like (except where caused by openings) having a length on plan not exceeding four times the thickness shall be classified as columns. Those having

a length over four times the thickness and those caused by openings in walls shall be classified as walls.

(b) Walls over 300 millimeters thick shall be given in cubic meters. Those not exceeding 300 millimeters thick shall be given in square meters stating the thickness. Retaining walls shall be so described.

(c) Projections on walls (measured beyond the face of the wall) to form cornices, bands and the like (grouped together) shall be given in cubic meters

(d) Concrete fillings to cavities of hollow walls shall be given in square meters stating the thickness. Splaying the top edge shall be deemed to be included in the item.

Casings to steel work	F9	Casings to steel beams, lintels, stanchions and the like shall each be given separately in cubic meters. Floor beams and roof beams shall be measured below the slab. Projections shall be added to the appropriate items. Horizontal members and sloping members not exceeding 15 degrees from horizontal (grouped together) shall be so described. Sloping members over 15 degrees from horizontal (grouped together) shall be so described.
Beams and columns	F10	Beams, lintels, columns and the like shall each be given separately in cubic meters. Floor, beams and roof beams shall be measured below the slab. Projections shall be added to the appropriate items. Horizontal members and sloping members not exceeding 15 degrees from horizontal (grouped together) shall be so described. Sloping members over 15 degrees from horizontal (grouped together) shall be so described.
Steps and staircases	F11	(a) Steps, staircases and strings (grouped together) shall be given in cubic meters. (b) Solid balustrades and landings shall each be given separately in square meters stating the thickness.
Kerbs	F12	Kerbs may be given in cubic meters or in linear meters stating the size.
Finishes cast on to concrete	F13	Finishes (measured on the exposed face) which are cast on to the concrete by lining formwork with the required material (e.g. granolithic; cast stone; terrazzo; mosaic) shall be given in square meters as extra over the concrete describing the material and the thickness of the finish.
Labours on	F14	(a) Treating the surface of unset concrete over 300 millimeters thick (e.g. grading to falls: grading to cross-falls; grading to cambers; grading to slopes, tamping; trowelling) shall be given in square meters. Such treatments to the surface of unset concrete not exceeding 300 millimeters thick shall be given in the description. (b) Forming channels and chases in the surface of unset concrete shall be given in linear meters stating the shape, width and depth. Channels to falls shall be so described. Channels and chases requiring additional concrete shall be so describing stating the size of the additional concrete. Formwork shall be given in the description. Ends angles, intersections and outlets shall be given in the description.
Expansion joints in concrete	F15	Expansion joints in concrete where over 300 millimeters wide shall be given in square meters. Expansion joints of 300 millimeters wide and under shall be given in linear, meters stating the width. Formwork shall be given in the description.

REINFORCEMENT

Bar rein-

F16(a) Particulars of the following shall be given:-

i. Kind and quality of steel

ii. Any tests of the bars

iii. Any restrictions as to hot or cold bending

(b) Bar reinforcement (measured as executed) including links, stirrups, binders, special spacers and the like shall be given in kilogrammes stating the size. Bends, hooks, tying wire, distance blocks and ordinary spacers shall be given in the description. No allowance in calculating the weight of reinforcement shall be made for tying wire, ordinary spacers or rolling margin. Reinforcement shall not be classified as to location in the structure.

(c) Bars over 12 meters long shall be so described stating the length in further stages of 2 meters.

(d) Bars specially bent to curve shall be so described irrespective of radius

(e) Twisted bars or bars of special section shall be so described

(f) High-tensile steel bars shall be so described

Fabric reinforcement

F17 (a) Fabric reinforcement shall be measured as to area covered but no allowance shall and no deduction shall be made for voids not exceeding 1 square meter. Bends, wire and distance blocks shall be given in the description.

(b) Fabric reinforcement shall be given in square meters stating the mesh, the weight per 1 square meter and the minimum extent of side and end laps.

(c) Strips required to be in one width (e.g. in foundations under walls; in tension strips to floors and roofs) shall be given in linear meters stating the width, the mesh, the weight per 1 square meter and the minimum extent of end laps.

(d) Self-centering fabric reinforcement shall be so described. Temporary strutting shall be given in the description and when over 3.50 meters high shall be so described stating the height in further stages of 1.50 meters.

Labours on fabric rein-forcement

F18 (a) Raking cutting and curved cutting on fabric reinforcement shall each be given separately in liner meters stating the mesh and the weight of the fabric.

(b) Notching fabric reinforcement around obstructions shall be deemed to be included.

FORMWORK

Formwork generally F19

(a) Formwork shall be measured as the actual surfaces of the finished structure which require to be supported during the disposition of the concrete, including the upper surfaces of the work sloping more than 15 degrees from horizontal. Where the face of the concrete is troughed or similarly shaped, the method of measuring the formwork shall be stated. No allowance shall be made for overlaps and passing at angles and no deduction shall be made for the following:-

i. Voids not exceeding 1 square meter

ii. Intersections of main beams with walls or columns

iii. Intersections of secondary beams with main beams

(b) Battens, struts, reversed cut strings, bolting, wedging, easing, striking and removing shall be deemed to be included with the formwork.

(c) Formwork to curved surfaces, conical surfaces and spherical surfaces shall each be so described stating the radius. Formwork to elliptical surfaces and other surfaces curved to more than one radius shall be so described stating the radii. Curved linear items of formwork shall be so described irrespective of the radii.

(d) Coating formwork with a retarding agent shall be measured in square meters

(e) Formwork left in shall be so described

(f) Wrought formwork shall be so described or alternatively may be given as extra over formwork for wrought face. Any further treatment after removal of formwork to produce the required finish (e.g. rubbing down with carborundum) shall be included with such item of formwork and fully described.

(g) Formwork required to be lined with particular material (e.g. wallboard; hard board; plywood; paper) shall be so described. Lining material which is required to be left in position on the concrete shall be given separately in square meters stating the method of securing.

(h) Making good exposed faces of concrete after removal of sawn formwork (e.g. cutting off projecting ins; filling in small voids) shall be given in the description of the formwork.

Formwork to surfaces F20

(a) Formwork to surfaces (other than those mentioned in Clauses F21 to F23 hereof) shall be given in square meters. Classification of formwork shall be as follows:-

i. To horizontal soffites of floors, roofs, landings and the like (grouped together)

ii. To sloping soffites of floors, roofs, staircases and the like (grouped together)

iii. To sloping upper surfaces of floors, roofs and the like where more than 15 degrees from horizontal (grouped together)

iv. To vertical or battering sides of foundations, ground-beams, machine bases and the like (grouped together)

v. To vertical or battering sides of walls, solid balustrades and the like (grouped together)

vi. To vertical or battering sides of stanchion-casings, columns, piers, pilasters and the like (grouped together)

vii. To sides and soffites of openings in walls, recesses in walls, projecting panels on walls and the like (grouped together)

viii. To sides and soffites of dormers, gablets and the like (grouped together)

ix. To sides and soffites of horizontal beam-casings, beams, lintels and the like (grouped together)

x. To sides and soffites of sloping beam-casings, staircase-strings and the like (grouped together)

xi. To sloping upper surfaces of beam-casings, beams, staircase-strings and the like where more than 15 degrees from horizontal (grouped together).

(b) Formwork to soffites requiring strutting over 3.50 meters high shall be so described stating the height in further stages of 1.50 meters. Formwork to sides and soffites of beams occurring below slabs where strutting is measured in accordance with the preceding rule shall be given separately stating the same strutting height as the slab soffite.

(c) Formwork to soffites of solid concrete floors or solid roofs over 250 millimeters thick shall be so described

(d) Formwork to isolated beam-casings and isolated beams (i.e. detached from concrete floors or roof) shall be so described. Where soffites require strutting over 3.50 meters high the formwork shall be so described, including formwork to sides, stating the height in further stages of 1.50 meters.

Formwork to edges and risers

F21 (a) Formwork to edges shall be given in linear meters stating the width in stages of 75 millimeters. Classification shall be as follows:-

i. To edges of beds, roads, footpaths, pavings and the like (grouped together).

ii. To edges of suspended floors, landings and roofs (grouped together)

iii. To sides of kerbs and upstands (grouped together).

iv. To risers of steps and staircase (grouped together)

(b) Formwork to soffites of projecting eaves and hoods (grouped together) shall be given in linear meters, where not exceeding 300 millimeters wide in stages of 75 millimeters and in square meters where exceeding 300 millimeters wide.

Formwork to bands and cornices	F22		Formwork to projecting or sunk bands, cornices and the like (grouped together) shall be given in linear meters as extra over, the formwork in which they occur giving the size.
Formwork to grooves, chases chamfers and mouldings	F23	(a)	Formwork to throats, grooves, chases, rebates, chamfers over 50 millimeters wide, splayed internal angles over 25 millimeters wide, mouldings and the like shall each be given separately in linear meters stating the size. Plain stops shall be deemed to be included with the formwork but stops which are splayed or moulded shall each be enumerated separately. Stops shall be deemed to be included with the formwork.
		(b)	Forming chamfers not exceeding 50 millimeters wide and forming splayed internal angles not exceeding 25 millimeters wide shall be given in the description of the formwork.
Labours on formwork	F24	(a)	Raking cutting and curved cutting shall each be given separately in linear meters.
		(b)	Splayed edges and notches shall be deemed to be included with the formwork items.
		(c)	Cutting and fitting formwork around projecting members which will be cast in (e.g. pipes; continuity bars) shall be enumerated singly or in groups

PRECAST CONCRETE UNITS

Precast units generally	F25	(a)	Precast units shall be given under an appropriate heading.
		(b)	Particulars of the following shall be given:-
		i.	Kind, quality and size of reinforcement
		ii.	Shape of cross-section of unit
		iii.	Nature and extent of surface finish
		iv.	Composition and mix of jointing and bedding materials
		v.	Method of fixing
		(c)	Formwork or moulds for precast units shall be deemed to be included with the items.
		(d)	Precast units over 2 meters long shall be so described stating the number.
Structural Units	F26		Structural units (e.g. stanchions; beams; purlins; trusses) shall each be enumerated separately stating the size.
Steps and staircases	F27		Steps, landings, solid balustrade panels and the like shall each be enumerated separately stating the extreme size. Members of irregular shape shall be so described. Nosings, rebates, fair ends, returned ends, shaped ends, wall-holds and the like shall be given in the description.

Kerbs and edgings	F28	Kerbs, edgings and the like shall each be given separately in linear meters stating the size. Curved members shall be so described stating the mean radius. Fair ends, rounded ends, angles, intersections and the like shall each be enumerated separately when specially cast.
Shelves seats, duct covers sills lintels and copings	F29	Shelves, divisions, seats, duct covers, sills, lintels, copings and the like shall each be fully described and given separately in linear meters stating the size. Curved members shall be so described stating the mean radius. Notches, rounded corners, fair ends, stooled ends, returned ends, angles and the like shall be enumerate separately. Members of irregular shape shall each be enumerated separately stating the extreme size.
Templates and bases	F30	Templates (or padstones), bases to posts and the like shall each be enumerated separately stating the size.
Pier-caps and chimney-caps	F31	Pier-caps, chimney-caps and the like shall each be enumerated separately stating the size and the shape where other than rectangular. Openings in chimney-caps shall be given in the description.

HOLLOW BLOCK SUSPENDED CONSTRUCTION

Hollow block construction Generally

Hollow block suspended construction and formwork in contact therewith only shall be given under the appropriate heading.

Floors, roofs like — F33

(a) Suspended floors, roofs and the like (measured over the ribs and bearings and the grouped together) shall be given in square meters in accordance with Clause F7 hereof. Filling ends of hollow-blocks shall be deemed to be included with the items. Solid concrete work in hollow-block construction shall be deemed to be included with the item, alternatively, solid concrete work in hollow-block construction may be measure separately and so described. Particulars of the following shall be given:-

i. Composition and mix of concrete for ribs and topping

ii. Overall thickness of slab

iii. Size and type of blocks

iv. Distance between centers of rows of blocks

v. Size and type of slip tiles to soffites of concrete ribs between blocks.

vi. Finish to exposed soffites of blocks and slip tiles (e.g. plain; keyed).

(b) Tops and cheeks of dormers (grouped together) shall be given in square meters stating thickness.

Labours on hollow-block Construction — F34

Forming hips and valleys shall each be given separately in linear meters stating the thickness

Fixing slips and metals	F35		Fixing-slips, metal clips and the like shall each be enumerated separately stating the method of fixing
Formwork	F36		Formwork shall be given in accordance with Clauses F19 to 24 hereof.

PRESTRESSED CONCRETE

Prestressed concrete generally	F37	(a)	Prestressed concrete work (i.e. work where reinforcement is tensioned before or as the load is applied) and its reinforcement and associated formwork shall be given under an appropriate heading.
		(b)	A general description of the prestressed work and of the system and method of tensioning shall be given. Where special and complicated construction is involved drawings shall be provided.
		(c)	Particulars of the following shall be given:-
		i.	Steel wires and any preparatory treatment
		ii.	Type of jack to be used for tensioning
		iii.	Types of cones, wedges, anchor-plates, spacers, distance-pieces, and the like
		iv.	Amount of tension to be applied to wires
		v.	Number and diameter of wires to be simultaneously tensioned
		vi.	Whether wires to be pre-tensioned or post-tensioned or tensioned as the load is applied and whether from one or both ends.
		vii.	Maturity of concrete before pre-tensioning is released or post-tensioning is applied.
		viii.	Tests to be applied.
		ix.	Cutting off, sealing and treating the ends of wires and cables.
Structural in-situ members	F38	(a)	Structural in-situ members (e.g. beams; columns) shall be given in accordance with Clause F10 hereof.
		(b)	Members cast in section (i.e. not in one continuous operation) shall be so described stating the number and average length of the sections.
		(c)	Construction joints between sections shall be enumerated.
Cores, ducts recesses	F39	(a)	Forming and grouting or sealing the ducts or grooves shall be given in linear units and meters stating the number and the size. Particulars of the following shall be given:-
		i.	Sleeves or sheathing

ii. Temporary supports required in the formation of the ducts

iii. Composition of the grout

(b) Ducts or grooves over 6 meters long shall be so described stating the length in further stages of 3 meters

(c) Curved sleeves and curved sheathing shall each be so described irrespective of radius.

(d) Forming and grouting the air-holes at ends or sides of ducts shall be enumerated

(e) Fillings in the jacking or anchoring recesses shall be enumerated stating the finish to exposed surface of filling

Wires and cables F40 (a) Supplying steel wires or cables (measured between anchorages) shall be given in kilogrammes stating the ultimate strength and the size of the wire or cable. Each size shall be given separately. No allowance shall be made for extra lengths, in anchorages or elsewhere.

(b) Fixing each length of wire or cable shall be enumerated stating the length, the number of strands in each cable, the type of central core and the type of sheathing (if any) to the wires. Degreasing, straightening, cutting to lengths and assembling wires and cables shall be deemed to be included with the items.

(c) Cones, wedges, anchor-plates, spacers, distance-pieces and the like expendable items shall each be enumerated separately.

(e) Tensioning each length of wire or cable shall be enumerated stating the sequence. Cutting off ends of wires and cables shall be deemed to be included with the items.

Reinforcement F14 Reinforcement shall be in accordance with Clauses F16 to F18 hereof.

Formwork F42 (a) Formwork shall be given in accordance with Clauses F19 to F24 hereof, subject to the following:-

i. Any special requirements as to strutting and supports shall be stated

ii. Formwork to pre-tensioned and post-tensioned work shall each be so described

iii. Temporary restraints for tensioning and the like shall be given in the description of formwork

(b) Formwork to recesses for anchorages shall be enumerated stating the size and shape

(c) Formwork to temporary construction joints shall be enumerated stating the sections of the abutting units.

PRECAST PRESTRESSED UNITS

Precast prestressed units Generally F43

(a) A general description of the precast prestressed units and of the system and method of tensioning shall be given.

(b) Particulars of the following shall be given:-

i. Steel wires and other requirements as appropriate in accordance with Clause F37 (c) hereof.

ii. Shape of cross-section of unit

iii. Nature and extent of surface finish

iv. Composition and mix of jointing and bedding material

(c) Formwork or moulds for precast units and for forming anchorage pockets shall be deemed to be included with the items.

Precast units F44

(a) Precast units shall be enumerated stating the number, the size, the length, the height above ground and the method of fixing and bedding. Units of identical section but of varying lengths not exceeding 3 meters may be grouped together and the lengths averaged. Those over 3 meters long may be similarly grouped in further stages of 1.50 meters and the lengths averaged in each case. Those of unusual shape or cross-section shall be so described and sketches provided. Classification shall be as follows:-

i. Pre-tensioned in the mould

ii. Post-tensioned on he ground after casting

iii. Cast in section, assembled and post-tensioned after erection

iv. Post-tensioned after hoisting but capable of self-support

v. Post-tensioned after hoisting but requiring support until tensioning is completed.

(b) Construction joints between adjacent units shall be enumerated

(c) Temporary supports required for post-tensioned units classified under (iv) and (vi) of paragraph (a) hereof shall be enumerated stating the size and span of the unit and height of the support.

Cores, wires and reinforcement F45

Cores, ducts and recesses shall be given in accordance with Clause F39 hereof. Wires and cables shall be given in accordance with Clause F40 hereof. Reinforcement shall be given in accordance with Clauses F17 to F19 hereof.

SUNDRIES

Grinding and sand-blasting	F46	Grinding, sand-blasting, bush hammering, brushing to expose aggregate and like treatment to the face of concrete shall each be given separately, in square meters. Such work to soffites shall be so described.
Cutting grooves chases chamfers and the like	F47	Cutting grooves, chases, rebates, chamfers and the like shall each be given separately in linear meters stating the size. For such details produced by formwork see Clause F23 hereof.
Holes	F48	(a) Holes for pipes, tubes, bars, cables, conduits and the like members (grouped together) shall be enumerated stating the size of the member as Clause A4 hereof and the thickness of the concrete. Fixing pipe-sleeves shall be given in the description.
Mortices	F49	Mortices, sinkings and the like shall each be enumerated separately stating the purpose. Running mortices with lead or mortar shall be given in the description.
Making good	F50	Making good concrete in connection with holes and mortices shall be given in the description of such labours.

SECTION G

WALLING

The Unit of Billing shall be the Meter

GENERALLY TO SECTION G

Walling generally

G1 Walling shall consist of blocks or bricks laid in mortar (e.g. solid and hollow concrete blockwork; natural stone block walling; brickwork).

G2 Particulars of the following shall be given:-

i. Material, kind, type, finish and size of blocks or bricks. Purpose-made blocks or bricks shall be so described

ii. Any requirements as to the stone and the quarry

iii. Type of bond for brickwork

iv. Composition and mix or mortar for bedding and jointing

Measurement of walling

G3 (a) Walling shall be measured the mean length by the average height. No deductions shall be made for the following:-

i. Voids not exceeding 0.10 square meters

ii. Chases

iii. Flues, lined flues and flue-blocks where the voids and the work displaced do not together exceed 0.25 square meters in sectional area.

(b) All fair raking, fair splayed and fair curved cutting shall be given separately in linear meters and described. All other labours (except cutting chases as Clause G13 hereof) shall be deemed to be included.

(c) Labours on different kinds of work shall be given separately. Labours on existing work shall be so described.

(d) Curved work shall be so described, stating the mean radius. Rough cutting within the thickness (or the provision of curved bocks or bricks) shall be given in the description of curved work.

(e) Measurements of walls shall be taken through attached piers. Attached piers shall be given in linear meters as extra over the walling in which they occur stating the width of the pier and the projection from the face of the wall. Attached or isolated piers (except where caused by openings) having a length on plan not exceeding four times the thickness shall be classified as piers and those having a length over four times the thickness and those caused by openings shall be classified as walls.

Classification G4

(a) Walling shall be given in square meters stating the thickness. Classification shall be as follows:-

i. Walls

ii. Filling existing openings

iii. Skins of hollow walls

iv. Backings or facings stating the thickness. Any necessary cutting and bonding and wall ties shall be fully described

v. Battering walls (i.e. walls of uniform thickness built battering).

vi. Tapered walls of diminishing thickness from base to top stating the average thickness whether one or both faces are battered and the rate of batter

vii. Walling used as formwork. Temporary strutting shall be given in the description

(b) i. Providing special blocks with solid ends shall be given in linear meters as extra over the work in which they occur.

ii Filling ends of hollow blocks shall be deemed to be included

Cube walling G5

Walling in each of the following classes shall be given separately in cubic meters

i. Chimney breasts (measured through the full thickness of the walls to which they are attached)

ii. Chimney stacks

iii. Stepped footings

iv. Isolated piers and columns. Alternatively these may be given in linear meters stating the size. Walls having a length on plan not exceeding four times their thickness (except where caused by openings) shall be classified as isolated piers.

Projections G6

Walling in projections, bands, oversailing courses and the like (measured beyond the face of the wall) shall be given separately in linear meters stating the size.

Thicknessing G7

Walling of any thickness in each of the following classes shall be given separately in square meters stating the thickness. Cutting and bonding new to existing and extra material for bonding shall be given in the description stating any special method bonding. Classification shall be as follows:-

i. Thickening existing walls (measured beyond the face of the existing wall).

ii. Projections on existing walls (measured beyond the face of the existing wall) of attached piers, chimney breasts and the like.

Grooved blocks G8

Grooved blocks and bricks shall be given in square meters as extra over the walling in which they occur.

Flue lining	G9		Refractory brick linings to flues shall be given in square meters stating the thickness. Those bonded to surrounding walling shall be so described.
Glass blocks	G10	(a)	Glass blockwork in walls and panels shall be given in square meters stating the size and thickness of the blocks.
		(b)	Bedding the perimeter of glass blockwork in material different from the mortar shall be given in linear meters stating the width and the kind of bedding material.
Cavity walls	G11	(a)	Forming cavities in hollow walls shall be given in square meters stating the width of the cavity. Wall ties shall be given in the description stating the type and the disposition or number.
		(b)	Closing cavities at ends of hollow walls or at jambs of openings shall be given in linear meters stating the width of the cavity and the method of closing.
Eaves filling	G12		Walling in eaves-filling shall be given in linear meters as a labour and material item stating the thickness and maximum height of the filling and including the description of the cutting.
Chases	G13		Horizontal rough chases in new work for edges of floors, landings and roofs shall be deemed to be included with the walling. Other horizontal rough chases and all raking, vertical and curved rough chases shall each be given separately in linear meters stating the size.
Rough arches	G14		Rough arches (measured the mean length on face) shall be given in linear meters as extra over the walling in which they occur stating the thickness and the number of rings in the arches.
Bonding ends	G15		Bonding ends of new walling to other types of construction or to existing work shall be given in linear meters, stating the thickness of the walling. Forming pockets in new construction, cutting pockets in existing construction and material for bonding shall be given in the description.
Reinforced walls	G16		Particulars of reinforcement in walls shall be given in the description of the item concerned.

WALLING IN CONNECTION WITH BOILERS

Seatings and the flues	G17	(a)	Boiler seatings and boiler flues shall be given in detail in accordance with relevant Clauses hereof under an appropriate heading. Firebricks and fireclay work shall each be so described.
		(b)	Boiler-seating blocks and curved flue-covers shall each be given separately in linear meters stating the size. Pieces of irregular shape shall be enumerated stating the size.
Chimneys	G18		Chimney-shafts shall be given in detail in accordance with the relevant Clauses hereof under an appropriate heading stating the number, the size on plan, the shape and the overall height. Chimney-shafts of different shapes and heights shall each be given separately. Those required to be built from outside scaffolding shall be so

FACEWORK

Facework Generally	G19	(a)	The rules relating to facework shall apply equally to fair face
		(b)	Particulars of the following shall be given:-
		i.	Method and description of dressing or facing
		ii.	Kind and quality of facing blocks or bricks where different from those in the body of the work. Purpose made blocks or bricks shall be so described
		iii.	Size of facing blocks or bricks where different from those in the body of the work and the method of bonding such facings to the backing.
		iv.	Composition and mix of mortar for pointing where different from that in the body of the work.
		v.	Method and description of pointing.
		vi.	Type of bond for brickwork except in the case of fair face.
		(c)	Facework shall be measured on exposed faces and shall be given in square meters as extra over the walling in which it occurs. Curved facework shall be so described. Pointing shall be given in the description. Reveals, returns, softies, offsets, exposed edges around superficial items of sunk or projection work and the like shall be measured in square meters and added to the general facework.
		(d)	Deductions of facework shall be made for string courses, cills, lintels, plates and the like.
		(e)	Facework built overhand shall be so described
		(f)	Battered facework shall be so described stating the rate of batter
		(g)	Facework sunk or projecting shall be so described stating the depth or projection.
		(h)	Facework to vaulting shall be so described
Angles and to chases	G20	(a)	Fair vertical internal angles and fair vertical external angles shall be deemed be included with the facework.
		(b)	Fair chases of any description shall be given in linear meters stating the size.
Tile creasings	G21	(a)	Flush, sunk and projecting tile creasings shall each be given separately in linear meters as extra over the walling in which they occur stating the number of courses and the depth or projection. Horizontal, raking vertical and curved members shall each be so described.
		(b)	Fair ends and angles of any description are deemed to be included.

