GENERAL SPECIFICATION

DIVISION - 1

GENERAL REQUIREMENTS

DIVISION – 1 : GENERAL REQUIREMENTS

1 .01 - GENERAL

The Conditions of the Contract, the Drawings and the Bill of Quantities shall be read in conjunction with the Specification and matters referred to, shown or described in the former are not necessarily repeated in the latter.

Notwithstanding the subdivision of the Specification into various headings, every part is to be deemed supplementary to every other part and the various parts are to be read with each other, so far as it may be practicable so to do, or when the context so permits.

1 .02 - STANDARDS, MATERIALS, GOODS AND WORKMANSHIP

In various places throughout this Specification and the Bills of Quantities reference is made to the Standards, Specification and By-laws issued by the British Standards Institution and other similar organizations. These references shall in every case be deemed to include the latest edition or issue of such Standards, Specification and By-laws including all revisions, amendments and addenda subsequently issued. Where materials are not specified to be to British Standard, then the materials shall in all respects comply with the relevant and current British Standard. In such cases where British Standards do not exist, the materials used shall be of the best type available and shall generally be to the satisfaction of the Consultant.

Materials, goods and workmanship shall be of the best quality of their respective kinds and, as far as applicable, shall comply in every respect with the requirements of the quoted Standards, Codes of Practice and Specification or any other National Standard approved by the Consultant. Preambles and descriptions of materials, goods and workmanship given in any one section of the Specification shall apply throughout the whole of these Specification unless otherwise described. The substitution of materials, goods, workmanship and the like from that specified shall only be permitted with the written approval of the Consultant.

Where the quality of the materials is not specified or Nominated Supplier is not named, the quality shall be the best obtainable and the workmanship shall be of the highest possible standard to the satisfaction of the Consultant.

The Contractor shall submit for the approval of the Consultant a list of names and addresses of the manufacturers and trademarks or names of all the various types of materials and goods he proposes to use in the Works. This list shall include the reference to the Specification Clause or Article to which the materials and goods apply.

All materials used in the Works shall be new and of the appropriate quality all to the approval of the Consultant. Materials shall be obtained from approved sources and used in accordance with the manufacturer's printed instructions. In the absence of a Specification all materials shall comply with a relevant Standard. The Consultant shall order the removal of any materials, which he has not approved.

No orders for materials and goods shall be placed until approval has been obtained for the materials and goods from the Consultant.

The Contractor shall note that it is his responsibility to include in his price for the cost of the

materials and products as specified and no adjustment will be allowed should the alternatives be rejected by the Consultant.

1 .03 - APPROVED MANUFACTURERS

Names of approved manufacturers are given separately.

Reference to proprietary items or approved manufacturers shall be construed as establishing a standard of quality and not as limiting competition.

The Contractor may offer alternatives to the materials specified provided that such materials meet or exceed the required minimum standards. The final decision on this matter rests with the Consultant.

1 .04 - SAMPLES

The Contractor shall submit samples of all materials and goods for the approval of the Consultant before placing the order for supply.

Samples shall be submitted promptly in order not to delay the Works.

All work executed shall comply in all respects with the approved samples and the Consultant may reject any work which, in his opinion does not comply with the approved samples.

The cost of providing all samples shall be deemed to be included in the Contract Price.

1 .05 - MANUFACTURER'S INSTRUCTIONS

All items or materials shall be delivered to the Site in the manufacturers brand and name clearly marked thereon.

All items or materials shall be assembled, mixed, fixed, applied or otherwise incorporated in the Works in accordance with the printed instructions of the manufacturer of the items or materials unless specifically instructed otherwise by the Consultant.

1 .06 - ORDERING MATERIALS

The Bills of Quantities shall not be used as a base for ordering materials and the Contractor is entirely responsible for assessing the quantities of materials to be ordered. Upon receipt of the Consultant's order to commence the works, the Contractor shall immediately place orders for all required materials and will be held responsible for any delays occurring due to the late placing of such orders. Prior to finalizing materials orders, the Contractor shall advise the Consultant and await the Consultant's written approval to complete the same.

The Contractor shall pay all expenses, taxes and dues etc. incurred on the procurement of materials from abroad.

1 .07 - SCAFFOLDING

The Contractor shall provide, erect, maintain, dismantle and clear away at completion proper and adequate scaffolding including that required for Sub-Contractors and suppliers. Put-log holes shall be made good to match the adjacent surface as the scaffolding is dismantled. The Contractor

shall be entirely responsible for all safety precautions in connection with the scaffolding and for its entire sufficiency for the work.

If in the Consultant's opinion scaffolding is considered dangerous then the Contractor shall rectify the same at his own expense. All work utilizing scaffold shall be halted until the scaffold is corrected all to the Consultant's written approval.

1 .08 - PROTECTION

The Contractor shall cover up and protect the Works from the weather and from damage by his own or other workmen performing subsequent operations. He shall provide all necessary dust sheets, barriers and guard rails and clear away same at completion.