Quoins	G22	(a)	Facework of flush quoins formed with facing blocks or bricks which differ in kind or size from the general facings shall be given in linear meters (measured on the vertical angle) stating the average girth and the method of jointing between quoin and general facework.
		(b)	Facework to sunk and projecting quoins shall each be given separately in linear meters (measured on the vertical angle) stating the average girth, the depth or projection and the method of jointing between quoin and general facework.
		(c)	Cut and rubbed quoins shall be so described
		(d)	Tile insets in quoins and rustications in quoins shall be given in the description.
Arches	G23	Facework to arches (measured the mean length on face) shall be given in linear meters stating the width or face, the width of the exposed soffite and the outline of the arch. All fair cutting shall be deemed to be included.	
Tumblings of Buttresses	G24	Facework to tumblings of buttresses shall be enumerated stating the size.	
Walling faced or fair on both sides	G25	(a)	Stone walling faced both sides built with blocks extending the full thickness of the wall shall be given separately in square meters.
		(b)	Half-brick walls and one-brick walls built fair both sides or entirely of facings shall each be given separately in square meters.
		(c)	Fair returns (e.g. ends of walls, reveals of openings) shall be given in square meters and so described.

BRICK FACEWORK

Angles	G26	Purpose-made bricks to form bull-nosed, squint, birdsmouth or moulded angles and the like shall be given separately and so described.	
Band courses	G27	(a)	Facework to all sunk and projecting plain bands not exceeding 300 millimeters and flush plain bands formed with facing bricks which differ in kind or size from the general facings shall be given in linear meters stating the width of the band and the depth or projection. Horizontal, raking, vertical and curved bands shall each be so described.
		(b)	Ends, angles, etc., shall be deemed to be included with the items.
Bricks on edge or moulded courses	G28	(a)	Facework, to flush, sunk and projecting brick-on-edge bands, dentilled bands, basket-pattern bands, moulded or splayed plinth cappings, moulded string courses, moulded cornices and the like shall each be given separately in linear meters stating the width of the band and the depth or projection. Horizontal, raking, vertical and curved members shall each be so described. Moulded or splayed bands which consist entirely of headers or stretchers shall be so described.

(b) Ends, internal angles, external angles and irregular angles shall each be enumerated separately.

Cills thresholds, copings

G29 (a) Cills, thresholds, copings and steps built of fair-faced brickwork or entirely of facings shall each be given separately in linear meters stating the size and the method of forming (e.g. all headers on edge; all stretchers-on-end). Horizontal, raking, vertical and curved work and work set weathering shall each be so described.

(b) Ends, internal angles, external angles and irregular angles shall be deemed to be included with the items.

Key blocks, corbels etc.

G30 Key blocks, corbels, bases to pilasters and cappings to isolated piers shall be enumerated separately stating the size. Fair cutting shall be deemed to be included with the items.

RUBBLE WALLING

Rubble walling Generally

G31 Rubble work shall consist of natural stones either irregular in shape or roughly dressed and laid dry or in mortar with comparatively thick joints.

G32 Dry rubble work (i.e. work built without mortar) shall be so described

G33 Particulars of the following shall be given:-

i. Type of walling stating whether of random or squared stones and where coursed, the average height of the courses or the maximum and minimum heights of diminishing courses.

ii. Texture and finish to exposed faces of stones (e.g. natural; rough dressed; hammer-dressed).

Levelled courses

G34 Levelling uncoursed rubble work for damp-proof courses, band-courses, sills places, copings and the like (grouped together) shall be given in linear meters stating the width.

Dressed margins

G35 Dressed margins on rubble work shall be given in linear meters stating the width of the margin. Stops and angles shall be deemed to be included with the items.

Copings

G36 Copings formed of rough stones shall be given in linear meters stating the width and average height of the coping. Ends and angles shall be deemed to be included with the items.

MASONRY

Masonry

G37 (a) Masonry shall consist of dressed blocks of natural stone accurately worked to given dimensions and laid in mortar in courses with fine joints.

(b) Particulars shall be given of texture and finish to exposed faces of stones (e.g. sawn; rubbed; tooled; vermiculated; reticulated; polished) and any requirements as to coating the surface of the finished work and cleaning on completion.

(c) Labours necessary to produce sawn stones of the required overall size shall be deemed to be included with the items.

(d) Stones shall be deemed to be set on their natural beds unless otherwise described.

(e) Stone dressings, to walls other than mansonry-faced walls, shall be so described.

(f) Templates and patterns shall be deemed to be included with the items.

(g) Joggle joints, sunk joints, rebated joints, concealed rebated joints and the like shall be given in the description of the work on which they occur. The extra stone required for joints shall be deemed to be included with the items.

Measurement G38

(a) Superficial items o f work shall be measured the mean length by the average height as executed. The measurements shall be taken over all mortar joints.

(b) Linear items of work shall be measured the mean length as executed. The measurements shall be taken over all mortar joints.

(c) Enumerated items of work shall be measured as the smallest block from which each item could be obtained having regard in the case of natural stone to the plane in which the stone is required to be laid with relation to its quarry bed. The measurements shall be taken over one mortar bed and one mortar joint.

(d) Plain work, sunk work, circular work and circular-circular work shall each be so described. Arrises shall be deemed to be included with the items on which they occur. For moulded work see Clause G46 hereof. Work curved on plan shall be so described stating the mean radius and the extra stone required for curved work shall be deemed to be included with the items. Curved labour shall be so described irrespective of the radius.

(e) Stones or blocks over 1.50 meters long shall be so described stating the length in stages of 0.50 meters.

(f) Stones or blocks over 0.50 cubic meters shall be so described stating the cube in further stages of 0.25 cubic meters

(g) Labours on different kinds of stone shall each be given separately

(h) Pointing shall be given in the description of the work on which it occurs.

Ends and angles of walls G39

(a) Square ends, square reveals and square external angles and battered internal angles of walls shall each be given separately in linear meters stating the thickness of the wall.

(b) Splayed ends, battered ends, battered external angles and battered internal angles of walls shall each be given separately in linear meters stating the thickness of the wall.

(c) The extra stone required for splayed or battered ends or angles of walls shall be deemed to be included with the items.

(d) Squint angles to walls and any ends or angles to walls which involve the use of stones thicker than the wall in which they occur shall be dealt with in accordance with Clause G51 hereof.

Stone facework G40

(a) Stone facework bonded to a backing of other material shall be given in meters stating the average thickness of the facework.

(b) Stone facework built against a backing of other material shall be given in square meters stating the thickness of the facework. Wall-ties or anchors shall be given in the description stating the type and spacing hereof and the method of securing to the backing.

(c) Stone facework used as formwork to concrete shall be so described. Temporary strutting shall be given in the description

Stone slabbing Or cladding to Walls G41

For pavings and stone slabbing or cladding to walls see Section S.

Rough cutting G42

(a) Rough notchings and rough sinkings (grouped together) for steel sections, concrete columns, concrete beams and the like shall be given in linear meters stating the girth of the cutting in stages of 150 millimeters.

(b) Rough notchings and rough sinkings (grouped together) for gusset-plates, ends of joists and the like shall be enumerated stating the size of the cutting.

Fair cutting G43

(a) Fair raking cutting on superficial items of stonework shall be given in linear meters stating the thickness. The extra stone required for raking cutting shall be deemed included with the items.

(b) Fair curved cutting on superficial items of stonework shall be given in linear meters stating the thickness. The extra stone required for curved cutting shall be deemed to be included with the items.

Rustications G44

Rustications shall be given in the description of the stone work on which they occur.

Grooves, rebates margins flutes, sinkings and angles G45

(a) Grooves, throats, rebates, margins, flutes, sinkings, chamfered angles, rounded angles and the like labours on superficial items of stonework shall each be given separately in linear meters stating the width or girth. Stops and mitres shall each be enumerated separately.

(b) Such labours on linear items of stonework shall be given in the description stating the width or girth. Stops and mitres shall each be enumerated separately.

(c) Such labours on linear items of stonework shall be given in the description stating the width or girth and the number of stops and mitres.

Mouldings G46

(a) Mouldings on superficial items of stonework shall be given in linear meters stating the girth. Undercut mouldings shall be so described. Stops, miters returned ends and the like shall each be enumerated separately.

(b) Mouldings on linear items of stonework shall be given in the description stating the girth. Stops, mitres, returned ends and the like shall each be enumerated separately.

(c) Mouldings on enumerated items of stonework shall be given in the description stating the girth and the number of stops, mitres, returned ends and the like.

(d) The extra stone required for projecting mouldings shall be added to the thickness of the stonework on which they occur.

Enrichments G47 Enrichments (e.g. bead-and-reel; egg-and-dart; dentils) shall each be given separately in linear meters stating the size. The extra stone required for projecting enrichments shall be added to the thickness of the stonework on which they occur. Mouldings on or between dentils shall be given in the description stating the girth. Stops, mitres, returned ends and the like to enrichments shall each be enumerated separately.

Ornaments G48 Ornaments (e.g. scrolls, rosettes; crockets) shall each be enumerated separately stating the size. The extra stone required for projecting ornaments shall be added to the thickness of the stonework on which they occur.

Small panels G49 (a) Stones forming small panels (i.e. panels not exceeding 0.10 square meters) shall each be enumerated separately stating the size. Those which are flush shall be so described. Those which are sunk or projecting shall each be so described stating set-back or projection.

(b) Small panels worked on other stones shall be enumerated stating the size and the set-back or projection. The extra stone required for projecting panels shall be added to the thickness of the stonework on which they occur.

Pilasters G50 (a) Stones forming pilasters shall be given in linear meters (measured vertically) stating the width on face, the total thickness and the projection beyond the face of the wall. Battered pilasters and those sunk to entasis shall each be so described.

(b) Caps and bases to plasters shall each be enumerated separately stating the size.

Quoins and G51 Stones forming quoins and jambs shall each be given separately in linear meters jambs (measured vertically) stating the width on face and the thickness. Those which are battered or projecting (or both) shall each be so described.

Columns G52 (a) Independent columns shall be given in linear meters (measured vertically) stating the size of the cross-section or the diameter. Those sunk to entasis shall be so described stating the greatest size or diameter.

(b) Stones forming attached columns shall be given in linear meters (measured vertically) stating the width on face, the total thickness and the diameter of the projection. Those sunk to entasis shall be so described stating the greatest diameter.

(c) Caps and bases to columns or attached columns shall each be enumerated separately stating the size.

Lintels, sills mullions and Transoms	G53	(a)	Lintels, sills, mullion and transoms shall each be given separately in linear meters stating the size.
		(b)	Ends and stoolings shall each be enumerated separately as extra over the member on which they occur.
Copings,	G54	(a)	Copings, cornices, band-courses, string-courses, plinth-cappings and the like members shall each be given separately in linear meters stating the size. Horizontal, raking and vertical members shall each be so described. Fair ends, returned ends and the like shall each be enumerated separately as extra over the member on which they occur.
		(b)	Kneeler-blocks, bonder-blocks, apex-blocks, angle-blocks, stooling-blocks and any end-blocks which involve the use of stone thicker than the member in which they occur shall each be enumerated separately stating the size.
		(c)	Plain band-courses over 300 millimeters wide shall be dealt with as walling or facework
Slab architraves and Surrounds to Openings	G55	(a)	Slab architraves and slab surrounds to openings (i.e. slabs not bonded to surrounding work) shall each be given separately in linear meters stating the size. Ends and angles shall be deemed to be included with the items.
		(b)	Plinth-blocks, angle-blocks, key-blocks and the like shall each be enumerated separately stating the size.
Arches	G56		Springers, voussoirs and keystones of arches shall be enumerated separately stating the size of the stone and the type of arch. Projecting members of arches shall be so described stating the projection.
Pier-caps and Chimney-caps	G57		Pier-caps, chimney-caps and the like shall each be enumerated separately stating the size. Openings in chimney-caps shall be given in the description.
Finials brackets corbels	G58		Finials, terminals, brackets, corbels and the like shall each be enumerated separately and stating the size.
Tracery	G59		Stones forming tracery shall be enumerated stating the size.
Special features	G60		Special features composed of one or more stones (e.g. ornamental panels; oriel windows; bullseye openings; niches; small domes; fleches) shall each be enumerated separately stating the nature and design of the feature, the number of stones, the total cubic feet of stones required and he dimensions of the exposed faces.
Steps, winders and landings	G61	(a)	Steps (except winders) shall be given in linear meters stating the size and the number of steps. Spandril steps (i.e. steps with sloping soffits) shall be so described. Fair ends, returned ends, rounded ends, stooled ends, wall-holds and the like shall each be enumerated separately as extra over the member on which they occur.
		(b)	Winders and landings shall each be enumerated separately stating the size and the number of stones. Landings of irregular shape shall be so described. Fair ends,

stooled ends, wall-holds, fair edges, nosings, rebate, grooves and the like shall be given in the description.

Handrails, cappings and kerbs	G62	(a)	Handrails, cappings and kerbs shall each be given separately in linear meters stating the size. Fully-moulded handrails shall be so described. Stopped ends, returned ends, mitres, stoolings, wall-holds and the like shall each be enumerated separately as extra over the member on which they occur.
		(b)	Scrolled ends, angle-blocks, ramp-blocks, wreath-blocks and the like shall each be enumerated separately stating the size.
Balustrade panels	G63		Balustrade panels and the like shall be enumerated stating the size. Those or irregular shape and those worked both sides shall be so described. Fair edges, shaped edges, perforations, sinkings and the like shall be given in the description.
Balusters	G64		Balusters, half-balusters, newels and newel-caps shall each be enumerated separately and newels stating the size.
Cover-stones and corbel-courses	G65		Cover-stones, corbel-courses and the like shall each be given separately in linear meters stating the size. Fair edges shall be given in the description. Fair ends shall be enumerated as extra over the member on which they occur.
Templates, basis and Hearths	G66		Templates, bases, thresholds, hearths and the like shall each be enumerated separately stating the size. Fair edges shall be given in the description stating the number.
Shelves, divisions, table-tops, seats and bath-panels	G67	(a)	Shelves, divisions, table-tops, work-tops, counter-tops, seats, bath-panels and the like over 300 millimeters wide shall each be given separately in square meters stating the thickness. Those not exceeding 300 millimeters wide shall be given in linear meters stating the thickness and the width. Members of irregular shape and curved members shall each be enumerated separately stating the thickness and the extreme size.
		(b)	Fair edges, rounded edges, moulded edges, jointed edges, grooves, rebates and the like shall each be given separately in linear meters. Stops to grooves and rebates, also internal angles and external angles to rounded edges and moulded edges shall each be enumerated separately.
		(c)	Notches, rounded corners, holes and the like shall each be enumerated separately stating the girth or size.
Carving and sculpture	G68	(a)	Carving and sculpture shall each be enumerated separately stating the character of the work. Detailed drawings shall be provided but where such drawings are not available or where a special carver or sculptor is required the work shall be given as a provisional or prime cost sum. Providing models shall be given in the description.
		(b)	Selecting blocks of stone for size and quality shall be given as an item. Boasting for carving shall be given in the description of the stone to be used for carving or sculpture.
		(c)	Temporary work (e.g. special accommodation special scaffolding; screens; shelters) required for the exclusive use of carvers or sculptors shall be given as an

item stating the nature of the temporary work. Removing temporary work and making good after shall be deemed to be included with the item.

(d) Attending upon and cleaning down after the carvers and sculptors shall be given as an item.

(e) Working mouldings and similar members to carving and sculpture shall be enumerated stating the size of the moulding or member.

CAST STONEWORK

Cast stonework generally — G69

(a) Cast stonework shall consist of blocks of reconstructed or artificial stone accurately cast to given dimensions and used in a similar manner and for the same purpose as natural stone.

(b) Particulars of the following shall be given:-

i. Any requirements as to the reinforcement of blocks

ii. Any requirements as to the thickness, mix and colour of the facing material

iii. Texture and finish of exposed faces of blocks (e.g. rough, smooth; rubbed; vermiculated; reticulated; polished).

iv. Any requirements as to coating the surface of the finished work and cleaning on completion.

(c) Moulds necessary to produce blocks of the required size and shape shall be deemed to be included with the items

Work in cast stone — G70

Work in cast stone shall be given in accordance with the rules for masonry in Clauses G37 to G68 hereof.

CLAYWARE WORK

Clayware generally — G71

(a) Clayware work shall consist of blocks of fired clayware cast to given dimensions and used in a similar manner and for the same purpose as natural stone.

(b) Particulars of the following shall be given:-

i. Kind of clayware (e.g. natural clayware; stoneware; terra cotta; faience).

ii. Any requirements to the colour

iii. Texture and finish of exposed faces of blocks (e.g. rough smooth; glazed; double glazed).

iv. Any requirements as to cleaning the finished work on completion

(c) Moulds necessary to produce blocks of the required size and shape shall be deemed to be included with the items.

(d) Blocks required to be cast hollow and filled with concrete shall be so described stating the composition and mix of the concrete. Formwork shall be deemed to be included with the items.

Work in claywork G72 Work in clayware shall be given in accordance with the rules for masonry in Clauses G37 TO G68 hereof.

SUNDRIES

Preparing for raising G73 (a) Preparing tops of old walls to receive new shall be given in linear meters stating the thickness of the old wall.

(b) Beds of mortar to cover rivets of girders under walls shall be deemed to be included with the walls which shall be measured from the top surface of the girders.

Weather fillets and angle-fillets G74 Weather-fillets and angle-fillets shall each be given separately in linear meters stating the width. Curved fillets shall be described irrespective of radius. Ends and angles to fillets shall be deemed to be included with the items.

Bedding G75 Bedding plates, corrugated sheeting, wood frames and sills and the like and pointing to one or both sides shall be deemed to be included with the items.

Wedging and pinning up G76 Wedging and pinning up new work to underside of old construction in cases where the load is to be transmitted to the new work shall be given in linear meters stating the thickness of the work. The materials for wedging and pinning shall be described.

Cutting G77 Cutting grooves for water-bars and the like shall be given in linear meters.

Preparing for flashings and asphalt Skirtings G78 (a) Raking out joint or cutting grooves for turned-in edge of flashings shall be given in linear meters. Horizontal, raking, stepped, vertical and curved work shall each be so described. Pointing shall be given in the description.

(b) Raking out and enlarging joint or cutting groove for nib of asphalt shall be given in linear meters. Horizontal, raking, vertical and curved work shall each be so described. Pointing shall be given in the description

(c) Dressing the face or rubble walling or similar facework to receive flashings and skirtings shall be given in the description.

Building in or cutting and pinning G79 (a) Building in metal windows, metal doors and the like (complete with frames) shall each be enumerated separately stating the overall size. Building in strong-room doors, safe-doors and the like (complete with frame) shall each be enumerated separately stating the overall size, the approximate weight and the floor level. Building in or cutting and pinning lugs, bedding frames and pointing to one or both sides shall be given in the description.

(b) Building in ends of lintels, steel sections, bearing bars, steps, timbers and the like as the work proceeds shall be deemed to be included with the walling items. No deduction shall be made for any ends mentioned in this sub-clause.

(c) Cutting and pinning ends of lintels, steel sections, tubular rails, steps, timbers, brackets and the like (grouped together) shall be enumerated irrespective of size. No deduction shall be made for any ends mentioned in this sub-clause.

Holes G80 (a) Holes for pipes, tubes, bars, cables, conduits and the like members (grouped together) shall be enumerated stating the sizes of the member as Clause A4 hereof and the thickness of the work. Fixing pipe-sleeves shall be given in the description.

(b) Holes for ducting, trunking, tray and the like members (grouped together) shall be enumerated stating the size of the member and the thickness of the work.

Mortices G81 Mortices and sinkings for ragbolts, bars, rails and the like (grouped together) shall each be enumerated stating the depth in stages of 100 millimeters. Running mortices with lead or mortar shall be given in the description.

Making good G82 Making good walls in connection with any of the labors mentioned in Clauses G79, G80 and G81 hereof shall be deemed to be included with the items. Making good fair face or facings in connection with any of the labours mentioned in Clauses G79, G80 and G81 hereof shall be given in the description of such labours.

Air-bricks ventilating gratings and soot-doors G83 Forming openings in walls and providing and building in air-bricks, ventilating gratings, soot-doors and the like shall each be enumerated separately stating the size of the opening, the nature of the wall and its thickness. Lintels and arches shall be given in the description.

Flues G84 (a) Parging and coring flues shall be given in linear meters stating the internal size of the flue where over 0.25 square meters in sectional area.

(b) Fireclay linings and precast concrete linings to flues shall each be given separately in linear meters stating the size. Cutting to form easings and bends in linings and cutting walls around linings shall be given in the description.

Gas flue-blocks G85 Flue-blocks shall be enumerated stating the type of blocks and the size and number of flues in each block. The method of building shall be described (e.g. built-in; free-standing). Rough cutting on walls around the flue-blocks shall be given in the description of built-in flue-blocks.

Chimney-pots G86 Chimney-pots shall be enumerated stating the type and the size. Setting and flaunching shall be given in the description.

Stoves and surrounds G87 (a) Stoves, grates, mantels, ranges and similar units shall each be enumerated separately stating the type and the size. Setting in fireplace opening and providing any concrete and brick backings shall be given in the description stating the width of the fireplace opening.

(b) Surrounds, hearths and similar units shall each be enumerated separately stating the size, the nature of the material (e.g. tile, marble) and the condition in which each unit is supplied (e.g. loose parts; pre-slabbed). Assembling and jointing or building up loose parts and setting shall be given in the description.

Cramps G88 Metal cramps, slate dowels, metal dowels, lead plugs and the like shall each be enumerated separately stating the size. Mortices and running with mortar or lead shall be given in the description.

Coating backs of stones G89 Coating backs of stones or blocks with slurry shall be given in the description of the walling on which it occurs. Coating with other material shall be given in square meters stating the kind of material.

CENTERING

Centering G90

(a) Particulars of the following shall be given:-

i. Nature of the surface to be supported (e.g. brickwork; blockwork)

ii. Shape of surface (e.g. flat; segmental; semicircular; groined).

(b) Centering left in shall be so described

(c) Centering with supports over 3.50 meters high shall be so described stating the height in further stages of 1.50 meters.

(d) Centering shall be measured as the actual surface to be supported. Strutting, shoring, bolting, wedging, easing, striking and removing shall be deemed to be included with the items.

Flat soffits G91

(a) Centering for flat soffits over 300 millimeters wide and not exceeding 2 meters span shall be given in square meters.

(b) Centering for flat soffits not exceeding 300 millimeters wide and not exceeding 2 meters span shall be given in linear meters stating the width.

(c) Centering for flat soffits over 2 meters span shall be enumerated stating the span of the opening and the width of the soffit.

(d) Centering for sloping soffits shall be so described.

Curved and vaulted soffits G92 Centering for curved soffits and vaulted soffits shall each be given separately in square meters.

Arches G93 Centering for segmental, semi-circular, invert and other curved arches shall each be enumerated separately stating the span of the opening and the width of the soffit. The rise shall also be stated except in the case of semi-circular arches.

Labours on centering G94

(a) Raking cutting, curved cutting, cutting to groin points, cutting to inter-sections, cutting against ribs and the like labours shall each be given separately in linear

meters. Scribed edges and splayed edges shall be deemed to be included with the items.

(b) Notching for key blocks, projecting voussoirs and the like shall each be enumerated separately stating the size or girth.

Supports to projecting stonework and tracery G95 (a) Supports to projecting masonry (e.g. corbel-courses; cornices; pediments; hoods) shall be given in linear meters of work to be supported stating the projecting.

(b) Strutting and ribbing for tracery work shall be enumerated stating the overall area of the tracery.

DAMP PROOF COURSES

Damp-proof Courses generally G96 Particulars of the following shall be given in:-

i. Kind and quality of damp-proof materials
ii. Gauge, thickness or substance (e.g. weight per square meter) of sheet material
iii. Number of layers
iv. Composition and mix of bedding material

Slate and sheet damp-curved G97 (a) Sheet damp-proof courses (e.g. bitumen-felt; sheet lead; sheet copper) over 300 millimeters wide shall be shall be given in linear meters stating the width. No allowance in measurement shall be made for laps which shall be deemed to be included in the items. No deduction shall be made for voids not exceeding 0.50 square meters. Horizontal, raking, vertical and curved work shall each be so described. Cutting to curve shall be given in the description of work in walls.

(b) Damp-proof courses with cavity-gutters in hollow walls shall be so described.

(c) Pointing exposed edges of damp-proof courses shall be deemed to be included with the damp-proof courses.

SECTION H

UNDERPINNING

The Unit of Billing shall be the Meter

GENERALLY TO SECTION H

Underpinning H1

(a) Underpinning work shall be given as a Section in the bill.

(b) A description of the existing structure (e.g. wall; pier) to be underpinned shall be given stating its location, its length or size on plan, the depth of the new work below the base of the existing foundation and the limit of length to be carried out in one operation. Underpinning which is curved on plan shall be so described.

(c) Underpinning required to be executed form inside existing buildings shall be so described. Handling materials and getting them in or out of such buildings shall be deemed to be included with the items.

WORK IN ALL TRADES

Work generally H2

Underpinning work shall be given in accordance with the rules in the relevant Sections hereof except as qualified hereunder.

Excavation H3

(a) Temporary supports to work to be underpinned shall be given as an item. Particulars of such supports shall be given where practicable.

(b) Allowances for working space (which shall not be subject to adjustments if more or less space is actually required) shall be made in the measurements or excavations. The width of the working space (measured horizontally from the face of the wall to be underpinned, or where projecting foundations are to be retained from the face of such projection) shall be related to the total depth of the excavation (measured from the top of the preliminary trench to the underside of the underpinning work). The allowances shall be as follows:-

i. 1 meter from the wall or projecting foundation where the total depth of the excavation does not exceed 1.50 meters.

ii. 1.50 meters from the wall or projecting foundation where the total depth of the excavation is over 1.50 meters but does not exceed 3 meters.

iii. 2 meters from the wall or projecting foundation where the total depth of the excavation iv over 3 meters.

(c) Excavation shall be given in accordance with Clause D5 to D17 hereof subject to the following:-

i. Excavating preliminary trenches down to the level of the base of the existing foundation shall be so described

ii. Excavating below the level of the base of the existing foundation shall be so described

(d) Cutting away projecting foundations shall be given in linear meters stating the number of courses of footings and the dimensions of concrete to be removed.

SECTION J

ASPHALT WORK

The Unit of Billing shall be the Meter

GENERALLY TO SECTION J

Asphalt work Generally J1

(a) Asphalt work shall be as follows and each group with its associated skirtings, angle-fillets and labours shall be given under an appropriate heading:-

i. Damp-proofing and tanking

ii. Paving

iii. Roofing

(b) Particulars of the following shall be given:-

i. Kind and quality of asphalt

ii. Thickness and number of coats

iii. Nature of base on which asphalt is applied

iv. Surface treatment with chippings, gravel, tiles and the like

(c) Sheathing felt, cork, fibreboard or other underlay in contact with asphalt and any reinforcement to asphalt shall be given in the description of the asphalt work in which they occur. Cutting, notching, bending and lapping the underlay and the reinforcement shall be deemed to be included with the items. The fixing of reinforcement on sloping surfaces shall be described.

(d) Work and labours executed overhand or in confined situations (where at least 1 meter of working space can not be provided) shall beach be so described.

(e) Work and labours on retaining walls, in sections and after continuity of laying has been interrupted by temporary obstructions shall each be so described. Jointing between sections shall be deemed to be included with the items.

(f) Curved work, conical work, spherical work and elliptical work shall each be so described irrespective of the radius. No distinction shall be made between straight and curved labours.

(h) Temporary rules shall be deemed to be included with the asphalt items.

MASTIC ASPHALT

Coverings to surfaces	J2	(a)	Coverings shall be measured the area in contact with the base and shall include all labours.
		(b)	Classification shall be as follows:-
		i.	Flat coverings, coverings to falls or cross-falls and sloping coverings not exceeding 15 degrees from horizontal (grouped together). Intersections on work to cross-falls shall be deemed to be included with the items.
		ii.	Sloping coverings over 15 degrees from horizontal
		iii.	Sloping coverings over 45 degrees from horizontal and vertical coverings (grouped together).
		(c)	Coverings which will be subsequently covered shall be so described
		(d)	Coverings to soffits shall be so described
		(e)	Internal angle-fillets shall be given in linear meters and shall be deemed to be in two coats unless otherwise stated. Ends and angles shall be deemed to be included with the items.
		(f)	Extra labour and material for turning coverings into grooves shall be given to separately in linear meters.
Skirtings the fascias and aprons	J3	Skirtings, fascias and aprons shall each be given separately in linear meters stating girth. Fair edges, drips, arrises and the like and turning nibs into grooves shall be given in the description. Internal coved or angle fillets and tilting fillets shall be given separately in linear meters.	
Gutters, valleys and kerbs	J4	(a)	Linings to gutters, linings to valleys and coverings to kerbs shall each be given separately in linear meters stating the girth. Fair edges, arrises and the like turning nibs into grooves shall be given in the description. Internal coved or angle fillets and tilting fillets shall be given separately in linear meters. Stop ends and outlets shall each be enumerated separately.
		(b)	Linings to isolated gutters and valleys shall each be so described

Channels	J5	(a)	Linings to channels shall be given in accordance with the rules for lining to gutters in J4 above.
		(b)	Forming shallow channels including additional materials shall be given in linear meters as extra over the covering in which they occur and stating the girth. Stop ends and outlets shall each be enumerated separately.
Cesspools and collars description.	J6	(a)	Linings to cesspools, sumps and the like shall each be enumerated separately stating the size. Arrises, internal angle-fillets and outlets shall be given in the
		(b)	Linings to bonding pockets, coverings to bonding blocks and the like shall each be enumerated separately stating the size. Arrises and internal angle-fillets shall be given in the description.
		(c)	Collars around pipes, standards and the like members (grouped together) shall be enumerated stating the size of the members as Clause A4 hereof. Arrises and internal angle-fillets shall be given in the description.

SECTION K

ROOFING

The Unit of Billing shall be the Meter

GENERALLY TO SECTION K

Roofing generally K1

(a) Work shall be grouped according to the kind of material and each group with its associated labours shall be given under an appropriate heading.

(b) Work to dormers and the like shall be so described.

(c) Work to curved, conical and spherical roofs shall each be so described stating the radius or diameter at base. Work to elliptical roofs and other roofs curved to more than one radius shall be so described stating the radii.

(d) Work to turrets shall be so described stating the type (e.g. octagonal; conical), the diameter or size at base and apex and the vertical height from base to apex.

(f) Works shall be measured on the finished surface

SLATE OR TILE ROOFING

Slate or Tile roofing K2

Particulars of the following shall be given:-

i. Kind, size, type and quality of slates or tiles (e.g. asbestos-cement slates; clay-ware tiles, concrete tiles; shingles).
ii. Extent of lap
iii. Method of fixing and the number and kind of nails or pegs per slate or tile
iv. Size and type of laths or battens

Roof coverings K3

Roof coverings shall be given in square meters. Coverings over 45 degrees from horizontal and vertical coverings shall each be so described.

Labours on roof coverings K4

(a) Square cutting around openings shall be given in linear meters. Square cutting against abutments and at top edges shall be deemed to be included with the roof coverings.

(b) Raking cutting and curved cutting shall each be given separately in linear meters

(c) Holes for pipes, standards and the like members (grouped together) shall be enumerated stating the size of the members as Clause A4 hereof.

Eaves K5

Double course at eaves and extra undercourse at eaves shall each be given separately in linear meters. Raking eaves and curved eaves shall each be so described. Bedding shall be given in the description stating the nature of the bedding material. Cut courses at eaves shall be deemed to be included in the items.

Verges	K6		Verges shall be given in linear meters. Raking verges, curved verges and verges with purpose-made or special tiles shall each be so described. Extra undercloak course, bedding, pointing and finishing with cement fillets shall be given in the description.
Valleys	K7	(a)	Cutting to valleys (measured to both sides) shall be given in linear meters one-and-half-width slates or tiles shall be deemed to be included with the items. Bedding and pointing to valleys (measured to both sides) shall be given in the description.
		(b)	Valley-tiles shall be given in linear meters as extra over the roof coverings in which they occur. Purpose-made valley-tiles shall be so described. Cutting and bonding to both sides shall be deemed to be included with the items.
		(c)	Laced or swept valleys shall be given in linear meters as extra over the roof coverings in which they occur. Cutting and bonding to both sides shall be deemed to be included with the items. Special finishes to tops or bottoms of valleys shall be enumerated stating the nature of the finish.
Hips and vertical angles	K8	(a)	Cutting to hips and cutting to vertical angles (measured to both sides) shall each be given separately in linear meters
		(b)	Hip tile and vertical angle tiles shall each be given separately in linear meters. Purpose-made hip tiles or angle tiles shall be so described. Cutting and bonding to both sides shall be deemed to be included with the items. Filled ends shall be deemed to be included with the items.
Ridge and Vertical angles	K9		Ridge-cappings and hip-cappings shall each be given separately in linear meters. Bedding and pointing shall be given in the description. Filled ends, purpose-made tiles, vents, finials and the like shall each be enumerated separately. Fitted ends, mitred angles and mitred intersections shall be deemed to be included with the items.
Special fillings	K10		Tile slips and other fillings shall each be given separately in linear meters. Bedding and pointing shall be given in the description.
Hip-irons	K11		Hip-irons shall be enumerated stating the method of fixing
Metal slates and soakers	K12		Metal slates and metal soakers shall each be enumerated separately stating the size.
Glass tiles	K13		Glass tiles and the like shall be enumerated as extra over the coverings in which they occur.
Lathing or battening	K14	(a)	Lathing or battering shall be given in the description of roofing (see Clause K2 (iv) hereof).
		(b)	Counter-battening shall be given in square meters stating the size and spacing of the battens and the method of fixing.
Under-felting	K15		Underfelting shall be given in square meters stating the extent of the laps and the method of fixing

CORRUGATED OR TROUGHED SHEET ROOFING

Corrugated Or troughed Roofing generally	K16	Particulars of the following shall be given:- i. Kind of sheeting (e.g. asbestos-cement; iron; steel; protected metal; aluminium). ii. Quality and gauge of sheeting and type of corrugation or troughing iii. Extent of side and end laps iv. Nature and general spacing of the structural supports (e.g. purlins). v. Method of fixing the sheeting vi. Material for bedding joints of sheeting stating which joints are to be bedded (i.e. horizontal, vertical or both)
Roof coverings	K17	(a) Roof coverings shall be given in square meters and shall include all cuttings and waste. Coverings over 45 degrees from horizontal and vertical coverings shall be so described. (b) Roof coverings which are fixed through an underlining laid over purlins shall be so described. (c) Cranks and upstands shall be given separately in linear meters as extra over the coverings in which they occur.
Labours on cases roof coverings	K18	(a) Square cutting around openings shall be given in linear meters except in where the work is designed to use standard sheets without cutting. Square cutting against abutments and at top edges shall be deemed to be included with the roof coverings. (b) Raking cutting and curved cutting shall each be given separately in linear meters. (c) Holes for pipes, standards and the like members (grouped together) shall be enumerated stating the size of the members as Clause A4 hereof.
Filler pieces	K19	Filler-pieces at eaves and jambs and openings, filler-pieces above roof glazing and over lintols, flashing-pieces under roof glazing and the like shall each be given separately in linear meters.
Bedding and pointing	20	Bedding and pointing at eaves, verges and the like and bedding and pointing eaves filler-pieces shall each be given in linear meters
Ridge, hip and angle cappings	K21	Ridge-cappings, hip-cappings and vertical angle-cappings shall each be given separately in linear meters. Capped ends, capped angles, capped intersections, vents, finials and the like shall each be enumerated separately. Fitted ends shall be deemed to be included with the items.
Barge-boards	K22	Barge-boards and comer-pieces shall each be given separately in linear meters stating the width. Mitred angles, mitred intersections, far and fitted ends shall be deemed to be included with the items.

Flashings and expansion Joints	K23	(a)	Flashings and expansion joints shall be given separately in linear meters stating the overall girth.
		(b)	Flashings around pipes, standards and the like members passing through sheeting shall be enumerated stating the size of the members as Clause A4 hereof.
Louvres	K24	Louvre-blades shall be given in linear meters stating the width or girth and the number	
Roof-lights and special Sheets	K25	(a)	Fixed and opening roof-lights (exclusive of glass) shall each be enumerated separately extra over the roof coverings in which they occur stating the size.
		(b)	Transparent plastics shall be enumerated as extra over the roof coverings in which they occur stating the size
		(c)	Ventilator-sheets shall be enumerated as extra over the roof-coverings in which they occur stating the size.
		(d)	Sheets with soaker-flanges for pipes shall be enumerated as extra over the roof coverings in which they occur stating the size of the pipe as Clause A4 hereof.
Roof Ventilators	K26	Roof ventilators shall be enumerated stating the size and the type of base.	

THATCH ROOFING

Thatch	K27	(a)	Particulars of the following shall be given:- i. Kind of thatch (e.g. marsh-reed; straw; makuti). ii. Thickness of finished work where appropriate iii. Method of fixing
		(b)	Ridges, valleys, dormers and the like in a material differing from the plain surfaces shall be so described.
Roof Coverings	K28	(a)	Roof coverings (except to dormers and turrets) shall be given in square meters. Coverings over 45 degrees from horizontal and vertical coverings shall each be so described.
		(b)	Roof coverings to dormers shall be enumerated stating the size. Roof coverings to turrets shall be enumerated stating the type, the diameter or size at base and apex and the vertical height form base to apex.
		(c)	Stripping old thatch and associated work preparatory to re-thatching shall be given in square meters.
Labours valleys, on roof coverings	K29	(a)	Cutting and facing to top abutments, side abutments, tile valleys, metal chimneys and the like (grouped together) shall be given in linear meters.
		(b)	Holes for pipes, standards and the like members (grouped together) shall be enumerated stating the size of the members as Clause A4 hereof.

Eaves, verges and hips	K30	Eaves, verges, hips, valleys, ridges and the like (measured extreme dimensions) where involving extra materials shall each be given separately in linear meters and described.	
Wire netting	K31	(a)	Wire netting (measured the area covered) shall be given in square meters stating the mesh, the gauge, the extent of laps and the method of fixing. Strips to ridges, eaves, verges and the like shall be given in linear meters stating the width.
		(b)	Raking cutting and curved cutting shall each be given separately in linear meters.

ROOF DECKING

Roof decking	K32	Particulars of the following shall be given:-	
		i.	Kind of decking (e.g. asbestos-cement; steel; aluminium; wood-wool).
		ii.	Thickness and quality
		iii.	Method of fixing
		iv.	Nature and general spacing of the structural supports
Roof decking Generally	K33	Roof coverings shall be given in square meters. Coverings over 45 degrees from horizontal and vertical coverings shall each be so described.	
Labours on Roof coverings	K34	(a)	Square cutting around openings over 0.50 square meter shall be given in linear meters, except in cases where the work is designed to use standard sheets without cutting. Square cutting at abutments and elsewhere shall be deemed to be included with the roof decking.
		(b)	Raking cutting and curved cutting shall each be given separately in linear meters.
		(c)	Holes for pipes, standards and the like members (grouped together) shall be enumerated stating the size of the members as Clause A4 hereof.
Bearings, be eaves, kerbs And flashings	K35	Bearings, eaves, kerbs, flashings and abutments with nibs built into chases shall each given separately in linear meters.	

BITUMEN-FELT ROOFING

Bitumen-Felt roofing generally	K36	(a)	Particulars of the following shall be given:-
		i.	Type, quality and substance of felt
		ii.	Number of layers and extent of laps
		iii.	Nature of base on which feltwork is laid
		iv.	Method of bonding or securing to base and bonding of succeeding layers
		v.	Surface treatment with chippings, tiles, macadam paint.
		(b)	Paper, cork fibrebord or other underlay in contract with the feltwork shall be measured separately or alternatively may be given in the description of the feltwork in which it occurs.

Roof	K37	Roof coverings shall be given in square meters. Classification shall be as follows:-	
		i.	Flat coverings, coverings to falls or cross-falls and sloping coverings not exceeding 45 degrees from the horizontal (grouped together). Intersections on work to cross-fall shall be deemed to be included with the items.
		ii.	Sloping coverings over 45 degrees from the horizontal and vertical coverings (grouped together).
Labours on roof coverings And underlays	K38	(a)	Raking cutting, curved cutting, fair edges, turning into grooves, wedging and the like labours shall each be given separately in linear meters.
		(b)	Notching, bending, extra felt for laps and turning into grooves, trimming and jointing feltwork to flashings and the like labours shall be deemed to be included with the items.
		(c)	Working feltwork into outlet pipes, dishing to gullies and the like (grouped together) shall be enumerated irrespective of size.
Flashings, skirtings and aprons	K39	The turndown at eaves, verges and aprons shall be given separately in linear meters stating the width. Flashings shall be given separately in linear meters stating the height and shall be deemed to include for any turn-up of the main roof sheeting. The turn-up of main roof sheeting at abutments where covered by a flashing of a different material shall be added to the measurement of the main roof covering or given separately in linear meters stating the girth. Stepped work and raking work shall each be so described. Turning into grooves, wedging and the like shall be given in the description. Cuttings, fair edges, angles, ends and extra felt for laps and for turning into grooves shall be deemed to be included with the items.	
Gutters valleys and kerbs	K40	(a)	Linings to gutters, channels and valleys and coverings to kerbs shall each be given separately in liner meters stating the girth in contact with base. Gutters to falls shall be so described. Turning into grooves wedging and the like shall be given in the description. Cuttings, fair edges, dressing over tilting fillets, angles, intersections and extra material for laps and for turning into grooves shall be deemed to be included with the items. Stop ends and outlets shall each be enumerated separately.
		(b)	Linings to gutters channels and valleys of roof of other materials shall each be so described.
Channels	K41	Forming shallow channels including additional material shall be given in linear meters as extra over the covering in which they occur stating the girth. Stop ends and outlets shall each be enumerated separately. Angles intersections and extra material for laps shall be deemed to be included with the items.	
Sumps and collars	K42	(a)	Linings to sumps and the like (grouped together) shall be enumerated stating the size. Outlets shall be given in the description.
		(b)	Collars around pipes, standards and the like members (grouped together) shall be enumerated stating the size of the members as Clause A4 hereof.

SHEET METAL ROOFING

Sheet metal Roofing Generally

K43 (a) Particulars of the following shall be given:-

i. Kind of metal (e.g. sheet zinc; sheet aluminium; sheet copper).

ii. Quality of metal

iii. Gauge or thickness

iv. Method of jointing

(b) In the absence of any directions to the contrary allowances shall be made in calculating the area of the finished surface of sheet metalwork as follows:-

Item	Zinc, Aluminium and copper
(i) For drips not exceeding 50 millimeters	0.15 meter
(ii) For cross-welts	0.10 meter
(iii) For wood-cored rolls not exceeding 50 millimeters	0.15 meter
(iv) For standing seams and welted seams	0.10 meter
(v) For edge-welts	0.05 meter
(vi) For vertical upstands	0.15 meter
(vii) For sloping upstands and for laps in pitched roofing	0.30 for 30° 0.35 for 25° 0.45 for 20° 0.60 for 15°

(c) Clips and tacks shall be given in the description stating the material to be used and the method of fixing. No allowance for them shall be made in the area of the sheet metalwork.

Roof coverings

K44 Roof covering will be given in square meters. Classification shall be as follows:-

i. Flat roof coverings roof coverings to falls and cross-falls and sloping roof coverings snot exceeding 45 degrees from horizontal (grouped together)

ii. Sloping roof coverings over 45 degrees from horizontal and vertical roof coverings (grouped together)

iii. Flat gutter coverings (for slopping gutter linings see Clause K53 hereof).

Labours on Sheet metals

K45 (a) Raking cutting and curved cutting shall each be given separately in linear meters.

(b) Notching and bending shall be deemed to be included with the items.

(c) Welted edges, beaded edges, wedging into grooves, burned or brazed angles, welted seams, burned or brazed seams and the like labours shall each be given separately in linear meters.

(d) Dressing into hollows and over mouldings shall each be given separately in linear meters stating the girth.

(e) Dressing over glass and glazing bars, over corrugated roofing, over tiling , over pan tiling and over similar materials (measured flat) shall each be given separately in linear meters stating whether along or across the bars or corrugations.

(f) Bossed, burned brazed or capped ends, angles and intersections to rolls, hollows, channels and mouldings shall each be enumerated separately.

(g) Dressing into outlet pipes, dishing to gullies and the like (grouped together) shall be enumerated irrespective of size.

Copper Nailing K46 Nailing shall be given in linear meters and described

Collars around pipes and standards K47 Collars around pipes, standards and the like members passing through roofs (grouped together) shall be enumerated stating the size of the members as Clause A4 hereof and kind of pipe or standard and the method of joining thereto. Burned or brazed joints to sheet metal work shall be given in the description.

Sumps and The like K48 Linings to sumps and the like (grouped together) shall be enumerated stating the size. Outlets and burned or brazed angles shall be given in the description.

SHEET METAL FLASHING AND GUTTER LININGS AND METAL TRIMS

Sheet metal Flashings And gutter linings Generally K49 (a) Particulars as Clause K43 (a) shall be given

(b) Clips and tacks shall be given in the description stating the material to be used and the method of fixing.

Flashings K50 (a) Flashings, stepped flashings, aprons, weatherings to cornices, cappings to hips, ridges, kerbs, gutter linings and the like shall each be given separately in linear meters stating the girth.

(b) Welted edges, beaded edges, scalloped, or otherwise shaped edges, wedging into grooves, dressing over tilting fillets and the like labours shall be given in the description.

(c) Dressing into hollows, and over moundings shall be given in the description stating the girth.

(d) Dressing over glass and glazing bars, over corrugated roofing, over tiling, over pantiling and other similar measured flat) shall be given in the description stating whether along or across the bars or corrugations.

(e) Dressing gutters through outlets dressing into rainwater heads and the like labour shall each be enumerated separately.

(f) Bossed, burned or brazed ends shall be enumerated and described.

Preformed flashings K51 Preformed flashings and trims, aprons, cappings and the like shall each be given separately in linear meters stating the girth and describing the profile and the method of jointing. Angles and ends shall be deemed to be included but preformed fittings shall be enumerated.

Flat gutters K52 Flat gutter coverings shall be given in accordance with the rules for sheet metal roofing. (See Clause K44 (iii) hereof).

Sloping gutters K53

(a) Linings to sloping gutters shall be given in linear meters stating the girth of the metal. Linings to secret gutters shall be so described.

(b) Dressing over tilting-fillets, wedging into groove and the like labours shall be given in the description.

(c) Bossed, burned or brazed ends and angles, dressing through outlets, dressing into rainwater heads and the like labours shall each be enumerated separately.