The Contractor shall take all reasonable and proper steps for the protection of all places on or about the Works, which may be dangerous to his workmen or any other persons or to traffic. The Contractor shall provide and maintain warning signs, red warning lamps and barricades as necessary in all such places.

1 .09 - SITE HOARDING

The Contractor shall provide a suitable Site hoarding at the boundary of the Site as required by the Municipality By-laws and to the entire satisfaction of the Municipality and the Consultant. The Site hoarding shall be maintained during the progress of the Works and shall be dismantled and cleared away upon completion.

The Contractor shall be responsible for ensuring the security of the Site, for protecting the same from trespass and providing all necessary watching and lighting in connection therewith.

1 .10 - CUTTING AND PATCHING

The Contractor shall be responsible for all cutting and patching and making good required for all trades for all work and his prices will be deemed to include for all such cutting and patching and making good.

1 .11 - WATER FOR THE WORKS

The Contractor shall make all necessary arrangements and provide all water for the proper execution of the Works, together with all transport, temporary plumbing, storage and distribution, pay all charges and alter, adapt and maintain temporary work as necessary and remove and make good at completion.

1 .12 - ELECTRICITY FOR THE WORKS

The Contractor shall make all necessary arrangements and provide all artificial lighting and power for the proper execution and security of the works and its protection, with all meters, temporary wiring and fittings, pay all charges and alter, adapt and maintain the temporary work as necessary and remove and make good at completion.

1 .13 - EXISTING SITE SERVICES

The Contractor shall follow up and obtain all the required information relating to any existing Site services, telephone, electrical, water, drainage and the like on the Site before commencing

excavation or piling.

The Contractor shall be responsible for the protection of all existing services within the Site and shall make good at his expense any damage to existing services resulting from his carrying out of the Works to the satisfaction of the Consultant and relevant authority. The Contractor shall be responsible for giving notice to the relevant authority where temporary or permanent re-routing or diverting of existing services is found to be necessary and shall complete the same at his own expense to the Consultant's and respective authorities approval.

Where diversions of services as aforementioned are not required in connection with the permanent Works, the Contractor shall uphold, maintain and keep the same in working order in existing locations.

1 .14 - PRICING GENERALLY

The Contractor shall satisfy himself as to the scope of the Work shown on the drawings and described in these Contract Documents and his price shall be deemed to cover all his obligations under the Contract and all matters and things necessary for the proper construction, completion and maintenance of the Works. The price shall include for all material, labour and plant – whether mechanical or non-mechanical, required for the completion of the Contract in accordance with the Drawings and Specification and removing at completion and making good any surfaces disturbed and shall include for all obligations inserted in the Preliminaries for the insurances and bonds required; for the costs of preparing a tender; for work in connection with measurements and the final account; for profit; and for all other establishment charges and on costs of whatever nature. No claim for additional payment will be allowed for any error or misunderstanding by the Contractor in these respects.

The Contractor has to allow in his pricing for all deposits required to obtain the building permit and the approval for all electrical works based on shop drawings presented by him and approved by the Consultant including obtaining the permanent electricity, water and other service connections necessary for the completion of the Works.

1 .15 - SITE OFFICES FOR CONSULTANT

The Contractor shall provide, maintain and clear away on completion of the Contract the following Site offices and facilities for the Consultant and his representatives.

The office shall be to the approval of the Consultant and shall be weatherproof, complete with electric power, lighting and air conditioning. The internal walls and ceilings shall be paint finished with carpet or vinyl tiled flooring. All windows to be glazed with dustproof seals and insect screens and finished with curtains and / or blinds.

The office shall have a minimum floor area of 20 square metres, complete with the following equipment / facilities:

1 no. desk and chair
1 no. large table suitable for meetings
5 no. chairs
2 no. filing cabinets
1 no. plan chest
1 no. drawing board and stool
1 no. desk top calculator

1 no. waste paper basket
1 no. desk lamp
1 no. photocopying machine (or use thereof)

Provide a fully equipped office similar to above of 20 square metres for occasional use by the other Consultants as required from time to time during the Contract.

Sanitary facilities for the Consultant's sole use comprising W.C., wash hand basin, shower and water heater all connected to water supplies and main drainage, fitted out with roller towel, soap dispenser, toilet roll holder and mirror.

Kitchen facilities complete with stainless steel, double bowl, double drainer, sink with cupboard unit under, refrigerator, hotplate and toaster unit, electric kettle, floor and wall mounted cupboards, water heater, connection to water supplies and main drainage.

The Contractor shall allow for the installation, maintenance and operation of a Site telephone system for the whole of the Contract period. A telephone connection shall be made to the Site office with an extension to the Consultant's office and reasonable use thereof shall be allowed. The Contractor shall be responsible for paying all costs and charges in connection therewith.

1 .16 - SITE OFFICES FOR CONTRACTOR

The Contractor shall provide, maintain and clear away on completion of the Contract all necessary Site offices, canteens, messing and welfare facilities, temporary buildings, toilets and the like for all Site staff employed by the Contractor and required by Sub-Contractors and suppliers.