Soakers and metal slates K54 Supplying soakers and metal slates (for fixing by tiler) shall be enumerated separately stating the size. Collars around pipes shall be given in the description of the metal slates stating the size of the pipe as Clause A4 hereof, the kind of pipe and the method of jointing thereto.

Saddles K55 Saddles over abutments and intersections of hips and ridges (grouped together) shall be enumerated stating the size of the metal. Dressing and bossing shall be given in the description.

SECTION L

CARPENTRY

The Unit of Billing shall be the Meter

GENERALLY TO SECTION L

Carpentry generally L1

(a) Particulars of the following shall be given:-

i. Kind and quality of timber
ii. Preliminary treatment of timber (e.g. impregnation).

(b) Timber shall be deemed to sawn on all faces and edges unless otherwise stated. Wrought timber shall be so described and 3 millimeters shall be allowed from the nominal size for each wrought face.

(c) Timber shall be deemed to be fixed with nails or steel screws. Particulars of any other method of fixing shall be given in the description of the item concerned.

(d) Curved or circular work shall be so described stating the radius. Work curved to more than one radius shall be so described stating the radii. Curved labours shall be so described.

(e) Moulded work shall be so described.

STRUCTURAL TIMBERS

Structural timbers generally L2

(a) Structural timbers shall be measured the net length as fixed in the work and given in linear meters stating the nominal size and describing their functions. Joints in continuous lengths shall be taken every 6 meters.

(b) Structural timbers over 6 meters long in one length shall be so described stating the length in further stages of 1 meter.

Labours on structural timbers L3

(a) All cutting, scribing, splaying, notching, halving, morticing, tenoning and wedging shall be deemed to be included in the items. Dovetailed, scarfed and fingered joints shall each be enumerated. All the foregoing labours shall be deemed to include the additional timber required.

(b) Rebates, grooves, chamfers, rounded edges, moulded edges and the like labours shall each be described with the item or may be measured separately in linear meters. Ends, angles, stops and mitres in all labours shall be deemed to be included with the items.

(c) The following additional labours on structural timbers shall each be enumerated separately.

i. Wrought ends of timbers stating the length.

ii. Shaped, turned or moulded ends of timber stating the length

Brandering and nogging L4 Brandering and nogging between joists measured over the joists shall each be given separately in linear meters stating the sizes.

Cleats and Sprockets L5 Cleats, sprockets and the like shall each be enumerated separately stating the size.

BOARDING

Boarding generally L6 Boarding shall be measured as executed describing the function. No allowance shall be made for tongues in tongued and grooved work or for laps in weather-boarding and no deduction shall be made for voids not exceeding 0.50 square meters. Particulars of the following shall be given:-

(a) i. Nominal thickness

ii Method of jointing

iii. Surface treatment after laying

(b) Boarding laid diagonally shall be so described

(c) Boarding shall be given in square meters and the classification shall be as follows:-

i. Horizontal surfaces
ii. Sloping surfaces not exceeding 45 degrees from horizontal
iii. Sloping surfaces over 45 degrees from the horizontal and vertical surfaces

(d) Work to falls and cross-falls shall be so described. Cutting at intersections on work to cross-falls shall be deemed to be included with the items. Firrings shall be given in linear meters stating the thickness and the average depth.

(e) Drips in flats shall be given in linear meters stating the size.

Weather boarding L7 Weather-boarding shall state the extreme thickness and width of the boards and the extent of the laps.

Gutter-boarding L8 (a) Gutter-boarding and gutter-sides over 300 millimeters maximum width in each length shall each be given separately in square meters. Those not exceeding 300 millimeters maximum width in each length shall each be given separately in linear meters stating the average width.

(b) Bearers shall be given in the description of gutter-boarding.

(c) Gusset ends, drips and sumps shall each be enumerated separately irrespective of size.

Eaves and verge boarding L9 (a) Boarding over 900 millimeters wide to eaves and the like (grouped together) shall be given in square meters. Boarding not exceeding 300 millimeters wide shall be given in linear meters stating the width.

		(b)	Bearers for boarding shall be given in linear meters stating the size.
Labours on boarding	L10	(a)	Raking cutting, curved cutting and scribed edges on boarding and perimeter cutting on diagonally-laid boarding shall each be given separately in linear meters.
		(b)	Splayed edges on boarding shall be deemed to be included with the items
		(c)	Rebates, grooves, chamfers, mitred angles and the like labours shall each be given separately in linear meters. Ends, angles and stops in all labours shall be deemed to be included with the items.
Fascia and barge boards	L11	Fascia-boards and barge-boards shall each be given separately in linear meters stating the width.	

FILLETS GROUNDS BATTENS AND BRACKETING

Fillets grounds and Battens Generally	L12	(a)	Fillets, grounds, battens and the like shall be given in linear meters stating the size.
		(b)	Angle fillets, tilting fillets, corner fillets and rolls shall be given in linear meters stating the extreme size.
		(c)	Angles, ends, intersections, mitres and the like shall be deemed to be included with the items.
		(d)	Clips for floor fillets shall be enumerated stating the method of fixing to concrete.
Skeleton framework	L13	(a)	Skeleton framework over 300 millimeters wide (measured overall) shall be given in square meters. Framework not exceeding 300 millimeters wide shall be given in linear meters stating the overall width of the framework. The size and the spacing of the members shall be given in the description.
		(b)	Skeleton framework framed on rake and spandrel-shaped framework (both measured net) shall each be so described. Skeleton framework of other irregular shapes shall be enumerated stating the size and shape of the framework and the size of the members.
		(c)	Alternatively the individual members may be measured in linear meters.
Bracketing	L14	(a)	Bracketing to form shaped false ceilings shall be given in detail.
		(b)	Bracketing and cradling (measured the extreme girth) around steelwork and to form false beams shall each be given separately in square meters stating the size of the members. Alternatively the individual members may be measured in linear meters.
		(c)	Bracketing for cornices shall be given in linear meters stating the extreme girth. Angle brackets shall be enumerated.

SUNDRIES

Plugging	L15	Plugging to concrete, brickwork, blockwork and stonework (grouped together and irrespective of the surface finish) shall be given in square meters or in linear meters or enumerated (as may be appropriate), or plugging may be given in the description of the work concerned.

SECTION M

JOINERY

The Unit of Billing shall be the Meter

GENERALLY TO SECTION M

Joinery M1 (a) Particulars of the following shall be given:-

i. Kind and quality of timber

ii. Preliminary treatment of timber (e.g. kiln drying; impregnation).

(b) Timber shall be deemed to b e wrought on all faces and edges and 3 millimeters shall be allowed from the nominal size for each wrought face or edge except where the work is described as being to finished sizes.

(c) Timber shall be deemed to be fixed with nails or steel screws. Particulars of any other method of fixing shall be given in the description of the item concerned.

(d) Timber over 225 millimeters wide in one width shall be so described stating the width; where not in one width the method of joining shall be stated.

(e) Curved or circular work shall be so described stating the radius. Work curved to more than one radius shall be so described stating the radii. Curved labours shall be so described.

(f) Rebates, grooves, chamfers, rounded edges, moulds not exceeding 50 millimeters girth and the like shall be termed labours. In members given in linear meters they shall be included in the description of the member on which they occur, stating the number (e.g. 100 millimeter by 50 millimeter frame with three labours). In work given in square meters the labours shall be given separately in linear meters. Ends, angles, mitres, stops and the like shall be deemed to be included with the labours. Masons mitres, stops which are splayed, shaped or moulded shall each be enumerated separately.

(g) Where the girth of the mould on any member is over 50 millimeters, the girth shall be stated in stages of 25 millimeters, except that any member which is fully-moulded shall be so described irrespective of the girth.

(h) Ends, angles and mitres and the like shall be deemed to be included with the items.

(i) Where this section requires the sizes of panes to be stated they shall be grouped and described as follows. Where panes of more than one size occur in any one sash, casement or door, the sizes shall be averaged for this purpose:-

i. Small (i.e. not exceeding 0.10 square meter each).

ii. Medium (i.e. over 0.10 square meters but not exceeding 0.50 square meter each).

iii. Large (i.e. over 0.50 square meters but not exceeding 1 square meter each).

FLOORING

Flooring generally	M2	(a)	Flooring shall be measured as executed. No allowances shall be made for tongues in tongued and grooved work and no deduction shall be made for voids not exceeding 0.50 square meters. Particulars of the following shall be given:- i. Nominal thickness ii. Method of jointing iii. Surface treatment after laying
		(b)	Flooring laid diagonally shall be so described
Board flooring and Strip flooring	M3		Board and strip flooring shall be given in square meters stating the nominal width of the boards or strips.
Cutting on flooring	M4	(a)	Raking cutting, curved cutting and scribed edges on board and strip flooring and perimeter cutting on diagonally-laid board and strip flooring shall each be given separately in linear meters.
		(b)	Cutting and fitting flooring around obstructions (e.g. detached columns; shaped ends of steps) notches, rounded corners, sinkings and the like shall be deemed to be included with the items.
Nosings and margins	M5		Nosings, bed-moulds and margins shall each be given separately in linear meters as extra over the flooring in which they occur stating the size. Tongued edges, rounded edges and moulded edges, also grooves in flooring shall be given in the description.
Access trapdoors	M6		Access trapdoors in floors shall be enumerated as extra over the flooring in which they occur stating the size. Bearers shall be given in the description.

BOARDED OR PANELLED LININGS, CASINGS AND PARTITIONS

Linings casings and partitions	M7	(a)	Boarded work shall be measured as executed. No allowance shall be made for tongues in tongued and grooved work and no deduction shall be made for voids not exceeding 0.50 square meters. Particulars of the following shall be given:- i. Nominal thickness ii. Type of boarding iii. Method of jointing

iv. Width of boards where required of a specific width

(b) Panelled work shall be measured as executed and no deduction shall be made for open panels of any size. Particulars of the following shall be given:-

i. Nominal thickness of the framing

ii. Nominal thickness of the panels and where other than rectangular the shape and arrangement thereof. Where panels do not exceed 0.10 square meters each they shall be so described.

(c) Panelled work with mouldings or bolection mouldings shall be so described stating whether worked on the solid or planted on and whether on one or both sides. Enriched mouldings and undercut mouldings shall each be so described.

(d) Panelled work with fielded panels, raised panels or raised and fielded panels shall each be so described.

(e) Panelled work with stiles, top rails or muntins over 100 millimeters wide, or with diminishing stiles, or with intermediate rails or bottom rails over 225 millimeters wide shall each be so described.

(f) Panelled work with curved heads (measured square) shall be so described stating the character of the curve (e.g. semicircular; segmental; elliptical).

Wall and ceiling linings — M8

(a) Linings over 300 millimeters wide to walls and ceilings shall each be given separately in square meters. Those not exceeding 300 millimeters wide (except where caused by voids) shall each be given separately in linear meters stating the width and where caused by voids shall be included with the work and given in square meters.

(b) Linings to ceilings over 3.50 meters above floor shall be so described stating the height in further stages of 1.50 meters.

(c) Panelled linings framed on rake and spandrel-shaped paneled linings (both measured net) shall each be so described. Panelled linings of other irregular shapes shall be enumerated stating the size and shape of the framework.

Beam and column casings — M9

(a) Casings (measured on external face) around sides and soffits of beams, lintols, cantilevers, pilasters, columns and the like (grouped together) shall be given separately in square meters except that casings with entasis shall be given in linear meters stating the maximum and the minimum girth and the number of casings.

(b) Casings around beams over 3.50 meters above floor (measured from ceiling level) shall be so described stating the height in further stages of 1.50 meters.

(c) Panelled casings framed on rake (measured net) shall be so described.

Cuttings on linings And casings — M10

(a) Cuttings on the individual boards of conical boarding, spherical boarding and groined boarding shall be deemed to be included with the items.

(b) Splayed edges on boarding shall be deemed to be included with the items.

(c) Rounded corners and the like shall each be enumerated separately stating the girth

Applied mouldings M11 Applied mouldings (other than panel moulds), cappings, inlays and the like shall each be given separately in linear meters stating the size. Enriched mouldings and undercut mouldings shall beach be so described.

Caps and bases to Columns M12 Caps and bases to columns and pilasters shall each be enumerated separately stating the size. Chamfers, mouldings and the like labours shall be given in the description.

Pipe casings M13 Casings (measured on external face) around pipes shall each be given separately in linear meters stating the girth and the number of sides.

Access trapdoors M14 Access trap doors in linings and casings shall be enumerated as extra over the work in which they occur stating the size. Bearers shall be given in the description.

DOORS, WINDOWS, SKYLIGHTS AND LANTERNS

Doors M15 (a) Doors shall be given in square meters irrespective of type (i.e. no distinction being made between single, folding, swinging and sliding doors) stating the thickness and the number of doors (each leaf being counted as one door). Fitting and hanging doors shall be deemed to be included with the items. Alternatively doors may be enumerated stating the size.

Doors shall be classified as follows:-

i. Flush doors stating the construction of the core, the finished thickness of the door, the kind, quality and thickness of the facing material and the method of fixing the facing material to the core. Solid lipping (to one or both vertical edges or to all four edges) and applied mouldings shall be given in the description. Openings in flush doors for glass shall be enumerated as extra over the floors in which they occur stating the size of the opening. Openings divided into panes shall be so described stating the size of panes and where other than rectangular the shape and arrangement thereof. Glazing beads shall be given in the description or in linear meters stating the size.

ii. Boarded doors stating the thickness of the boardings, ledges, braces and framing and the method of jointing the board covering or filling.

iii. Panelled doors stating the nominal thickness for the framing, the number and nominal thickness of the panels and where moulded stating whether the mouldings are worked on the solid or planted on and whether on one or both sides. Panelled doors with open panels for glass shall be so described. Open panels divided into panes shall be so described stating the size of the panes and where other than rectangular the shape and arrangement thereof. Glazing beads shall be given in the description or in linear meters stating the size. Panelled doors with top rails or muntins over 100 millimeters, or with diminishing stiles or with intermediate or bottom rails over 225 millimeters shall each be so described.

(b) Doors not exceeding 1 square meter in height shall be so described

(c) Doors of irregular shape (measured square) shall be described

(d) Doors with curved heads (measured square) shall be so described stating the character of the curve (e.g. semi-circular; segmental; elliptical).

Casements M16

(a) Casements shall be given in square meters stating the thickness and the number. Alternatively casements may be enumerated stating the size. Fitting and hanging casements shall be deemed to be included with the items. Those divided into panes shall be so described stating the size of the panes and where other than rectangular the shape and arrangement thereof. Glazing beads shall be given in the description or in linear meters stating the size.

(b) Bullseye casements shall be enumerated stating the thickness and the overall diameter.

(c) Casements with curved heads (measured square) shall be so described.

(d) Casements with curved heads (measured square) shall be so described stating the character of the curve (e.g. semi-circular; segmental; elliptical).

Double Hung sash Windows M17

(a) Double-hung sash windows shall be measured over the frames and sills

(b) Double-hung sash windows (complete with sashes, frames and sills) shall be enumerated stating the size or given in square meters stating the number of windows, the thickness of the sash and the sizes of the various parts of the frame and sill. Sashes divided into panes shall be so described stating the size of the panes. Glazing beads shall be deemed to be included with the items. Pulleys, cords, chains and weights or spring balances shall be given in the description. Fitting and hanging sashes shall be deemed to be included with the items.

(c) Multiple-light double-hung sash windows shall be so described. Solid mullions and cased mullions shall be given in the description stating the size of the members.

(d) Windows of irregular shape (measured square) shall be so described.

(e) Windows and curved heads (measured square) shall be so described stating the character of the curve (e.g. semi-circular; segmental; elliptical).

Skylights and lanterns M18

(a) Skylights and lantern-tops shall each be given separately and enumerated stating the size or alternatively given in square meters stating the thickness and the number. Glazing bars and fitting and hanging sky-lights shall be given in the description. Glazing bars and fitting and hanging sky-lights shall be given in the description. Glazing beads shall be deemed to be included with the items.

(b) Lantern-sides shall be given according to the rules for casements

(c) Rolls to ridges and hips (grouped together) shall be given in linear meters.

Window-boards and nosings	M19		Window-boards, nosings and bed moulds shall each be given separately in linear meters stating the size and number. Tongued edges, rounded edges, moulded edges and bearers shall be given in the description.

FRAMES, SILLS AND KERBS

Frames, sills and kerbs	M20	(a)	Frames, mullions, transoms, sills and kerbs shall be measured the length as fixed in the work. Framed ends, framed angles, framed intersections, halved and dovetailed joints, scarfed joints and the like shall be deemed to be included and to include the additional timber required.
		(b)	Members over 6 meters long in one length shall be so described stating the length in further stages of 1 meter.
		(c)	Door-frames, window frames (except to double-hung sash windows and to bullseye windows) lantern-frames, mullions, transoms, sills and kerbs shall each be given separately in linear meters stating the size. Frames to bullseye windows and the like shall be enumerated stating the size and overall diameter.
		(d)	Heading-joints in curved frames and in curved transoms shall be given in the description of the member but joints at the apex of shaped heads shall be enumerated. Keys, wedge and hand-rail screws shall be given in the description.

FILLETS, GLAZING BEADS AND GROUNDS

Fillets	M21	(a)	Weather fillets and the like shall be given in linear meters stating the size. Those which are tongued on shall be so described.
		(b)	Stop-fillets around doors and casements shall be given in linear meters stating the size. Cut and mitred stop-fillets around centre-hung casements shall be so described.
Glazing beads and glazing fillets	M22		Glazing-beads and the like except where otherwise included with the items shall be given in linear meters stating the size.
Grounds and wall battens	M23		Grounds (or battens) shall be given in linear meters stating the size, or they may be given in the description of the work concerned.
Skirtings, architraves in picture-rails and cornices	M24	(a)	Skirtings, architraves, picture-rails, dado-rails, wall mouldings, cornices, cappings, pelmets, cover-fillets and the like shall each be given separately linear meters stating the size.

(b) Built-up members shall be so described stating the size of each component. Bracketing shall be given in the description.

(c) Plinth-blocks to architraves shall be enumerated stating the size.

SHELVES, TABLE-TOPS AND SEATS

Shelves, table-tops and seats M25

(a) Shelves, divisions, table-tops, work-tops, counter-tops, seats and the like over 300 millimeters wide shall be given in square meters stating the thickness. Such work not exceeding 300 millimeters wide shall be given in linear meters stating the width and the thickness.

(b) Slated shelves and seats shall each be given separately in square meters stating the size and spacing of the slats and battens.

(c) Bearers and legs shall be given in linear meters stating the size. Framed work shall be so described.

Cuttings and housings on Shelves, table-Tops and seats M26

(a) Raking cutting curved cutting and scribed edges shall each be given separately in linear meters

(b) Rounded corners and the like shall be enumerated separately stating the girth.

(c) Housings, tongued and grooved joints, ship-lap joints and the like shall each be given separately in linear meters.

DRAINING-BOARDS AND BACKBOARDS

Draining- M27

(a) Draining-boards shall be given in square meters stating the thickness and the number. Those which are fluted on the surface shall be so described. Labours to edges shall be given in linear meters and openings shall be enumerated. Alternatively, draining-boards may be enumerated in which case the thickness and size shall be stated and all labours given in the description.

(c) Back-boards shall be enumerated stating the size. Labours to edges shall be given in the description.

FITTINGS AND FIXTURES

Fittings and fixtures M28

(a) Fittings and fixtures (e.g. cupboards; tables; work-benches; counters; dressers; bookcases) shall be given in detail in accordance with the relevant Clauses hereof, each under an appropriate heading stating the overall size. Alternatively, they may be enumerated and fully described. Fittings and fixtures of a similar character may be grouped together.

(b) Drawers shall be enumerated stating the overall dimensions, the thickness of the component parts and the method of jointing together.

Applied coverings	M29	(a)	Applied coverings (e.g. plastics) shall be given in square meters stating the method of securing. Alternatively, they may be given in the description of the work on which they occur stating whether on one or both sides. Splayed edges and chamfered edges to coverings shall be deemed to be included with the items.
		(b)	Applied coverings on edges shall be given in linear meters stating the width.

STAIRCASES

Staircases Generally	M30		Work in staircases shall be given under an appropriate heading.
Landings	M31	(a)	Landings shall be given in square meters stating the thickness and the method of jointing. Bearers shall be given in the description.
		(b)	Raking cutting and curved cutting shall each be given separately in linear meters.
Treads and risers	M32	(a)	Treads and risers (grouped together) shall be given in square meters stating the thickness and the method of jointing and blocking together. Winders (measured net) and their risers shall be so described. Carriages shall be given in the description stating the size.
		(b)	Raking cutting and curved cutting on treads (but not on winders) shall each be given separately in linear meters.
		(c)	Ends housed to strings shall be deemed to be included with the items.
		(d)	Returned ends, rounded ends, quadrant ends and curtail ends shall each be enumerated separately.
Strings, apron-linings and mouldings	M33		Strings, apron-linings, cappings and applied mouldings shall each be given separately in linear meters stating the size. Ramped members and wreathed members shall each be so described. Ends, angles and mitres, returned ends, and housed ends shall be deemed to be included with the items. Short ramps and short wreaths shall each be enumerated as extra over the member in which they occur. Quadrant-pieces and the like shall each be enumerated separately stating the size.
Handrails	M34	(a)	Handrails shall be given in linear meters stating the size. Curved handrails, ramped handrails and wreathed handrails shall each be so described. Quadrants, ramps and wreaths not exceeding 0.50 meters girth shall each be enumerated separately as extra over the members in which they occur, one quadrant or wreath being taken for each quarter-turn or less.
		(b)	Framed ends, housed ends, dowelled ends, rounded ends, moulded ends, scrolled ends, mitred angles, irregular angles, and the like to handrails shall each be enumerated separately. Ends on rake shall be so described. The overall size of scrolled ends shall be stated. Heading joints shall be deemed to be included with the items and handrail screws shall be given in the description.
Balusters newels	M35	(a)	Balusters shall be enumerated stating the size and the length. Framed ends and housed ends shall be given in the description stating if on rake.

(b) Newels and storey-posts shall be enumerated and where turned the length of the turned portion shall be stated. Sunk panels in newels and mouldings planted on or housed in shall each be enumerated.

(c) Newel-caps and pendants shall each be enumerated separately stating the size, the shape and the method of fixing.

STANDARD UNITS

Standard units M36 Stock-pattern units and standard units (e.g. doors; casement windows; double-hung sash windows; cupboards) shall be enumerated stating the appropriate reference. Ironmongery normally supplied with standard units shall be given in the description.

SUNDRIES

Plugging M37 Plugging to concrete, brickwork, blockwork and stonework (grouped together and irrespective of the surface finish) shall be given in square meters or in linear meters or enumerated (as may be appropriate); or plugging may be given in the description of the work concerned.

Holes in timber M38

(a) Holes and countersunk holes for bolts and the like shall each be enumerated separately stating the size of the bolt and the thickness of the timber. Pellating shall be given in description.

(b) Holes for pipes, tubes, bars, cables, conduits and the like members (grouped together) shall be enumerated stating the size of the member as Clause A4 hereof and the thickness of the timber. Fixing pipe-sleeves shall be given in the description.

(c) Holes for ducting, trunking, trays and the like members (grouped together) shall be enumerated stating the size of the member and the thickness of the timber.

IRONMONGERY

Ironmongery M39

(a) Particulars of the following shall be given:-

i. Kind and quality of ironmongery
ii. Surface finish
iii. Nature of the background (e.g. timber, metal) to which items are fixed
iv. Method of fixing

(b) Preparing timbers to receive ironmongery (e.g. sinking; boring; grooving; morticing) shall be deemed to be included with the items.

(c) Stock-pattern or, standard units (or sets) of ironmongery shall be enumerated stating the appropriate reference. Fixing with screws to match shall be deemed to be included with the items. Alternatively, supplying some or all of the ironmongery may be given as a provisional or prime cost sum as Clause A7

hereof (which shall be deemed to include supplying screws to match) in which case fixing the units (or sets) shall be enumerated. Where an item of fixing involves handling an ornamental or unusually expensive units (or sets) particulars of the character and value shall be given in the description.

(d) In the case of fanlight-openers and lantern-gearing, the character of the gearing and the method of securing shall be described

(e) In the case of sliding-door gear, each component shall be itemized in detail and the method of securing described

Water-bars	M40	Water-bars in sills and the like shall be given in linear meters stating the size. Those bedded in white lead or mortar shall be described.
Dowels and cramps	M41	Dowels and cramps shall each be enumerated separately stating the size. Mortices in timber shall be given in the description.
Bolts	M42	Bolts shall be enumerated stating the diameter and length. Nuts and washers shall be given in the description.

SECTION N

STRUCTURAL STEELWORK

The Unit of Billing shall be the kilogramme

GENERALLY TO SECTION N

Structural steelwork Generally

N1 (a) Steelwork shall be grouped as follows and each group with its associated labours shall be given under an appropriate heading:-

i. Unframed steelwork (i.e. steel mainly or completely unframed)

ii. Framed steelwork (i.e. steel in structures mainly or completely framed)

(b) Particulars of the following shall be given:-

i. Kind and quality of steel

ii. Any tests of materials, workmanship and finished structure

(c) In the case of framed steelwork, particulars shall also be given of the method of fabrication and the type of site connections (e.g. riveted; bolted; turned bolted; welded). Framing plans and all available detail drawings of framed steelwork shall be provided with the bill but where this is not practicable, the work shall be described in detail stating the area on plan, the number of storeys and the overall height of each block.

(d) Work in position involving extra handling or fixing between existing work shall be so described stating the location

(e) Steelwork shall be measured as executed but no deduction shall be made for splay cut, notches, holes and slots and no allowances shall be made for rolling margin or the weight of weld-metal. Plates of irregular shape shall be measured net. All cuttings, welds, notchings and the like labours shall be deemed to be included with the items.

(f) The weight given for compound or composite members (e.g. compound girders; roof trusses) shall be the aggregated weight of the component parts together with the weight of the bolts and rivet-heads.

(g) Where steel sections are required to be classified in accordance with this Clause, they shall be grouped and described as follows:-

i. Angles and tees (grouped together)

ii. Joists and channels (grouped together)

iii. Broad-flange joists and universal joists (grouped together)

iv. Castellated joists.

(h) Where the weight-groups of steel sections are required to be stated in accordance with this Clause, the weights per linear meter shall be grouped and described as follows:-

i. Not exceeding 5 kilogrammes

ii. Over 5 kilogrammes but not exceeding 10 kilogrammes

iii. Over 10 kilogrammes but not exceeding 20 kilogrammes

iv. Over 20 kilogrammes but not exceeding 50 kilogrammes

v. Over 50 kilogrammes but not exceeding 100 kilogrammes

vi. Over 100 kilogramme but not exceeding 150 kilogrammes

vii. Over 150 kilogrammes

(i) Steel sections (except those forming part of compound or composite members) in length not exceeding 1.50 meters shall be so described.

(j) Curved steel sections (except those forming part of compound or composite members) shall be so described stating the length, the radius or radii of the curve and whether curved in the width or the depth.

(k) Curved compound or composite members shall be so described stating the radius or radii and whether curved in the width or the depth

(l) Cranked members shall be so described stating the number of cranks.

GRILLAGES AND GIRDERS

Grillages N2

(a) Grillages shall be given in kilogrammes

(b) Plain grillages (i.e. those consisting of joists or channels) shall be so described and the components classified as Clause N1 (g) hereof stating the weight-group as Clause N1 (h) thereof.

(c) Compound grillages shall be so described and the components classified in accordance with the rules for compound girders in Clause N4 (c) hereof.

Girders N3

(a) Girders shall be given in kilogrammes

(b) Plain girders (i.e. those consisting of joists or channels) shall be so described and classified as Clause N1 (g) hereof stating the weight-group as Clause N1 (h) hereof.

(c) Compound girders shall be so described and classified as follows:-

i. Compound single (i.e. those consisting of one joist or channel with one or more flange-plates)

ii. Compound multiple (i.e. those consisting of two or more joists or channels with one or more flange-plates)

(d) Plate girders shall be so described and classified as follows stating the composition and depth (except where shown on the drawings provided):-

i. Plain plate (i.e. those consisting of one web-plate with angle-flanges)

ii. Compound plate (i.e. those consisting of one web-plate with angle-flanges and one or more flange-plates)

iii. Box plate (i.e. those consisting of two web-plates with angle-flanges and two or more flange-plates)

(e) Shelf-angles and stiffener-angles (grouped together) on girders shall be given in kilogrammes stating the weight-group of the angles as Clause N1 (h) hereof. Those required to be fitted to the girder shall be so described.

(f) Latticed girders shall be so described stating the length and the composition and depth (except where shown on the drawings provided)

(g) Runaway rails for traveling cranes on girders shall be given in the description of the girder to which they are attached stating the shape of the cross-section and the method of fixing. The weight of the runway rails together with the weight of the associated fastenings shall be aggregated with the weight of the girder.

STANCHIONS, COLUMNS AND PORTAL FRAMES

Stanchions N4

(a) Stanchions shall be given in kilogrammes

(b) Plain stanchions (i.e. those consisting of joists or channels) shall be so described and classified as Clause N1 (g) hereof stating the weight-group as Clause N1 (h) hereof and the number of stanchions.

(c) Compound stanchions shall be so described and classified as follows stating the number of stanchions:-

i. Compound single (i.e. those consisting of one joist or channel with one or more flange-plates)

ii. Compound multiple (i.e. those consisting of two or more joists or channels with one or more flange-plates)

(d) Latticed stanchions and battened stanchions shall each be so described stating the number of stanchions and the composition (where not shown on the drawings provided)

(e) Bloom-bases to stanchions shall be given in kilogrammes stating the number of bases, the method of attachment and the extent of machining required.

Solid or tubular columns N5

(a) Solid steel columns shall be given in kilogrammes stating the diameter and the number of columns.

(b) Tubular steel columns shall be given in linear meters stating the thickness of the metal, the outside diameter and the number of columns.

Portal frames N6 Portal frames shall be given in kilogrammes stating the composition and the span.

ROOF MEMBERS, BRACES, STRUTS AND RAILS

Roof trusses N7

(a) Roof-trusses shall be given in kilogrammes stating the span in stages of 3 meters and the composition (except where shown on the drawings provided)

(b) Gable-trusses, hip-trusses, half-trusses and valley-trusses shall each be so described.

Gables, hips and as valleys N8 Gable-members, hip-members, valley-members and the like (grouped together) shall be given in kilogrammes and classified as Clause N1 (g) hereof stating the weight-group Clause N1 (h) hereof.

Purlins and rails N9

(a) Purlins and rails shall be given in kilogrammes or alternatively in linear meters stating the weight.

(b) Plain purlins and plain rails (grouped together) shall be so described and classified as Clause N1 (g) hereof stating the weight-group as Clause N1 (h) hereof.

(c) Compound purlins, compound rails, battened purlins and battened rails (grouped together) shall be so described.

Braces and struts N10 Braces, struts and the like (grouped together) shall be given in kilogrammes and and struts classified as Clause N1 (g) hereof stating the weight-group as Clause N1 (h) hereof.

SUNDRIES

Fittings N11

(a) Fittings to unframed steelwork (e.g. caps; bases; splice-plates; cleats; brackets; stiffeners; distance-pieces; separators) shall each be enumerated separately stating the size and method of fixing. Notchings, bolts, rivets and welds shall be given in the description of the fittings.

(b) Fittings to framed steelwork shall be deemed to be included with the items and the weight of the fittings together with the weight of associated bolts and rivet-heads shall be aggregated with the weight of the member to which they are attached.

Holes	N12		Holes, countersunk holes and tapped holes which are required for other trades shall each be enumerated separately stating the size of the hole and the thickness of the metal. Those required to be made on site shall be so described. All other holes shall be deemed to be included with the items of both unframed and framed steelwork.
Site rivets	N13	(a)	Driving rivets on site shall be deemed to be included with the items. The weight of the heads of the rivets shall be aggregated with the weight of the work in which they occur.
		(b)	Countersinking rivet-heads on site shall be enumerated
Wedging bases and Grillages	N14		Wedging under stanchion-base and under steel grillages shall each be enumerated separately irrespective of the number of wedges.
Turned bolts	N15		Turned-bolts shall be enumerated stating the diameter and the length. Nuts and washers shall be given in the description.
Anchor bolts	N16		Anchor-bolts shall be given in kilograms stating the diameter. Nuts and washers shall be given in the description.
Gutters	N17	(a)	Gutters in conjunction with structural steel work shall be given in kilogrammes or alternatively in linear meters stating the shape of the cross section, the thickness of the metal and the method of jointing and securing.
		(b)	Gutter-fittings (e.g. bends; junctions; angles; stopped ends; outlets) shall each be enumerated separately as extra over the gutters in which they occur.
Painting	N18		Painting by the steel fabricators or erectors shall be given in kilogrammes of steel to be treated stating the preparation of surfaces, the number of coats to be applied and whether executed at the steelworks or at the site before erection or after erection. The parts to be treated shall be briefly described.

SECTION P

METALWORK

The Unit of Billing shall be the Meter

GENERALLY TO SECTION P

Metalwork Generally	P1	(a)	Particulars of the following shall be given:-
			i. Kind and quality of metal
			ii. Gauge, thickness or substance of metal and wire, both for the material and the labours thereon
			iii. Method of fixing, stating the nature of the background or support to which the metalwork is fixed
		(b)	Patterns for work required to be cast shall be deemed to be included with the items
		(c)	Work shall be deemed to be purpose-made unless otherwise described
		(d)	Work required to be welded shall be so described stating whether:-
			i. Members shall be welded and left as laid
			ii. Members shall be fillet-welded and left as laid
			iii. Members shall be prepared, welded and ground to smooth finish.
		(e)	Work required to be primed or painted before delivery to site shall be so described.
		(f)	Work required to be galvanized, chromium-plated, stove-enamelled, anodized or otherwise treated shall be appropriately described stating whether treated before or after manufacture or assembly
		(g)	Curved work shall be so described stating the radius
		(h)	Work shall be measured as executed but no deduction shall be made for notches, holes and slots and no allowance shall be made for rolling margin or weld-metal.

WORK IN PLATES, BARS, SECTIONS AND TUBES

Plates, bars sections and tubes generally	P2	(a)	Metal plates, bars, sections and tubes shall be deemed to be formed by casting, rolling, drawing, extruding or other appropriate method at the contractor's option unless a particular method is specifically.
Floor-plates and ductcovers	P3	(a)	Floor-plates shall be given in square meters stating the average size. Chequer plates and perforated plates shall each be so described.

		(b)	Duct-covers shall be given in linear meters stating the width. Chequer plates and perforated plates shall each be so described.
		(c)	Frames for duct-covers shall be given in linear meters stating the size and the shape of the cross-section. Lugs shall be given in the description stating the spacing. Ends, angles and intersections shall each be enumerated separately.
		(d)	Raking cutting and curved cutting on plates, shall each be given separately in linear meters.
Burglar bars and Grilles	P4	(a)	Burglar bars shall be given in linear meters stating the size. Fanged ends, twists, bends and the like shall be enumerated separately.
		(b)	Ornamental grilles shall be enumerated stating the size, pattern and method of fixing.
		(c)	Burglar proofing of flat bars forming part of and attached to windows shall be enumerated inpanes (irrespective of size) stating the size of the bars. Alternatively, burglar proofing may be given in the description of the unit to which it is attached.
Handrails and core-rails	P5	(a)	Handrails and core-rails shall each be given separately in linear meters stating the size and the shape of the cross-section. Fanged ends, rounded ends, scrolled ends, mitred angles, bends, ramps, wreaths and the like shall each be enumerated separately.
		(b)	Handrail brackets shall be enumerated stating the size and the girth.
Arch-bars, bearers and Stays	P6	Arch-bars, bearers, stays and the like shall each be given separately in linear meters stating the size. Fanged ends, twists, bends and the like shall be enumerated separately.	
Straps, collars and Brackets	P7	Straps, collars, hangers, cantilever-brackets, corbels and the like shall each be enumerated separately stating the size.	
Mat-frames	P8	Mat-frames shall be enumerated stating the size of the members and the overall size of the frame. Lugs shall be given in the description stating the number.	

WORK IN SHEET METAL

Coverings and linings	P9	(a)	Coverings to doors, bench-tops, counter-tops and the like shall each be given separately in square meters. Bending at edges shall be deemed to be included with the item.
		(b)	Linings to safes, cisterns, sinks and the like shall each be given separately in square meters. Bending at edges shall be deemed to be included with the items.
		(c)	Raking cutting and curved cutting shall each be given separately in linear meters.
		(d)	Welted or beaded edges, burned, brazed or welded angles, welted seams and the like labours shall each be given separately in linear meters.

(e) Dressing into hollows, dressing over curbs and the like labours shall each be given separately in linear meters. Bossed, brazed or welded ends, angles and intersections shall each be enumerated separately.

(f) Clout nailing, copper nailing and screwing at edges of coverings and linings shall each be given separately in linear meters. Close nailing and close screwing i.e. where spacing does not exceed 50 millimeters) shall be so described.

WORK IN WIRE MESH OR EXPANDED METAL

Wire mesh and expanded metal generally

P10 (a) Mesh coverings and expanded-metal coverings over 300 millimeters wide to partitions, door panels and windows shall each be given separately in square meters stating the size of mesh. Such coverings not exceeding 300 millimeters wide shall each be given separately in linear meters stating the size of mesh and the width in stages of 100 millimeters.

(b) The method of fixing (e.g. beads, staples, welding) shall be stated

(c) Raking cutting and curved cutting shall each be given separately in linear meters.

COMPOSITE UNITS

Composite units generally

P11 Composite units (other than standard units) shall be measured in detail in accordance with Clause P12 to P15 hereof and each unit with its associated labours shall be billed under an appropriate heading stating the character, the overall size and the number of units. Classification shall be as follows:-

i. Balustrades stating whether level or raking

ii. Railings stating whether level or raking

iii. Gates stating the shape where other than rectangular

iv. Grilles and gratings (grouped together) stating the shape where other than rectangular

v. Cloak-room fittings

vi. Cycle racks, storage racks and the like (grouped together)

vii. Ladders.

viii. Staircases, landings and gangways (grouped together)

ix. Framework and other supports for partitions, false ceilings, lift enclosures and the like (grouped together)

x. Tubular roof trusses

xi. Tubular purlins

xii. Tanks stating the shape where other than rectangular.

Members of composite units	P12	(a)	Rolled plates over 300 millimeters in both dimensions shall be given in square meters. Those not exceeding 300 millimeters in one dimension shall be given in linear meters stating the width. Those not exceeding 300 millimeters in both dimensions shall be enumerated stating the size.
		(b)	Rolled or extruded bars, sections and tubes shall each be given separately in linear meters stating the size.
		(c)	Cast members shall be enumerated stating the size the shape and the character. Standard castings shall be so described. Lugs cast on shall be given in the description stating the number.
Labours on Members of Composite units	P13	(a)	Raking cutting and curved cutting shall each be given separately in linear meters.
		(b)	Notches, slots and rounded corners shall be deemed to be included with the members of composite units.
		(c)	Fanged ends, pointed ends, rounded ends, bends, ramps, wreaths, twists and the like shall each be enumerated separately.
Opening portions of composite Units	P14	Opening portions in balustrades, railings and the like shall each be enumerated separately as extra over the work in which they occur stating the overall size. Hinges and fastenings shall be given in the description stating the type.	
Connections between members of nuts, composite units	P15	(a)	Cleated connections and plated connections shall each be enumerated separately stating the size of the cleat or plate and the thickness of the metals to be connected. Irregular connections shall be so described. Setscrews, bolts, washers, rivets, holes, countersunk holes, tapped holes, welds, spot welds and the like shall be given in the description stating the size.
		(b)	Bolted connections, screwed connections and welded connections shall each be enumerated separately stating the thicknesses of the metals to be connected. Irregular connections shall be so described. Setscrews, bolts, nuts, washers, holes, countersunk holes, tapped holes, welds, spot-welds and the like shall be given in the description stating the size.
Special metal windows and doors	P16	Special metal windows and special metal doors shall each be enumerated separately stating the overall size, the nature of the construction, the shape where other than rectangular, the finish and the number of opening portions.	

STANDARD UNITS

Standard units generally	P17	Assembling and jointing together the component parts of composite units and providing any necessary jointing compound shall be deemed to be included with the item concerned.

Standard metal windows And doors	P18	(a)	Standard metal windows and doors (complete with frames, mullions, transoms, hinges, fastening and lugs) shall each be enumerated separately stating the type. Composite windows and composite doors shall each be described.
		(b)	Steel accessories (e.g. subframes, subsills, window-boards and window surrounds) shall be enumerated separately stating the size and the type.
Steel door frames	P19		Steel door-frames (except those forming an integral part of a door unit) shall be enumerated stating the size and the type.
Fireproof doors and Strong room Doors	P20		Fireproof doors and strong room doors (complete with frames, hinges, fastenings and lugs) shall be enumerated separately stating the size and the type.
Roof-lights	P21		Lantern-lights, skylights, laylights and the like (complete with frames, mullions, ridges, hips, hinges, fastenings and lugs) shall each be enumerated separately stating the size and the type. Composite units shall be so described.
Pavements lights and Stallboard lights	P22		Pavement-lights and stallboard-lights (complete with frames, lugs and glass lenses) shall each be enumerated separately stating the size and the type.
Skirtings, picture-rails purlins and The like	P23		Skirtings, picture-rails and the like shall each be given separately in linear meters stating the size and the type. Fitted ends, mitred ends and the like shall be deemed to be included. Special fittings shall each be enumerated separately.
Duct covers	P24		Duct-covers (complete with frames and lugs) shall be given in linear meters stating the width and the type. Ends, angles and intersections shall each be enumerated separately.
Balustrades and railings	P25		Balustrades, railings and the like forming part of a building shall each be given separately in linear meters stating the height and described.
Collapsible gates and revolving shutters	P26		Collapsible gates, revolving shutters and the like (complete with frames, guides, tracks, fastenings, lugs and the like) shall each be enumerated separately stating the size and the type.
Grilles and gratings	P27		Grilles and gratings (complete with frames and lugs) shall each be enumerated separately stating the size and the type.
Surface boxes and Mat rims	P28		Surfaces-boxes, inspection-covers, mat-rims and the like (complete with frames and lugs) shall each be enumerated separately stating the size and the type.
Sectional Tanks	P29		Sectional tanks shall be enumerated stating the capacity, the size and the type.

SUNDRIES

Holes and slots	P30	(a)	Holes for pipes, tubes, bars, cables, conduits and the like members (grouped together) shall be enumerated stating the size of the member as Clause A4 hereof and the thickness of the metal.
		(b)	Other holes, countersunk holes, tapped holes, slots and the like (except where deemed to be included or where given in the description of other items) shall each be enumerated separately stating the size of hole or slot and the thickness of the metal.
Bolts	P31		Bolts, anchor-bolts, ragbolts and the like (except where deemed to be included or where given in the description of other items) shall each be enumerated separately stating the diameter and the length. Nuts and washers shall be given in the description.

SECTION Q

PLUMBING AND ENGINEERING INSTALLATIONS

The Unit of Billing shall be the Meter

GENERALLY TO SECTION Q

Plumbing engineering installations generally

Q1 (a) Work shall be grouped as follows and each group shall be given under an and appropriate heading:-

i. Rainwater installation

ii. Sanitary installation

iii. Cold and hot water installation

iv. Heating installation stating the type

v. Ventilating and air-conditioning installation stating the type

vi. Fire fighting installation

vii. Hydraulic installation

viii. Compressed air installation

ix. Gas installation stating the type

(b) Particulars of the following shall be given:-

i. Any regulations, rules, byelaws and the like with which the installation is required to comply

ii. Kind of material

iii. Quality of material

iv. Gauge, thickness or substance of material

v. Any tests with which materials, plant and equipment are required to comply

(c) Assembling and jointing together the component parts of composite units and providing any necessary mating flanges and jointing materials shall be deemed to be included with the items concerned. Where composite units are supplied by the employer, particulars of the assembly work involved shall be given.

(d) Patterns, moulds, templets and the like shall be deemed to be included with the items.

(e) Work required to be primed or painted before delivery to the site shall be so described.

(f) Work required to be galvanished, chromium-plated, stove-enamelled, porcelain-enamelled, anodized or otherwise specially finished shall be appropriately described stating whether treated before or after manufacture or assembly.

(g) The method of fixing and the provision of nails, bolts, nuts, holes, screws, plugs, shot-fired pins and the like shall be given in the description of the work. For cutting and pinning see Clause 45 hereof.

(h) The nature of the background to which work is fixed shall be given in the description of the work. Backgrounds shall be grouped and described as follows:-

i. Building-board (which shall be deemed to include hard-board, asbestos-cement sheet, plaster-board, fibreboard and similar materials which do not grip a wood-screw)

ii. Timber (which shall be deemed to include softwood, hardwood, blockboard, plywood and similar materials which will grip a wood-screw when a lead-hole has been drilled).

iii. Metal-faced or composition-faced timber (which shall be deemed to include faced block-board, faced plywood and similar materials which will grip a wood-screw when a lead-hole and a shank-clearance hole have been drilled)

iv. Brickwork, concrete or stonework (which shall be deemed to include reinforced concrete, block-work and similar materials which require plugging) irrespective of any plaster, composition or other finish (excluding glass or glazed tiles) to the surface

v. Backgrounds as (iv) but finished with glazed tiles or similar materials

vi. Plain metal (which shall be deemed to include any metal which requires drilling).

vii. Glass (which shall be deemed to include any material resembling glass)

(i) Heating, ventilating and air-conditioning work within boiler-houses and plant rooms and such work external to buildings shall be so described in each case.

(j) Temporary work shall be so described. Removing temporary work and making good after shall be deemed to be included with the items.

(k) Adequate drawings and specifications of engineering installations shall be provided with the bill.

GUTTERWORK

Gutters generally	Q2		Rainwater gutters (measured over all gutter-fittings, short running lengths and branches) shall be given in linear meters stating the type and the size.
Curved Gutters	Q3		Curved gutters shall be so described stating mean radius.
Gutter-joints	Q4	(a)	Providing materials, bolts, nuts, washers and everything else necessary for jointing shall be deemed to be included with the items of gutterwork.
		(b)	Joints in the running length shall be given in the description of the gutter stating the method of jointing.
Gutter-fittings	Q5		Gutter-fittings (e.g. bends; elbows; junctions; stopped ends; nozzle outlets) shall each be enumerated separately as extra over the gutter in which they occur. Cuttings and jointing the gutters to gutter-fittings shall be deemed to be included with the gutters.
Gutter-Supports	Q6		Lugs cast on to gutters, brackets and straps shall be given in the description of the gutter.

PIPEWORK

Pipes	Q7	(a)	Pipes (measured over all pipe-fittings, short running lengths and branches) shall be given in linear meters stating the type and the nominal size. Classification shall be according to the purpose for which the pipes are installed (e.g. over-flow; waste; soil and vent; cold water service; high pressure cold water supply; water main; cooling water; condense water; hot water service; flow and return header pipes; low pressure hot water heating; high pressure hot water heating; steam heating stating the pressure and the temperature; low-pressure hydraulic; high-pressure hydraulic; gas; compressed-gas; compressed-air; oil; smoke-flue; gas-flue)
		(b)	Flexible pipe and extensible pipes (measured as fully extended) shall each be so described.
		(c)	Pipes laid or fixed in ducts, trenches and chases shall be so described in each case.
		(d)	Pipes embedded in floor screed shall be so described
Special pipework	Q8	(a)	Curved pipes shall be so described stating the mean radius
		(b)	Wrapped, coated or lined pipework shall be so described stating the type of treatment.
		(c)	Pipework required to be temporarily fixed in position, dismantled for chromium-plating and subsequently re-fixed shall be so described.

Pipe joints Q9

(a) Providing materials, heat, bolts, nuts, washers and everything else necessary for making joints in pipes shall be deemed to be included with the items.

(b) Joints and connectors in the running length shall be given in the description of the pipe stating the method of jointing.

(c) Ornamental joints in the running lengths shall be enumerated as extra over the pipe in which they occur.

(d) Reducing joints between pipes of different sizes shall be enumerated as extra over the main pipe in which they occur. Classification shall be as follows:

i. Soldered branch joints

ii. Welded reducing joints

(e) Branch joints shall be enumerated as extra over the main pipe in which they occur. Perforating the pipe shall be deemed to be included with the items. Classification shall be as follows:-

i. Soldered branch joints

ii. Welded branch joints stating the type of branch (e.g. square; angle; sweep).

(f) Screwed sockets, tappings, bosses and welding-necks welded to pipes or flanges shall each be enumerated separately stating the size and kind of pipe or flange concerned. Perforating the pipe of flange shall be deemed to be included with the items.

(g) Special connections and special joints in pipes shall each be enumerated separately (except where given in the description of another enumerated item) stating the size and kind of pipe concerned and the method of jointing. Classification shall be as follows:-

i. Connections between pipes of differing materials

ii. Connections between pipes and appliances or equipment stating the nature of the appliance or equipment

iii. Isolated joints which differ from those given in the description of the pipe (e.g. flanged joints in pipes having welded joints generally).

iv. Expansion joints stating the type of joint (e.g. bellows; sliding) and the amount of the expansion to be accommodated.

(h) Connecting ends of flue pipe to boilers stone chimneys and the like shall each be enumerated separately stating the size and kind of pipe concerned, the method of jointing and the type of packing required.

Labours on pipes	Q10		Labours (e.g. made bends, made springs, made offsets) on pipes of all diameters shall each be enumerated separately as extra over the pipe on which they occur.
Pipe fittings	Q11		Pipe fittings (e.g. bends, springs, swan-necks, offsets. Y-junctions, double–junctions, shoes, blank flanges, puddle flanges, bushes, reducers, elbows, twin-elbows, tees, crosses, unions) except fittings as Clause Q9 (b) shall each be enumerated separately as extra over the pipes in which they occur. Cutting and fitting the pipes to all fittings shall be deemed to be included with the items.
Pipe support	Q12	(a)	Particulars of the method of fixing shall be given in the description of pipe-supports as Clause Q1 (g) hereof. Cutting and pinning ends of pipe-supports shall be given in the description of the items.
		(b)	Ears cast, soldered or welded on to pipes shall be given in the description of the pipe.
		(c)	Pipe-supports (e.g. clips; saddles; pipehooks; holderbats) shall be given in the description of pipes.
		(d)	Brackets; rollers; chairs and hangers; back-plates; and girder-lugs; anchors and guides for supporting pipes shall each be enumerated separately stating the size of the component and the size and kind of pipe. Spring compensated components shall be so described stating the loading and the movement to be accommodated.
		(e)	Pipe-stays and collars shall be enumerated stating the size and kind of pipe and the length of the stay.
		(f)	Pylons and other pipe-supports shall each be enumerated separately stating the size, the method of fixing and the nature of the structure.
Pipe-sleeves and plates	Q13	(a)	Pipe-sleeves shall be enumerated stating the length thereof, the size and kind of pipe passing through and the type of packing required.
		(b)	Wall-plates, floor-plates and ceiling plates shall each be enumerated separately stating the size thereof and the size and kind of pipe passing through. Where plates are fitted to pipe-sleeves they shall be given in the description of the sleeve stating whether to one of both ends.
Inspection doors	Q14		Inspection doors in pipes shall be enumerated as extra over the pipe in which they occur stating the method of sealing the door. Where such doors occur in pipe-fittings they shall be given in the description of the fitting concerned.
Dampers	Q15		Dampers in pipes shall be enumerated as extra over the pipe in which they occur stating the method of operation.
Traps, thimbles, ferrules, and cones	Q16		Traps, thimbles, ferrules, cones and the like shall each be enumerated stating the size thereof, the kind of pipe and appliances to which it is attached and the method of jointing thereto.
Rainwater-heads and Roof outlets	Q17		Rainwater, roof-outlets and the like shall each be enumerated separately stating the type, the size and the method of jointing

Hopper-heads	Q18		Hopper-heads and the like shall be enumerated stating the type and size thereof, the kind of pipe to which it is attached and the method of jointing.
Gratings	Q19		Gratings shall be enumerated stating the size of pipe of outlet to which it is attached.
Cowls, terminals, etc	Q20	(a)	Cowls, terminals, hinged flaps, cross-wired ends and the like shall each be enumerated separately stating the size and kind of pipe to which it is attached and the method of jointing thereto.
		(b)	Flashing-plates, weathering-aprons, cravats and the like shall be enumerated separately stating the size thereof and the size and kind of pipe passing through.
Exhaust Heads	Q21		Exhaust heads shall be enumerated stating the number, type and size of the connections
Driptrays	Q22		Drip-trays and tundishes shall each be enumerated separately stating the number, type and size of the connections.
Independent chimneys	Q23	(a)	Independent vertical steel chimneys shall be enumerated stating the internal diameter and the method of jointing. Base-plates, linings, claddings, anchor, bolts, guy-ropes, ladders, guard-rails, painter's hooks, cleaning-doors, cowls, terminals and the like shall be given in the description stating the number, the type and the size.
		(b)	Connections to boilers and connections to stone chimneys shall each be enumerated separately stating the method of jointing and the type of packing required.
Connections to mains	Q24		Connecting the ends of pipes at public mains, making good public highways and any other work which may only be carried out by a public undertaking or local authority shall be given as a provisional or prime cost sum as Clause A7 hereof.

DUCTWORK

Ducting	Q25	(a)	Ducting (measured over all duct-fittings, short running lengths and branches) shall be given in linear meters stating the size. Stiffeners shall be given in the description.
		(b)	Flexible ducting and extensible ducting (measured as fully extended) shall each be so described.
		(c)	Curved ducting shall be so described stating the mean radius
		(d)	Lining ducting internally with acoustic or protective material shall be given in the description of the ducting.
Ducting for joints	Q26	(a)	Providing materials, heat, bolts, nuts, washers and everything else necessary making joints in ducting shall be deemed to be included with the items.

(b) Joints in the running length shall be given in the description of the ducting stating the method of jointing.

(c) Special connections and special joints in ducting shall be enumerated separately (except where given in the description of another enumerated item) stating the size and kind of ducting concerned and the method of jointing. Classification shall be as follows:-

i. Connections between ducting of differing materials

ii. Connections between ducting and equipment stating the nature of the equipment

iii. Isolated joints which differ from those given in the description of the ducting (e.g. flanged joints in ducts having spigot and socket joints generally).

iv. Flexible connections between ducting and plant

Ducting fittings Q27 Ducting-fittings (e.g. stop-ends; bends; offsets; diminishing pieces; change of-section pieces; junction pieces; nozzle outlets) shall each be enumerated separately as extra over the ducting in which they occur. Where there is a preponderance of fittings (e.g. in plant rooms), they shall each be enumerated separately as individual items. Cutting and jointing ducting to the fittings and forming openings in ducting for branches shall be deemed to be included with the ducting. Forming and stiffening openings in ducting shall be given in the description.

Ducting supports Q28 (a) Particulars of the method of fixing shall be given in the description of ducting supports as Clause Q1 (g) hereof. Cutting and pinning ends of ducting supports shall be given as Clause Q45 hereof.

(b) Components for supporting ducting (e.g. brackets; hangers) shall be enumerated stating the size of the component and the size of the ducting. Spring compensated components shall be so described stating the loading and the movements to be accommodated.

Extract-hoods cowls and terminals Q29 Extract-hoods, cowls, terminals and the like shall each be enumerated separately stating the size and type thereof, the size of the ducting to which it is attached and the method of jointing hereto.

EQUIPMENT: TANKS, SANITARY AND FIRE FIGHTING APPLIANCES AND ANCILLARIES

Equipment Generally Q30 All items of equipment shall be enumerated and fully described

Water tanks Q31 Expansion tanks, water-storage tanks and condense-water tanks shall each be enumerated separately stating the type, the nominal or actual capacity in gallons and the number, type and size of the connections for pipes and mountings. Standing over-flows, access-holes and covers shall be given in the description stating the number, the type and the size.

Hot water and thermal-storage cylinders

Q32 (a) Hot-water cylinders and thermal-storage cylinders shall be enumerated separately stating the nominal or actual capacity in gallons, the working and test pressures, the maximum operating temperature and the number, type and size of the connections for pipes and mountings. Access-holes, covers and internal fittings shall be given in the description stating the number, the type and size.

(b) Electrical immersion-heaters shall be given in the description of the cylinders stating the loading. For electrical connections see Section R hereof.

Appliances generally

Q33 Assembling, providing mating flanges, couplings and everything necessary for jointing shall be deemed to be included with the appliance items. The method of fixing and jointing to service and waste pipes shall be stated.

Sanitary appliances

Q34 Baths, lavatory-basins, wash-tubs, showers, WC pans, WC suits, sinks, urinals, flushing cisterns, drinking fountains and the like shall each be enumerated separately stating the type and the size. Cantilever brackets shall be given in the description

Fire-fighting appliances

Q35 Fire-fighting appliances, foam-inlets, hydrants and the like shall each be enumerated separately stating the type and the size.

Ancillaries be generally

Q36 (a) Providing mating flanges, couplings and everything necessary for jointing shall deemed to be included with the ancillary items.

(b) Notwithstanding the following provisions for the enumeration of ancillaries, where such items form an integral part of the equipment to which they relate, or where they are required to be supplied by the manufacturer of the equipment to which they relate, they shall be given in the description of the equipment concerned.

Valves and cocks

Q37 Valves, cocks and other special fittings shall each be enumerated separately stating the type and the size. Those with extended spindles shall be so described stating the length of the spindle and detail of integral locking devices and remote operating gear. Those with hose-unions shall be described. Connecting ends of vales, cocks and the like to pipes and appliances shall be given in the description stating the kind and type of pipework and appliance and the method of jointing thereto.

THERMAL INSULATION

Thermal

Q38 (a) Particular of the following shall be given:-

i. Kind of insulating material

ii. Thickness

iii. Finish

iv. Method of fixing

(b) Smoothing the insulation material and working around supports (e.g. hangers; brackets) shall be deemed to be included with the insulation items.

Insulation to plant Q39

(a) Insulation to cylinders; tanks; and the like shall be enumerated stating the overall size of the unit. Particulars shall be given of any protection to the insulation.

(b) Working insulation around pipes, fittings and the like shall be deemed to be included.

Insulation to pipework And fittings Q40

(a) Insulation to pipework shall be given in linear meters stating the type and bore of the pipe. Particulars shall be given of any protection to the insulation

(b) Working insulation around valves, gauges and over flanges and pipe fittings and the like shall be deemed to be included. Particulars shall be given of any boxes for valves.

(c) Sectional insulating coverings to pipework shall be so described and given in accordance with paragraph (a) of this Clause.

(d) Fitting sectional coverings around pipe-fittings shall each be enumerated separately as extra over the sectional coverings in which they occur.

(e) Flanged joints in sectional coverings shall each be given in the description stating whether boxes are required. Isolated flanged joints (i.e. where not consistent with the general method of jointing described) shall be enumerated as extra over the sectional coverings in which they occur.

SUNDRIES

Marking positions Q41 Marking the position of holes, mortices, chases and the like in the structure for each installation shall be deemed to be included.

Plans of the installation Q42 Preparing plans or diagrams of the installation as fitted shall be given as an item stating the kind of information to be shown and the number of copies of each drawing required to be provided.

Testing the Installations Q43 Testing each installation shall be given as an item and fully described

BUILDER'S WORK

Builder's work generally Q44 Builder's work in connection with plumbing and engineering installations shall be grouped together under an appropriate heading and where required to be executed by the plumber or engineer it shall be so described and billed with the installation concerned.

Cutting and pinning	Q45	Cutting, pinning and making good ends of supports for equipment, appliances, fittings and the like shall be enumerated or may be included with the description of the support.
Cutting as away and Making good	Q46	Cutting away for and making good after the plumbers and engineers shall be given follows:-

i. Holes for pipes and the like shall be given in accordance with the rules in the appropriate section hereof

ii. Mortices, sinkings and the like shall each be enumerated separately stating the size thereof and the nature of the structure.

iii. Cutting chases shall be given in linear meters stating the size of the pipe classified in accordance with Clause A4 hereof and the nature of the structure.

SECTION R

ELECTRICAL INSTALLATION

The Unit of Billing shall be the Meter

GENERALLY TO SECTION R

Electrical installation generally

R1 (a) Work shall be grouped as follows and each group shall be given under an appropriate heading:-

i. Main switchgear (e.g. high-voltage gear; transformers; medium-voltage gear) and any other equipment serving more than one distribution group.

ii. Power-distribution

iii. Lighting

iv. Heating

v. Ventilating and air-conditioning

vi. Telephones

vii. Bells

viii. Clocks

ix. Sound-distribution

x. Signals

xi. Fire-alarms

xii. Burglar-alarms

xiii. Earthing conductors

xiv. Lighting conductors

(b) Particulars of the following shall be given:-

i. Type of installation

ii. Any regulations, rules, byelaws and the like with which the installation is required to comply

iii. Kind of material (e.g. cast iron; sheet steel; sheet copper; drawn copper)

iv. Quality of material

v. Gauge, thickness or substance of material

vi. Any tests with which materials, plant and equipment are required to comply

vii. Type and voltage of the main electricity supply stating the location of the main supply point.

(c) Assembling and jointing together the component parts of composite units and providing any necessary jointing materials shall be deemed to be included with the items concerned. Where composite units are supplied by the employer, particulars of the assembly work involved shall be given.

(d) Patterns, moulds templets and the like shall be deemed to be included with the items.

(e) Work required to be primed or painted before delivery to the site shall be so described.

(g) Work required to be galvanized, chromium-plated, stove-enamelled, anodized or otherwise specially finished shall be appropriately described stating whether treated before or after manufacture or assembly.

(h) The method of fixing and the provision of nails, bolts, nuts, holes, screws, plugs, shot-fired pins and the like shall be given in the description of the work.

(i) The nature of the background to which work is fixed shall be given in the description of the work. Backgrounds shall be grouped and described as follows:-

i. Building-board (which shall be deemed to include hardboard, asbestos-cement sheet, plaster-board, fibreboard and similar bases which do not grip a wood-screw.

ii. Timber (which shall be deemed to include softwood, hardwood, blockboard, plywood and similar bases which will grip a wood-screw when a lead-hole has been drilled).

iii. Metal-faced or composition-faced timber (which shall be deemed to include faced block-board, faced plywood and similar bases which will grip a wood-screw when a lead-hole and a shank-clearance hole have been drilled.

iv. Brickwork, concrete or stonework (which shall be deemed to include reinforced concrete, blockwork and similar bases which require plugging) irrespective of any plaster, composition or other finish (excluding glass and glazed tiles) to the surface.

v. Backgrounds as (iv) but finished with glazed tiles of similar materials.

vi. Perforated metal (which shall be deemed to include any metal which requires drilling)

vii. Glass (which shall be deemed to include any material resembling glass).

(j) Temporary work shall be so described. Removing temporary work and making good after shall be deemed to be included with the items

(k) Adequate drawings and specifications of the electrical installations shall be provided with the bill.

EQUIPMENT AND CONTROL GEAR

Equipment R2 Equipment (e.g. prime-movers; generators; motors; fans; mechanical drives; batteries; rectifiers; circuit-breakers; feeder-pillars; transformers) shall each be enumerated separately stating the rated capacity and the type. Connecting the cable-tails shall be deemed to be included with the items.

Control-gear R3 Control-gear (e.g. fuse-and-link disconnecting boxes; isolator-switches; changeover-switches; switch-fuses; fused-switches; distribution boards; contactors; starters; busbar-chambers) shall each be enumerated separately stating the rated capacity and the type. Connecting the cable-tails shall be deemed to be included with the items.

CONDUITS, TRUNKING AND TRAY

Conduits R4

(a) Conduits (measured over all conduit-boxes, conduit fittings, short running lengths and branches) shall be given in linear meters stating the type, the external size and the method of jointing. Conduits shall be deemed to be exposed unless described as concealed. Saddles or crampets shall be given in the description of the conduit stating the pattern. Bending, cutting, threading, jointing and providing all conduit-fittings (e.g. tees; elbows; bends; cover-plates; bushes; lock-nuts; stopping-plugs; reducing-bushes) shall be deemed to be included with the conduit items.

(b) Conduit-boxes shall be given in the description of the conduit stating the size and type of box. Special boxes (e.g. adaptable boxes; floor-trap boxes; boxes which are required to differ from those given in the description of the conduit) shall be enumerated as extra over the conduit in which they occur stating the type and size of box.

(c) Flexible conduits and extensible conduits (measured as fully extended) shall each be given separately in linear meters stating the type, the size and the terminations.

(d) Forming holes for conduit entries in special boxes, trunking, accessories, fittings, control-gear and equipment and providing associated components (e.g. bushes; lock-nuts; nipples; additional boxes) shall be deemed to be included with the items in which they occur.

(e) Conduits embedded in floor screed and conduits embedded in concrete shall be so described.

Trunking R5

(a) Trunking (measured over all trunking-fittings, short running lengths and branches) shall be given in linear meters stating the nominal size of the trunking, the number and the nominal size of any compartments and the method of jointing. Components for earth-continuity shall be deemed to be included with the trunking items.

(b) Trunking-fitting (e.g. stop-ends; bands; tees; crosses; offsets; reducers) shall each be enumerated as extra over the trunking in which they occur. Cutting and jointing trunking to such fittings shall be deemed to be included with the trunking.

(c) Forming openings in trunking for entries from equipment and control-gear (e.g. busbar-chambers; distribution-boards; isolator-switches; switches-fuses) shall be enumerated stating the size of the opening in the trunking and the thickness, type and size of any bushing material.

(d) Pin-racks for supporting cables in trunking shall be enumerated stating the type and the size.

Tray R6

(a) Tray for cables shall be given in linear meters stating the width, the method of jointing and the distance between the fixing centers.

(b) Stools shall be enumerated stating the size

(c) Tray-fittings (e.g. bends; tees; crosses; offsets) shall each be enumerated separately as extra over the tray in which they occur. Cutting and jointing tray to such fittings shall be deemed to be included with the tray.

CABLES AND CONDUCTORS

Cables R7

(a) Cables in conduits, ducts or trunking and cables fixed to try shall be measured as the net length of the conduit, duct, trunking or tray. Other cables shall be measured as laid (but without allowance for sag) between the boxes of equipment, control-gear, fittings, accessories and the like. The following allowance shall be made:-

i. 0.5 Meters on each cable entering fittings and accessories

ii. One meter on each cable entering equipment and control-gear

(b) Cables shall be given in linear meters stating the type and the size. Cables required to be colour-coded or otherwise marked for identification shall be so described. Classifications shall be as follows:-

i. Drawn into conduits or ducts.

ii. Laid in or drawn into trunking

iii. Laid in or drawn into trunking and laced into circuit groups

iv. Fixed to surfaces

v. Wrapped around pipework (e.g. trace heating).

vi. Laid in trench

vii. Fixed to insulators in overhead lines

viii. Suspended from catenaries.

(c) The following work shall be deemed to be included with the cables:-

i. Reading drawings and determining circuits

ii. Skinning ends of cables to expose the conductors

iii. Capping ends of cables (including the ends on cable drums or coils after cutting).

iv. Providing draw-wires, draw-cables and the like for drawing or hoisting cables.

v. Swabbing and clearing foreign matter from conduits, ducts, trunking and tray.

(d) Cables drawn into old conduits, old ducts or old trunking shall each be so described. Removing and replacing old covers, old inspection lids and the like, shall be deemed to be included with the items.

Cable-joints R8 (a) Cable joints shall be enumerated stating the type and size of cable. Joint-boxes, sealing-boxes and the like shall be given in the description stating the type. Materials and heat for making the joint shall be deemed to be included with the item.

(b) Line-taps shall be enumerated stating the size and type of the cable. Shrouds shall be given in the description stating the type.

Cable-Supports R9 (a) Components for supporting cables (e.g. saddles; cleats; clips; hangers; suspenders) shall be given in the description of the cables stating the type of component and the spacing along the cable.

(b) D-irons insulators and the like shall each be enumerated separately stating the type of component and the size and kind of cable.

Cable-termination glands R10 (a) Cable-termination glands shall be enumerated stating type and size of the cable and the type of gland. Providing insulating material, jointing material, lock-nuts, bushes and the like shall be deemed to be included with the items.

(b) Conduit-boxes, adaptable boxes and the like (used with cable-termination glands) shall each be enumerated separately stating the type and the size. Cable

connector-blocks shall be given in the description stating the type and the size. Connecting cable-tails to connector-blocks shall be deemed to be included with the items.

Cable-sleeves R11 (a) Supplying cable-sleeves (e.g. short lengths of metal pipe or of stoneware conduit) for fixing by other trades through walls, floors and ceilings shall be enumerated stating the size and the type of packing required.

(b) Wall-plates, floor-plates and ceiling-plates shall each be enumerated separately stating the size. Where plates are fitted to pipe sleeves they shall be given in the description of the sleeves stating whether to one or both ends.

Earthing conductors R12 (a) Tapes for earthing shall be given in linear meters stating the size. Saddles, cleats, clips, hold-fasts and the like shall be given in the description stating the type and the spacing along the conductor.

(b) Conductor connections and conductor junctions shall each be enumerated separately stating the type and size of the conductor. Tinning, sweating and providing any jointing materials, heat, holes, rivets, bolts, nuts, washers and clamps shall be deemed to be included with the items.

(c) Radius-bends (i.e. bends in the wide dimension of tape conductors) shall be enumerated as extra over the conductor in which they occur. Other bends shall be deemed to be included with the conductor items.

(d) Test-clamps shall be enumerated stating the type, the size and the method of connecting.

(e) Earth-electrodes shall be enumerated stating the type and the size. Driving the electrodes into ground shall be given in the description. Connecting the electrodes to the conductors shall be deemed to be included with the items. Excavating pits for earth-electrodes shall be given in accordance with Section D hereof.

Lighting conductors R13 (a) Lighting conductors shall be given in accordance with the rules for earthing conductors in Clause R 12 hereof.

FITTINGS AND ACCESSORIES

Lighting fittings R14 (a) Pendant fittings (e.g. plain flexible cord pendants; conduit pendants; chain pendants) shall be enumerated stating the length of the pendant drop in stages of 300 millimeters. Boxes, conduit-boxes, wood-blocks, moulded pattresses, break-joint rings, ceiling-roses, connector-blocks, dome-covers, back-plates, ball-and-socket back-plates, earth-continuity, flexible cords, conduit, chains, hooks, lamp-holders, swan neck bends and the like shall be given in the description stating the type and the size. Bushes, nipples, locknuts and connecting the cable-tails shall be deemed to be included with the items.

(b) Incandescent lighting fittings and fluorescent lighting fittings shall each be enumerated separately stating the type and the size. Boxes, conduit-boxes, wood-blocks, moulded pattresses, break-joint rings, ceiling-roses, connector-blocks, flexible cords, earth-continuity, chokes, capacitors, starters and lamp-holders shall be given in the description stating the type and size. Bushes, nipples, lock-nuts and connecting the cable-tails shall be deemed to be included with the items.

(c) Cold-cathode lighting fittings and connecting to the circuit wiring shall be given as a provisional or prime cost sum as Clause A7 hereof.

(d) Fixing lighting fittings provided by the employer shall be enumerated stating the type and the size. Accepting delivery, storing and handling the fittings and connecting the cable-tails shall be deemed to be included with the items. Providing any additional material and internal wiring required shall be given in the description. Where an item fixing involves handling an ornamental or unusually expensive fitting particulars of the character and value shall be given in the description.

(e) Lamps shall be enumerated stating the type, the wattage, the voltage and the kind of cap

(f) Lamp-locks shall be enumerated stating the type and the size

(h) Shades shall be enumerated stating the type and the size

Clocks, telephones, alarms, speakers and immersion-Heaters

R15 Clocks, telephones, fire-alarms, loud-speakers and the like shall each be enumerated separately stating the type and the capacity. Boxes conduit-boxes, wood-blocks, moulded-pattresses, cover-plates and the like shall be given in the description stating the type and the size. Connecting the cable-tails to the components shall be deemed to be included with the items.

(b) Electric immersion-heaters and the like shall be given in accordance with Section Q hereof. Connections to immersion-heaters shall be enumerated stating the capacity and the method of wiring.

Accessories

R16 Accessories (e.g. switches; socket-outlets; switch-socket-outlets; clock-connector points; thermostats; telephone-outlet points; bell-pushes; signal indicating units) shall be enumerated in gangs stating the rated capacity and type of each accessory and the number of accessories in each gang. Boxes, conduit boxes, wood blocks, moulded-pattresses, cover-plates, plug-tops and the like shall be given in the description stating the type and the size. Connecting the cable-tails to the accessories shall be deemed to be included with the items.

SUNDRIES

Marking be positions

R17 Marking the positions of holes, mortices, chases and the like in the structure shall given as an item for each installation. Where the nature of the work necessitates any of these to be formed during construction, the relevant particulars shall be given.

Identification plates	R18	Plates, discs and labels for the identification of plant, equipment, cables, switches and the like shall each be enumerated separately. Charts giving the key thereto shall be enumerated.
Loose keys tools and spares	R19	Loose keys, tools, spares and the like shall each be enumerated separately stating the type and quantity. Racks for holding tools and the like shall be enumerated stating the size.
Electric meters	R20	Electric meters shall be enumerated stating the capacity and the type. Connecting the cable-tails shall be deemed to be included with the items.
Connections to mains	R21	Connecting the ends of cables to public mains, making good public highways and other work which may only be carried out by a public undertaking or local authority shall be given as a provisional or prime cost sum as Clause A7 hereof.
Temporary operation of installation	R22	Temporarily operating each electrical installation shall be given as an item stating any required qualifications of the attendant, the duration of the operating period in hours, the purpose (e.g. lighting; heating; drying the building; reducing the ambient humidity) and particulars of any special insurance cover required by the employer. Providing current shall be given as a provisional or prime cost sum as Clause A7 hereof.
Disconnecting and re-fixing Equipment	R23	Disconnecting, setting aside and re-fixing equipment (e.g. radiators; convectors) for the convenience of other trades shall be given as an item stating the relevant particulars.
Plans of the installation	R24	Preparing plans or diagrams of the electrical installation as fitted shall be given as an item stating the kind of information required to be shown and the number of copies of each drawing required to be provided.
Testing the installations	R25	Testing the installations shall be given as an item stating particulars of any special insurance cover required by the employer. Providing instruments, appliances, fuel, water, gas, electricity, lighting and attendance for the tests shall be deemed to be included with the item.

BUILDER'S WORK

Builder's work generally	R26	Builder's work in connection with the electrical installations shall be grouped together under an appropriate heading and where required to be executed by the electrician shall be so described and billed with the installation.
Cable-trenches	R27	(a) Excavating cable-trenches shall be given in linear meters stating the average depth to the nearest 250 millimeters. Grading bottoms, planking and strutting, back-filling, compacting and disposing of surplus spoil shall be given in the description.
		(b) Sand for bedding cables in trenches shall be given in linear meters stating the average width and depth of the sand.
		(c) Cable-covers in trenches shall be given in linear meters stating the type and the size.

Cable-ducts and inspection chambers R28 Duct-trenches, stoneware ducts and inspection chambers for underground cables shall be given in accordance with the rules for drainage in Section V hereof.

Bedding and pointing R29 Bedding and pointing components or units of plant appliances and the like shall be enumerated stating the size thereof and the composition and mix of the bedding material.

Cutting and pinning R30 Cutting and pinning ends of supports for equipment appliances, fittings, trunking, tray and the like shall be enumerated.

Cutting away and making good R31

(a) In new structures (i.e. structures in the course of construction) cutting away for and making good after the electrician shall be enumerated as points stating whether conduits or cables are concealed or exposed. Classification shall be as follows:-

i. Lighting points stating the type and the size of the lighting fitting. Associated switch points shall be given in the description irrespective of number.

ii. Power points stating the type and the size of the power outlet. Associated switch points shall be given in the description irrespective of number.

iii. Fire alarms, signal points and bell points (grouped together). Associated push points and the like shall be given in the description irrespective of number.

iv. Meters, isolator-switches, switch-fuses, distribution-boards, busbar-chambers and the like (grouped together).

(b) In old structures, cutting away for and making good after the electrician shall be given as follows:-

i. Holes for conduits, cables, trunking, tray and the like shall be given in accordance with the rules in the appropriate Sections hereof.

ii. Mortices, sinkings and the like shall each be enumerated separately stating the size thereof and the nature of the structure

iii. Lifting and replacing old chequer-plates and the like shall be given in linear meters.

iv. Lifting and replacing old floorboards (measured along the route of the cable of conduit) shall be given in linear meters stating the number of cables or conduits in groups of 3 (e.g. not exceeding 3 cables or conduits; over 3 but not exceeding 6 cables or conduits). No distinction shall be made between routes parallel to or at angle to the floorboards. Cutting floorboards and notching joists shall be deemed to be included with the items.

v. Cutting chases shall be given in linear meters stating the size of the cable, conduit or trunking and the nature of the structure.

vi. Cutting out old plasterwork, old brickwork, old plain concrete, old reinforced concrete and the like not exceeding 300 millimeters in width and making good after shall each be given separately in linear meters.

Pylons and poles

R32 (a) Pylons, poles, hut-posts, wall-brackets, pole-brackets, pole-stays and the like for supporting cables shall each be enumerated separately stating the size, the method of fixing and the nature of the structure.

(b) Boring or excavating holes in ground for poles and stays shall be enumerated stating the depth, the nature of the filling (e.g. excavated material; concrete) and the treatment of the spoil.

(c) Excavating pits and forming concrete bases for pylons shall be given in accordance with the rules in Section D and F hereof.

(d) Catenaries shall be given in linear meters stating the type and the size. Eye-bolts, shackles and straining screws shall be given in the description stating the method of fixing.

Metalwork

R33 Metalwork in connection with the electrical installation (e.g. framework for supporting plant, control-gear, equipment and the like; metal ladders and gantries for access to plant; metal duct-covers) shall be given in accordance with the rules in Section P hereof.

PROTECTION

Protection

R34 Where the work involves the use of mineral-insulated copper-covered cable, protecting such cable shall be given as an additional item stating he total length.

FLOOR, WALL AND CEILING FINISHINGS

The Unit of Billing shall be the Meter

GENERALLY TO SECTION S

Floor, wall S1 (a) Work shall be grouped according to the kind of material and each group with its associated labours shall be given under an appropriate heading. For mastic asphalt floor finishings see Section J hereof.

(b) Work and labours on external surfaces shall be so described

(c) Work and labours executed overhand shall be so described

(d) Work and labours sin repairs shall be so described and the preparation of existing surfaces to receive such work shall be given in the description

(e) Work on existing surfaces shall be so described stating the thickness of any dubbing

(f) Work to pattern or in more than one colour shall be so described stating the nature thereof.

(g) Curved work, conical work and spherical work shall each be so described stating the radius. Eliptical work and other work curved to more than one radius shall be so described stating the radii. Curved labours shall be so described irrespective of the radius.

IN-SITU FINISHINGS

In-situ Finishings Generally S2 (a) Particulars of the following shall be given:-

i. Kind of material, composition and mix

ii. Thickness, which shall be deemed to be exclusive of keys, grooves and open joints in walling

iii. Number of coats. (where none stated the number shall be deemed to be at the Contractor's option)

iv. Nature of surface treatment (e.g. steel trowelled; wood floated).

v. Nature of base (e.g. concrete; brickwork; blockwork; metal lathing; screeded bed; screeded backing). Work on concrete, brickwork and blockwork may be grouped together provided the composition and mix of the finishing is the same in each case.

vi. Preparatory work (e.g. hacking concrete) and any special treatment of base (e.g. grouting; applying bonding-agent)

vii. Any special curing of finished work.

(b) Work shall be measured the area in contact with the base

Floors and pavings S3

(a) Floors and pavings to fall, cross-falls and slopes not exceeding 15 degrees from horizontal (grouped together) and to slopes over 15 degrees from horizontal shall each be given separately in square meters. Intersections on work to cross-falls shall be deemed to be included with the items.

(b) Work laid in bays or panels shall be deemed to be included with the items

(c) Work to floors laid in one operation with the base concrete shall be so described.

Walls and Ceilings S4

(a) Work to walls and ceilings shall each be given separately in square meters. Work to battering walls, to sloping ceilings, to sloping soffits of stairs and to flowing soffits of stairs shall each be so described.

(b) Work to ceilings and beams over 3.50 meters above floor (measured from ceiling level in both cases) shall each be so described stating the height in further stages of 1.50 meters.

(c) Work behind wood skirtings and the like shall be dealt with as work to walls disregarding any grounds.

(d) Work to sides of columns shall be included with work to walls

(e) Work to sides and soffits of beams (grouped together) shall be so described.

(f) Projecting quoins, projecting plinths and the like shall each be so described. Plinth blocks shall be enumerated stating the size.

Staircases S5

(a) Work to quarter-space and half-space landings (grouped together) shall be given in square meters. Work to larger landings shall be classified as work to floors.

(b) Work to treads, risers and edges of landings shall each be given separately in linear meters stating the width. Undercut risers shall be so described. Arrises, nosings and moulds shall be given in the description of the risers and edges. Ends and angles shall be deemed to be included.

(c) Non-slip inserts shall be given in linear meters as extra over the work in which they occur

(d) Flush bands (or similar margins) of contrasting colour in finishings to treads, risers and landings shall be given in accordance with Clause S8 (b) hereof.

(e) Work to wall-strings and open strings shall each be given separately in linear meters stating the extreme width. Ends and angles shall be deemed to be included with the items. Ramps and wreathed corners shall each be enumerated separately.

(f) Work to kerb-strings shall be given in linear meters stating the girth. Raking kerb-strings shall be so described. Arrises shall be given in the description. Ends

and angles shall be deemed to be included with the items. Ramps and wreathed corners shall be enumerated separately.

Labours on finishings S6

(a) All joints and fair joints to abutments and boundaries shall be deemed to be included with the items.

(b) i) Fair joints to flush edges of existing finishings (e.g. all kinds of existing in-situ, tile, slab, blocks, sheet and fibrous plaster-finishings) shall each be given separately in linear meters. Preparing edges of the existing finishings shall be deemed to be included with the joints.

ii) Coved joints shall be so described

(c) Internal angles shall be deemed to be included with the finishings in which they occur, except as otherwise provided in paragraph (e) of this Clause.

(d) Fair edges, rounded edges, chamfered edges, arrises, chamfered external angles not exceeding 25 millimeters wide, rounded external angles not exceeding 25 millimeters radius, coved internal angels not exceeding 25 millimeters radius, intersections to groins and the like shall be deemed to be included with the items.

(e) Quirks, beaded edges, moulded edges, chamfered external angles over 25 millimeters wide, rounded external angles over 25 millimeters radius and coved internal angles over 25 millimeters radius shall each be given separately in linear meters stating the girth of the visible contour. Ends, angles and intersections shall be deemed to be included within the items.

(f) Working finishings into recessed duct-covers and the like shall be given in linear meters as extra over the finishings in which they occur stating the width in stages of 100 millimeters. Working finishings into shaped insets, recessed manhole-covers, mat-sinkings and the like shall each be enumerated separately as extra over the finishings in which they occur stating the size.

(g) Making good around steel joists, channels, angles, tees, pipes, tubes, bars, cables, conduits, ducting, trunking, brackets, newels, WC pedestals, floor-springs, ventilators, soot-doors and the lie shall be deemed to be included with the finishings items.

(h) Dishing around gullies, outlets and the like (grouped together) shall be enumerated irrespective of size.

(i) Mortices, sinkings and the like shall each be enumerated separately stating the size or purpose.

(j) All cuttings on mosaic work shall be deemed to be included with the items.

Dividing strips S7 Dividing strips in finishings shall be given in linear meters stating the size. Ends, angles and intersections shall be deemed to be included with the items.

Skirtings bands and margins S8

(a) Skirtings shall be given in linear meters stating the height on face. Raking skirtings and vertical skirtings shall each be so described. Fair edges, rounded edges, beaded edges, moulded edges and coved junctions with paving shall be

given in the description. Ends, angles and ramps shall be deemed to be included with the items. Flush skirting formed in the same material as the wall finishing and having a vee or beaded top shall be dealt with in accordance with this sub-clause.

(b) Flush, raised or sunk bands (or similar margins) of contrasting colour in floor or wall finishings shall each be given separately in linear meters as extra over the finishings in which they occur stating the width in stages of 100 millimeters. Raking members and vertical members shall each be so described. Ends, angles, intersections and ramps shall be deemed to be included with the items.

Kerbs S9 Work to kerbs shall be given in linear meters stating the girth on face. Raking kerbs and vertical kerbs shall each be so described. Arrises, rounded edges and coves shall be given in the description. Ends, angles and inter-sections shall be deemed to be included with the items.

Channels S10

(a) Working finishings into shallow channels shall be given in linear meters as extra over the finishings in which they occur stating the girth on face. Channels to falls shall be so described. Arrises and coves shall be given in the description. Ends, angles and intersections shall be deemed to be included with the items.

(b) Linings to channels shall be given in linear meters stating the girth on face. Channels to falls shall be so described. Arrises and coves shall be given in the description. Ends, angles and intersections shall be deemed to be included with the items.

Mouldings and cornices S11

(a) Architraves, mouldings, ceiling-ribs and cornices (measured on face of wall or beam) shall each be given separately in linear meters stating the girth of the visible contour. Undercut mouldings, raking members and vertical members shall each be so described. Ends, angles and intersections shall be deemed to be included with the items.

(b) Cornices with bracketing shall be so described

(c) Cornices with flat or weathered tops shall be so described. The width of the top shall be deemed to be part of the visible contour for the purpose of sub-clause (a) of this Clause.

(d) Enrichments (i.e) regularly recurring features) shall be given n the description of mouldings. Ornaments (i.e. irregularly occurring features applied where required) shall be enumerated stating the size and character. Undercut enrichments and undercut ornaments shall each be so described.

Flush raised or sunk panels S12 Flush, raised or sunk panels of contrasting colour (or of different material) in finishings shall each be enumerated separately as extra over the finishings in which they occur stating the size and shape.

Metal beads S13 Metal angle-beads, screed-beads and casing-beads in plasterwork shall each be given separately in linear meters stating the method of fixing. Working plasterwork to the beads shall be included with the item.

TILE, SLAB OR BLOCK FINISHINGS

Tile, slab Or block Finishings Generally S14 (a) Particulars of the following shall be given:-

i. Kind of tile, slab or block units (e.g. precast concrete; precast terrazzo; precast mosaic; precast asphalt; clayware; brick; natural stone; cast stone; slate; marble; glass; plastics; composition; wood-blocks; metal; linoleum; cork; rubber)

ii. Thickness and size of tile, slab or block units

iii. Shape of units where other than rectangular

iv. Nature of surface finish (e.g. glazed; rubbed; polished)

v. Bedding or other method of fixing units and any additional security safe-guards required (e.g. screws; screws and rosettes; clips; anchors).

vi. Layout of joints (e.g. breaking joint; draughtboard pattern; basket pattern; herringbone pattern).

vii. Grouting, pointing or other finish to joints

viii. Nature of base (e.g. wood; screeded bed; concrete, brickwork and block-work grouped together).

(b) Temporary moulds for precast tile, slab and block units shall be deemed to be included with the items.

(c) Work shall be measured as executed.

Floors pavements walls, etc. S15 (a) Work to floors, pavements, walls, ceilings and staircases shall be given in accordance with the rules for in-situ finishings in Clause S3, S4 and S5 except that glass coverings shaving any of the labours mentioned in Clause S16 hereof paragraphs (d) (e) (g) (h) (i) (j) and (l) shall be enumerated as units stating the size.

(b) Bent glass coverings shall be enumerated as units stating the size, the radius or girth of the bend and whether bent in the long or the short dimension or both.

Labours on Finishings S16 (a) Square cutting shall be deemed to be included with the items.

(b) Raking cutting and curved cutting shall each be given separately in linear meters except where occurring within a pattern. In the case of work laid to diagonal

patterns, straight perimeter cutting and curved perimeter cutting shall each be given separately in linear meters except as otherwise provided in sub-clause (c) of this Clause.

(c) Plain block borders shall be given in the description of block finishings. Raking cutting and curved cutting on block finishings laid to a diagonal pattern within a plain border shall be deemed to be included with such finishings.

(d) Fair edges, rebated edges, rounded edges, chamfered edges, splayed edges, beveled edges and the like shall each be given separately in linear meters. Ends, angles and intersections shall be deemed to be included with the items, except that internal angles worked on the solid shall be enumerated.

(e) Moulded edges, grooves, flutes and the like shall each be given separately in linear meters. Ends, angles and intersections shall be deemed to be included with the items.

(f) Cutting and fitting into recessed duct-covers and the like shall be given separately in linear meters as extra over the finishings in which they occur stating the width. Cutting and fitting into shaped insets, recessed manhole covers, mat-sinkings and the like shall each be enumerated separately as extra over the finishings in which they occur stating the size. Jointing which is required to line up with adjoining work shall be deemed to be included.

(g) Cutting and fitting around steel joists, channels, angles, tees and the like (grouped together) shall be enumerated stating the size.

(h) Cutting and fitting around pipes, tubes, bars, cables, conduits and the like members (grouped together) shall be enumerated stating the size of the member in stages as Clause A4 hereof.

(i) Cutting and fitting around ducting, trunking, brackets, newels, WC pedestals, floor-springs, ventilators, soot-doors and the like (grouped together) shall be enumerated stating the size of the member.

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(j) Cutting and fitting around profiles of steps shall be enumerated stating the girth.

(k) Dishing around gullies, outlets and the like (grouped together) shall be enumerated irrespective of size.

(l) Mortices, sinkings, notches, rounded corners and the like shall each be enumerated separately stating the size, girth or purpose.

(m) Forming access panels shall be enumerated as extra over the finishings in which they occur stating the size and method of securing

(n) Any labours which are on glass coverings shall be given in the description of the glass units. The width of bevels shall be stated. Holes in glass units shall be given in the description and countersunk holes shall be so described.

Dividing strips S17 Dividing strips in finishings shall be given in linear meters stating the size. Ends, angles and intersections shall be deemed to be included with the items.

Skirtings, bands, margins and sills S18 (a) Skirtings shall be given in linear meters stating the extreme height. Raking skirtings and vertical skirtings shall each be so described. Rounded edges, moulded edges and junctions with paving shall be given in the description. In the case of stone, slate or coved marble coved skirtings the thickness stated shall include the projection of the cove. Ends, angles and ramps shall be deemed to be included in the items.

(b) Flush, raised or sunk bands (or similar margins) of contrasting colour in floor or wall finishngs shall each be given separately in linear meters as extra over the finishings shall each be given separately in linear meters as extra over the finishings in which they occur stating the width. Raking members and vertical members shall each be so described. Ends, angles and intersections shall be deemed to be included with the items.

(c) Sills and the like (grouped together) shall be given in linear meters stating the extreme width and thickness. Rounded edges and moulded edges shall be given in the description. Ends and angles shall be deemed to be included with the items.

Kerbs S19 (a) Work to kerbs shall be given in linear meters stating the girth on face. Raking kerbs and vertical kerbs shall each be so described. Rounded edges and covers shall be given in the description. Angles and intersections shall be deemed to be included with the items.

(b) Work to ends of kerbs shall be enumerated stating the size. Rounded edges and coves shall be given in the description.

Channels S20 Block channels and linings to channels shall each be given separately in linear meters stating the width and the average depth. Channels to falls shall be so described. Rounded edges shall be given in the description. Ends, angles, intersections and outlets shall each be enumerated separately.

Coves and mouldings S21 Special tiles and special slabs to form coved internal angles of any radius, rounded external angles of greater radius than the thickness of the finishing, architraves, mouldings, ceiling-ribs, cornices and the like shall each be given separately in linear meters stating the extreme size. Raking members and vertical members shall each be so described. Ends, angles and intersections shall each be enumerated separately.

Flush, raised or sunk panels S22 Flush, raised or sunk panels of contrasting colour (or of different materials) in finishings shall each be enumerated separately as extra over the finishings in which they occur stating the size and shape.

PLAIN SHEET FINISHINGS

Plain sheet S23 (a) Particulars of the following shall be given in:-

i. Kind of sheeting (e.g. plywood; chipboard; plasterboard; fibreboard; wall-board; asbestos-cement; plastic; linoleum; cork; rubber; steel; lead; zinc; aluminium; copper.)

ii. Thickness and quality of sheeting

iii. Method of fixing and treatment of joints

iv. Nature of base.

(b) Work shall be measured as executed

(c) Laps and seams shall be given in the description stating the extent of lap and the type of seam. No allowance in measurement shall be made for these and this shall be stated.

Floor finishings S24 Finishings to floors shall be given in accordance with the rules for in-situ finishings in Clause S3 hereof.

Wall and ceiling Finishings S25 (a) Finishings to walls and ceilings shall each be given separately in accordance with the rules for in-situ finishings in Clause S4 hereof.

(b) Cover-strips over joints of finishings shall be given in linear meters stating the size. Ends, angles and intersections shall be deemed to be included with the items.

Labours on S26 (a) Square cutting shall be deemed to be included with the items.

(b) Raking cutting and curved cutting shall each be given separately in linear meters except where occurring with a pattern.

(c) Rounded external angles and coved internal angles shall each be given separately in linear meters stating the girth of the visible contour.

(d) Cutting and fitting around pipes, tubes, bars, cables, conduits and the like members (grouped together) shall be enumerated stating the size in stages as Clause A4.

(e) Cutting notching and fitting around ducting, trunking, brackets, newels, WC pedestals, floor-springs, ventilators and the like (grouped together) shall be enumerated stating the size of the member.

(f) Cutting around profiles of steps and the like shall be given in linear meters

(g) Forming openings of all sizes shall be enumerated stating the size.

(h) Forming access panels shall be enumerated as extra over the finishings in which they occur stating the size and the method of securing.

BEDS AND BACKINGS

Beds and S27 (a) Particulars of the following shall be given:-

i. Composition and mix

ii. Thickness which shall be deemed to be exclusive of keys, grooves, open joints in walling

iii. Number of coats if more than one

iv. Nature of base as Clause S2 (b) (v) hereof

v. Preparatory work (e.g. hacking) and any special treatment of base (e.g. grouting; applying bonding agent).

(b) Beds and backings shall be measured the area in contact with the base

(c) Reinforced beds and reinforced backings shall be so described.

Beds and backings for floor, wall, ceiling and roof finishings S28 (a) Screeds, beds and backing for floor, wall, ceiling and roof finishings shall be given in accordance with the rules for in-situ finishings in Clauses S3 and S4 hereof stating the type of finish and the covering which they are to receive. All labours mentioned in Clause S6 hereof shall be deemed to be included with the items.

(b) Triangular and coved internal angle fillets at edges of screeds and beds shall each be given separately in linear meters stating the size.

(c) Forming shallow channels in beds shall be given in linear meters as extra over the beds in which they occur stating the girth on face. Channels to falls shall be so described. Arrises, rounded edges, coves, ends, angles, intersections, outlets and the like shall be deemed to be included with the items.

(d) Linings to channels shall be given in linear meters stating the girth on face. Channels to falls shall be so described. Arrises, rounded edges, coves, angles, intersections, outlets and the like shall be deemed to be included with the items.

LATHING AND BASEBOARDING

Lathing and S29 (a) Particulars of the following shall be given:-

i. Type and thickness of baseboarding and treatment of joints
ii. Type, gauge and mesh of metal lathing and extent of the laps
iii. Method of fixing

(b) Lathing and baseboarding shall be measured the area covered.

Baseboarding S30 Baseboarding (e.g. plaster-boarding) for wall and ceiling finishings shall be given in the description of the finishing applied to them. Raking cutting, curved cutting and notching shall be deemed to be included with the items.

Metal lathing S31

(a) Metal lathing over 300 millimeters wide for floor wall and ceiling finishings shall each be given separately in square meters. Such work not exceeding 300 millimeters wide (except where caused by voids) shall be given n linear meters stating the width in stages of 100 millimeters and where caused by voids shall be included with the work given in square meters.

(b) Raking cutting and curved cutting shall each be given separately in linear meters

(c) Forming openings and cutting metal lathing around pilasters, columns, steel sections, pipes, tubes, conduits, bars, cables, standards, ducting, trunking, brackets, floor-springs, ventilators and the like shall be deemed to be included with the items.

(d) Steel runners shall be given in linear meters stating the size and the method of fixing. Hangers shall be enumerated stating the size, the length and the method of fixing.

SUSPENDED PLAIN SHEET LININGS WITH SUPPORTING METAL WORK

Suspended S32

(a) Particulars of the following shall be given:-

i. Kind thickness and quality of sheeting

ii. Size and spacing of supporting metalwork (e.g. metal sections; brackets; hangers)

iii. Length of hanger

iv. Nature of structure to which the brackets and hangers are fixed and where to steel framing, the size and spacing of the members of such framing.

v. Method of securing brackets and hangers to structure.

(b) Linings shall be measured overall on the exposed faces and shall be deemed to include all necessary supporting metalwork and accessories for fixing.

Wall, ceiling S33

a) Linings over 300 millimeters wide shall be given in square meters. Those not exceeding 300 millimeters wide (except where caused by voids) shall be given in linear meters stating the width in stages of 100 millimeters and where caused by voids shall be included with the work given in square meters.

b) Linings to upstands of ventilators, roof-lights and the like shall each be so described

c) Linings under roofs shall be so described stating whether over or under the purlins and the nature of the roof coverings.

d) Linings over 3.50 meters from floor shall be so described stating the height in further stages of 1.50 meters.

e) Square cutting shall be deemed to be included with the items

f) Raking cutting and curved cutting shall each be given separately in linear meters except where occurring within a pattern.

g) Cutting around profiles of steps and the like shall be given separately in linear meters

h) Forming openings of all sizes shall be enumerated stating the size

i) Forming access panels shall be enumerated as extra over the linings in which they occur stating the size and the method of securing

Metal trim S34 Metal trim at edges of linings shall be given in linear meters stating the size and method of fixing. Ends, angles and intersections shall be deemed to be included with the items.

SELF-FINISHED PARTITIONS

Self-finished partitions S35 Self-finished partitions (e.g. precast terrazzo; precast mosaic) shall be given in accordance with the rules for precast concrete units in Section F hereof.

SECTION T

GLAZING

The Unit of Billing shall be the Meter

Glazing generally T1

(a) Work shall be grouped according to the kind and quality of glass and each group with its associate labours shall be described in accordance with the usual trade terms.

(b) Templates shall be deemed to be included with the items

(c) Materials resembling glass shall be given in accordance with the rules for glass.

GLASS IN OPENINGS

Panes Generally T2

(a) Particulars of the following shall be given:-

i. Kind, type and thickness (or substance) of glass. Thickness shall be deemed to be nominal unless described as exact.

ii. Kind and type of glazing compound

iii. Method of glazing (e.g. with compound and sprigs; with wood beads or mouldings; with metal beads or mouldings; with metal clips or angle pieces).

iv. Method of securing beads or mouldings (e.g. with brads; with screws)

v. Whether panes in beads or mouldings are bedded in compound

vi. Nature of sash or other surround (e.g. wood; metal; stone).

(b) Panes of irregular shape shall be measured as the smallest rectangular area from which such irregular shape can be obtained and shall be so described

(c) Panes in double-glazed lights not hermetically sealed (each pane measured separately shall be so described)

(d) Panes of Georgian wired polished plate and panes of patterned or decorated glass which are required to align one or both ways (within the limits of manufacture) between adjacent panes shall be so described.

Glass generally T3 Sheet glass, rolled or cast glass, plate float or toughened glass shall each be given separately in square meters stating the size of the pane where one or both dimensions are over the normal maximum stated below:-

Normal Maximum sizes

Sheet Glass … ¼"	3 meters x 2 meters 200 millimeters
Sheet Glass … 3/16"	2 meters x 1 meter 200 millimeters
Sheet Glass … 32 oz	1 meter 600 millimeters x 1 meter 200 millimeters
Sheet Glass … 18 oz	1 meter 200 millimeters x 1 meter
Polished Plate Glass ¼"	2 meters 200 millimeters x 3 meters 800 millimeters

The size of other panes shall be classified as follows:-

i. Not exceeding 0.10 square meters stating the number of panes

ii. Over 0.10 but not exceeding 0.50 square meters

iii. Over 0.50 and continuing in further stages of 0.50 square meters

Labours on T4

(a) Raking cutting shall be deemed to be included with the items

(b) Curved cutting shall be given in linear meters

(c) Blackened edges to panes shall be given in the description of the items

(d) Ground and polished edges and beveled edges shall each be given separately in linear meters stating the width of the bevel. Work on cured or on bent panes shall be so described. Internal mitres, scallops and other shapings shall be enumerated separately. External mitres shall be deemed to be included with the item.

(e) Grinding, sandblasting and embossing (measured over the whole are of the pane) shall each be given separately in square meters stating whether the pane is wholly or partly obscured. For embossing, the type of acid work shall be stated. For design work, a full description of the design stating the type of acid work shall be given, even if in plain lines. Where one or more dimensions of the pane does not exceed 300 millimeters, the size of the pane shall be stated.

Drilled panes T5 Drilled panes shall be enumerated stating the size of the pane, and the diameter and number of the holes. Counter sunk holes shall be so described.

Bent panes T6 Bent panes shall be enumerated stating the size of the pane, the radius or girth of the bend and whether bent in the long or the short dimension or both.

Brilliant cut panes T7 Brilliant cut panes and panes with other decorative work shall each be enumerated separately stating the nature of the decoration and the size of the pane.

Silvered panes T8 Silvered panes shall be enumerated stating the size of the pane. Coloured silvering and gold silvering shall each be so described. Venetian treatments sand protective coatings shall be given in the description.

Hermetically sealed units	T9	Double or multiple factory-made hermetically-sealed units shall be enumerated stating the size, type and altitude above sea-level at which they are to be fixed.
Glass louvers	T10	Double or multiple factory-made hermetically-sealed units shall be enumerated stating the size, type and altitude above sea-level at which they are to be fixed.
Bedding in strip material	T11	Bedding edges of panes in strips or channels shall be given in linear meters stating the kind of material.
Hacking out	T12	Hacking out old glass and preparing rebates (measured the perimeter of the pane) shall be given in linear meters.

LEADED LIGHTS & COPPER LIGHTS IN OPENINGS

Lights the generally — T13

(a) Particulars in accordance with Clause T2 (a) hereof shall be given with addition of the following:-

i. Type, section and width of panes stating whether nominal or finished width and whether reinforced.

ii. Shape of panes (e.g. rectangular; diamond; ornamental).

iii. Average size of panes.

(b) Lights shall be measured overall as executed. Opening lights ranging with fixed lights shall be measured the same size as the fixed lights. Lights of irregular shape shall be measured as the smallest rectangular area from which such irregular shape can be obtained and shall be so described.

(c) Lights which are required to align one or both ways between adjacent lights shall be so described.

(d) Fire-resisting copper lights shall be so described stating the Authority whose requirements are to be satisfied.

Lights in openings — T14

(a) Leaded lights and copper lights over 300 millimeters in both dimensions shall each be given separately in square meters without distinction as to the size. Those not exceeding 300 millimeters in one direction shall be given in linear meters stating the width. Those not exceeding 300 millimeters in both dimensions shall be enumerated stating the size.

(b) Lights with shaped heads, trefoils, quatre-foils and the like below the springing shall be included with those given in accordance with paragraph (a) of this clause. The shaped heads above the springing shall be given in square meters stating the shape and the number.

Labours on glass in lights	T15	Raking cutting and curved cutting on glass in lights shall be deemed to be included with the items.
Bent lights	T16	Bent lights shall be enumerated stating the size of the light, the radius or girth of the bend and whether bent in the long or the short dimension or both.

Saddle bars T17 Saddle bars shall be given in linear meters stating the material, the size of the bar and the method of securing the light.

Mirrors T18 Mirrors shall be enumerated stating the size and the method of fixing. Coloured mirrors shall be so described. Protective coatings, holes, countersunk holes, brilliant cutting, polished edges, beveled edges, rounded corners and the like shall be given in the description.

PATENT GLAZING

Patent the glazing T19

(a) Patent glazing (measured over bars) shall be given in square metes stating length and spacing of the glazing bars, the nature of the beading (e.g. timber; metal; concrete) and the span between bearings. Classification shall be as follows;-

i. To roof

ii. To skylights.

iii. To lantern lights stating the type (e.g. lean-to; gable-ended; hipped domed; barrel)

iv. To vertical surfaces

(b) Opening portions of patent glazing shall be enumerated as extra over the work in which they occur stating the size. Opening gear shall be given in the description stating the type and the method of fixing.

Labours on Patent glazing T20 Raking cutting and curved cutting shall each be given separately in linear meters.

DOME-LIGHTS

Dome-lights T21 Dome-lights shall be enumerated stating the overall size, the shape and the method of fixing.

SECTION U

PAINTING AND DECORATING

The Unit of Building shall be the Meter

GENERALLY TO SECTION U

Painting and Decorating generally U1

(a) Work shall be grouped as follows and each group shall be given under an appropriate heading:-

i. Internal work

ii. External work

(b) Work required to be executed on members before they are fixed shall be so described.

(c) Material required to be applied by a particular method shall be so described stating the method.

(d) Work shall be measured the area covered and appropriate allowances made (unless otherwise provided herein) for the extra girth of edges, mouldings, panels, sinkings, corrugations, flutings, carvings, enrichments and the like.

PAINTING AND SIMILAR WORK

Painting And similar Work generally U2

(a) Particulars of the following shall be given:-

i. Kind and quality of materials

ii. Nature of work (e.g. limewhiting; distempering; painting; staining; graining; varnishing).

iii. Nature of the base on which work is executed

iv. Preparatory work (e.g. rubbing down; burning off; stripping old paper or other decorations; cutting out and repairing cracks; knotting; stopping; spot-priming; applying strips of scrim).

v. Number of priming or sealing coats

vi. Number of undercoats

vii. Number of finishing coats stating the surface finish

(b) Rubbing down between coats with glasspaper shall be deemed to be included with the items. Particulars of any other abrasive required to be used shall be given.

(c) Moulding and bands picked out in colours different from the surrounding work shall be so described.

On general U3 meters. Surfaces

(a) Work on surfaces over 300 millimeters girth shall be given in square Work on isolated surfaces not exceeding 300 millimeters girth shall be given in linear meters stating the girth in stages of 100 millimeters. Work on isolated surfaces not exceeding 0.10 square meter shall be enumerated irrespective of size. Classification of work shall be as follows:-

i. On walls

ii. On ceilings

iii. On floors

iv. On other general surfaces (grouped together) except those separately dealt with herein.

(b) Work on ceilings (having no applied finish other than the painting) requiring scaffolding over 3.50 meters shall be so described stating the height in further stages of 1.50 meters.

(c) Work on friezes shall be added to similar work on abutting walls or ceilings. Work on piers and columns shall be added to similar work on walls. Work on beams and cornices shall be added to similar work on ceilings.

(d) Work on corrugated surfaces, fluted surfaces and carved surfaces shall each be so described (measured overall regardless of actual girth).

(e) Work on surfaces with apertures or indentations (e.g. honeycomb walling; plain or ornamental concrete grilles and the like) shall each be so described and measured overall regardless of voids or actual girth.

(f) Work in multi-colours (i) on walls (ii) on ceilings and beams and (iii) on cornices shall each be so described. The terms multi-colours shall only be used in connection with work on such surfaces and shall mean the application in one room of more than one colour on either the walls, or the ceilings, beams and cornices; except that where a frieze is finished in the same colour as the ceiling and the remainder of the wall is finished in a different colour, this shall not be regarded as work in multi-colours.

(g) All cutting in shall be deemed to be included with the items.

(h) Carved rosettes, modillions, centre flowers and the like (grouped together) picked out in colour different from the surrounding work shall be enumerated stating the size.

On wood frames, wood Windows and Glazed wood Doors	U4	(a)	Work on wood frames, linings, architraves, mullions and transoms (measured on each side) shall be given in accordance with Clause U3 hereof
		(b)	Work on wood sashes, wood casements and glazed wood doors (grouped together and measured on each side over glass) shall be given in square meters.
		(c)	Work on edges of opening casements and additional painting (caused by opening lights) on the surrounding frame shall be deemed to be included with the items.
		(d)	Work on glazing beads, butts and fastenings shall be deemed to be included with the items to which they are attached.
On metal windows and glazed metal doors	U5	(a)	Work on metal windows and glazed metal doors (grouped together and measured on each side over permanent ventilators, frames, mullions, transoms and glass) shall be given in square meters.
		(b)	Work on edges of opening casements and additional painting (caused by opening lights) on the surrounding frame shall be deemed to be included with the item.
		(c)	Work on metal sub-sills, hopper-cheeks and the like shall be measured and added to similar work on metal windows.
		(d)	Work on glazing beads, butts and fastenings shall be deemed to be included with the items to which they are attached.
On structural steelwork	U6	Work on structural steelwork shall be given in square meters. Work on members of roof trusses, lattice steelwork and the like (grouped together) shall be so described. Work on hookbolts, clips and the like shall be deemed to be included with the purlins, rails and the like with which they are associated.	
On grilles, balustrades, railings and mesh	U7	(a)	Work on ornamental grilles, ornamental balustrades, ornamental railings, ornamental gates and the like (measured overall regardless of voids) shall each be given separately in square meters. Each side shall be measured and this shall be stated.
		(b)	Work on mesh, chain-link, expanded metal, welded mesh and the like (measured overall) shall each be given separately in square meters. Each side shall be measured and this shall be stated.
On gutters	U8	(a)	Work over 300 millimeters girth on valley-gutters, parapet-gutters and the like grouped together) shall be given in square meters. Work not exceeding 300 millimeters girth on such members shall be given in linear meters stating the girth in stages of 100 millimeters.
		(b)	Work (of any girth) on eaves-gutters shall be given in linear meters stating the girth in stages of 100 millimeters (or the size of the gutter)/ Work on ordinary brackets shall be deemed to be included with the work on eaves-gutters but work on ornamental brackets shall be enumerated.

On pipes	U9	(a)	Work on small pipes shall be given in linear meters
		(b)	Work on large pipes shall be given in linear meters
		(c)	Work on extra large pipes hall be given in square meters (measured externally) or be given in linear meters stating the diameter.
		(d)	Work on lagged pipe shall be given in square meters (measured externally).
		(e)	Work on pipes in different colours for identification purposes shall be so described.
On bars, cables, conduits, straps and ducting	U10	Work over 300 millimeters girth on bars, cables, conduits, standards, straps, ducting, trunking, tray and the like (grouped together) shall be given in square meters. Work not exceeding 300 millimeters girth on such members (grouped together) shall be given in linear meters stating the girth in states of 100 millimeters. Work on conduit boxes and the like shall be deemed to be included with the work on conduits.	
On sundries	U11	(a)	Work on saddles, pipehooks, holderbats and the like shall be deemed to be included with the work on pipes, tubes and conduits, but work on other components for fixing (e.g. straps and hangers) shall be given separately.
		(b)	Work on ventilating gratings, soot-doors, flushing-cisterns, rainwater-heads, brackets, strap-hinges and the like shall each be enumerated separately irrespective of size.

POLISHING

Polishing	U12	(a)	Particulars of the following shall be given:-
			i. Kind and quality of materials
			ii. Type of polish (e.g. French polish; wax polish).
			iii. Nature of base on which work is executed
			iv. Preparatory work on base (e.g. staining; fuming; bodying in; stopping; rubbing down).
		(b)	Polishing shall be given in accordance with the rules for painting.

SIGNWRITING

Signwriting	U13	Letters or numerals, stops, direction-indicators and the like shall each be enumerated separately stating the style and height of the letters or numerals and the number of coats. Work finished with gold leaf shall be so described.

SECTION V

DRAINAGE

The Unit of Billing shall be the Meter

GENERALLY TO SECTION V

Drainage generally	VI	(a)	Any information available concerning the nature of the ground and strata and particulars of any trial holes or trial bores shall be given.
		(b)	Work beyond the boundary of the site shall be so described
		(c)	Work inside existing buildings shall be so described. Handling materials and getting them in or out of such buildings shall be deemed to be included with the items.

WORK IN ALL TRADES

Pipe trenches	V2	(a)	Excavating pipe trenches shall be given in linear meters stating the starting level if other than the existing ground level, the depth-range in successive steps of 1.50 meters (e.g. not exceeding 1.50 meters total depth; between 1.50 meters and 3.00 meters total depth) and the average depth with the depth-range to the nearest 250 millimeters. Excavating curved trenches shall be so described. The internal diameter of the pipe to be received shall be stated in each case, except that trenches to receive pipes not exceeding 150 millimeters in diameter may be grouped together and so described. Grading bottoms, planking and strutting, filling, compacting and disposing of surplus spoil shall be deemed to be included with the items.
		(b)	Excavating trenches in running silt or running sand (grouped together) shall be in cubic meters as extra over all kinds of trenches irrespective of depth.
		(c)	Excavating trenches in rock (as defined in Clause D5 (d) hereof) shall be so described or may be given in cubic meters as extra over all kinds of trenches for breaking up rock irrespective of depth. When given in cubic meters the maximum width to be measured shall be stated.
		(d)	Breaking up concrete, reinforced concrete, brickwork and the like met with in excavation shall each be given separately in cubic meters as extra over all kinds of trenches irrespective of depth.
		(e)	Breaking up surface concrete, reinforced surface concrete, brick paving, tarmacadam and the like on the surface of the ground shall each be given separately in linear meters as extra over all kinds of trenches irrespective of depth.
		(f)	Disposal of water shall be given in accordance with Clause D 18 hereof.

Beds benchings and coverings	V3	Concrete beds, benchings and coverings shall each be given separately in linear meters stating the mix and size of the concrete and the internal diameter of the pipe. Formwork shall be given in the description.
Pipes	V4	(a) Pipes of any material (measured over all pipe-fittings) shall be given in linear meters stating the kind of material, the quality of pipe the internal diameter and the method of jointing. (b) Pipe-fittings (e.g. bends; junctions; diminishing pipes) shall each be enumerated separately as extra over the pipes in which they occur. Cutting and jointing pipes to such fittings shall be deemed to be included with the items. (c) Suspended pipes shall be so described and the supports enumerated separately. (d) Vertical pipes shall be so described.
Accessories	V5	Accessories (e.g. gullies; traps; inspection shoes; fresh-air inlets; non-return flaps) shall each be enumerated separately stating the kind, quality and size of the accessory and the internal diameter of each inlet and outlet. Jointing pipes to such accessories, bedding in concrete and providing gratings, sealing plates and the like shall be given in the description of the accessories.
Open surface water channels and Drains	V6	Open surface water channels and drains shall be given in linear meters and fully described. Excavation and formwork shall be given in the description. Angles ends and intersections shall be deemed to be included with the items.
Manholes, soakaways, cesspits and Septic tanks	V7	(a) Inspection chambers, manholes, soakaways and the like (grouped together) shall be given in detail under an appropriate heading stating the number of each type of unit. (b) Cesspits, septic tanks and the like for the treatment and disposal of sewage shall each be given separately in detail under an appropriate heading stating the number of units. (c) Excavation, concrete work, walling and other work shall be given in accordance with the rules in appropriate Section hereof. (d) Building in ends of pipes shall be enumerated stating the internal diameter of the pipe. Cutting pipes shall be deemed to be included with the items. (e) Channels, concrete benchings, foot-irons, covers and intercepting raps shall each be enumerated separately stating the type, the quality, the size. (f) Work in existing manholes, cesspits and septic tanks shall each be so described.
Connections to sewers	V8	Connecting ends of drains to public highways and any other work which may only be carried out by a Local Authority shall be given as a provisional or prime cost sum as Clause A7 hereof.
Testing Drains	V9	Testing the drainage system shall be given as an item stating the method of testing.

SECTION W

FENCING

The Unit of Billing shall be the Meter

GENERALLY TO SECTION W

Fencing generally W1

(a) Particulars of the following shall be given:-

i. Kind of material (e.g. softwood; hardwood; concrete; steel).

ii. Preliminary treatment of material (e.g. impregnating; galvanizing).

(b) Fencing specially designed to suit sloping ground shall be so described.

(c) Fencing set out to a curve (i.e. straight between posts) shall be so described irrespective of radius. Curved fencing (i.e. curved between posts) shall be so described stating the radius.

(d) Posts, struts and other supports which occur at regular intervals in fencing shall be given in the description of the fencing stating the size, the spacing, the height above the surface of ground or base and the depth below such surface.

(e) Ends-posts, angle-posts, gate-posts, straining-posts and other posts which differ from those given in the description of the fencing in which they occur stating the size and the depth in the ground or other base. Struts shall be given in the description stating the size, the number and the method of fixing to the post.

(f) Excavating and bedding ends of posts, struts, end posts, angle posts, gate stops, gate catches and the like in concrete shall be given in the description of the item stating the composition and mix of the concrete.

(g) Fencing shall be measured overall (i.e. over posts and other supports). The height of fencing shall be measured from the surface of the ground (or other base) to the top of the filling (or to the top wire) between the posts.

OPEN-TYPE FENCING

Post-and-wire fencing W2

Post-and-wire fencing shall be given in linear meters stating the height of the fencing, the gauge and number of line-wires, the method of attaching the line-wires to the posts (e.g. threaded through the posts; stapled to the posts) and the method of straining. Barbed wire shall be so described stating the spacing of the points.

Post-and-rail fencing	W3	Post-and-rail fencing shall be given in linear meters stating the height of the fencing, the size and number of horizontal rails and the method of fixing the rails to the posts.
Chain-link and wire-mesh fencing	W4	Chain-link fencing and wire-mesh fencing shall each be given separately in linear meters stating the height of fencing, the gauge and number of line-wires, the method of attaching the line-wires to the posts, the size of mesh and gauge of wire in the fabric and the method of attaching the fabric to the line-wires.
Metal bar fencing	W5	(a) Metal bar fencing shall be given in linear meters stating the height of the fencing, the size, spacing and arrangement of the bars, the treatment of the tops of the bars (e.g. pointed; shaped), the size and number of the rails, the method of assembling (e.g. riveted; welded) and the method of fixing the rails to the posts. Side-stays, back-stays and struts shall each be enumerated separately stating the size and the method of fixing. (b) For railings forming part of a building see Section P hereof.
Close-boarded fencing	W6	Close-boarded fencing shall be given in linear meters stating the height of the fencing, the size and number of horizontal rails, the method of jointing the rails to the posts, the type of boarding, the type of boarding, the type of joint between boards (e.g. flush; overlapping) and the method of fixing the boarding to the rails. Weathered capping and supporting fillets shall be given in the description stating the size of the members and the method of fixing to the boarding.
Build-up concrete fencing	W7	Built-up concrete fencing shall be given in linear meters stating the height of the fencing, the size and thickness of the infilling units between posts, the method of jointing the units to posts, the size of the cappings and the method of fixing the cappings to the infilling units.
Corrugated fencing	W8	Corrugated fencing shall be given in linear meters stating the height of the fencing, the size and number of horizontal rails, the method of fixing the rails to the posts, the kind and gauge or thickness of the corrugated sheeting, the extent of the laps in the sheeting, the treatment of the tops of the corrugations (e.g. pointed; shaped) and the method of fixing the sheeting to the rails.

GATES

Gates	W9	(a) Gates shall be enumerated stating the size and the method of construction. Hinges, locks, fastenings and the like shall be given in the description. Gate posts (other than those forming part of the fencing) shall be enumerated stating the size. (b) Gate-stops, gate-catches and independent gate-stays shall each be enumerated separately stating the method of fixing.