The Contractor shall obtain the approval of the Consultant for the proposed Site layout, type and drainage arrangement of all the buildings prior to erection of the same. All buildings shall be supplied and maintained in good condition and of neat appearance, all maintenance to same as instructed by the Consultant shall be carried out at the Contractor's expense.

Under no circumstances shall overnight accommodation be permitted on Site except for the Site watchman in carrying out his duties.

1 .17 - CONTRACTORS SITE AREA

Throughout the period of the Contract the Contractor shall maintain the area of his operation within the limits of and around the Site in a clean, tidy and safe condition by arranging materials and the like in an orderly manner. All rubbish, debris, waste materials and the like shall be systematically cleared from the Site as it accumulates.

The Contractor shall satisfy himself as to the means of access to the Site and other relative items affecting the same for both himself, his Sub-Contractors and suppliers.

1 .18 - SITE PROGRESS MEETINGS

During the course of the Works, Site progress meetings shall be held at regular intervals for the purpose of co-ordinating the Contractor's works and to ensure that full compliance is maintained. Minutes of such Site meetings will be recorded, copies will be distributed to all persons concerned and full effect shall be given to all instructions contained therein.

Prior to such meetings the Contractor shall give to the Consultant's Representative details in

writing of that portion of the Works he proposes to construct during the coming two weeks with details of the plant and the method he proposes to employ. These proposals shall be discussed at the meeting and no work based on such proposals shall proceed without the approval of the Consultant's Representative.

The Contractor shall submit all reports as instructed by the Consultant in connection with Site progress meetings and the day to day management of the Works.

1 .19 - PROGRESS PHOTOGRAPHS

The Contractor shall supply once a month, at the time of submitting his valuation, 12 photographs showing the progress of the Works and as directed by the Consultant.

The photographs shall be submitted in three copies unmounted of a size no less than 15x10 centimetres. The negatives shall have the date on the same and remain the property of the Consultant and no prints from these negatives may be supplied to others unless previously authorized in writing by the Consultant.

The Contractor shall also include for the enlargement of up to 2 (two) photographs per month to a size of 25x20 centimetres as directed by the Consultant.

1 .20 - SETTING OUT

The Contractor shall be responsible for accurately setting out the Works to the specified positions, dimensions, levels and building lines and also checking the Site surveys for dimensional and level accuracy and reporting any discrepancies before building work commences.

The Contractor shall provide the Consultant with all facilities, equipment and labour to enable him to check the setting out and levels of the Works at all times. The checking of any setting out point, line or level by the Consultant shall not in any way relieve the Contractor of his responsibility.

All setting out points, benchmarks, Site rails, pegs and other survey points shall be clearly marked and protected from damage or disturbance during the execution of the Works.

1 .21 - DEFECTIVE WORK

Any defective work, materials and also deviations from the working details in respect of setting out, correct lines and levels, verticality, sizes, thickness of members and/or any other dimensional variation of any kind whatsoever, shall be removed and reconstructed or otherwise rectified without undue delay to the approval of the Consultant and the Contractor shall be responsible for all additional cost incurred.

1 .22 - ERECTION EQUIPMENT OR OTHER PLANT

If cranes or any other type of plant which places any load on the structure are proposed, all details of such plant shall be submitted to the Consultant for approval before the work is actually commenced. If approved by the Consultant and architecturally acceptable, permission may be given for the structure to be strengthened, in order to carry out loads, and the Contractor shall be responsible for any resulting additional costs.

The Contractor shall be responsible for making good to the satisfaction of the Consultant any damage to the permanent structure which may be caused by his plant and equipment.

1 .23 - LOADING IN EXCESS OF DESIGN LOAD

No loading in excess of the design loading shall be placed on any portion of the structure without the written permission of the Consultant.

If such permission is granted, all beams or other members of the structure which are subjected to loading other than the designed loading shall be strengthened and supported to the satisfaction of the Consultant and the Contractor shall be responsible for any resulting additional costs.

The Contractor shall be responsible for making good to the satisfaction of the Consultant any damage to the permanent structure which may be caused by such excess loading.

1 .24 - CONTROL AND TEST EQUIPMENT

During the Contract, the Contractor shall provide, maintain and clear away on completion the following listed items of control and test equipment. All items shall be to the Consultant's approval.

The items listed hereunder are indicative and not limited to the items that the Consultant may request during the Contract.

a) A separate caravan or the like for housing all test and control equipment.
b) Three sets of six number, 150 mm cast iron or steel concrete cube moulds.
c) Maximum and minimum thermometers including replacements in the event of breakage.
d) Metric weighing scales.
e) Water tank with thermostatically controlled heating and cooling for curing concrete test cubes.
f) Concrete thermometer and replacements as before.
g) Compaction equipment.

DIVISION - 2

EXCAVATION AND EARTHWORK

DIVISION - 2 : EXCAVATION AND EARTHWORK

2 .01 - AUTHORITIES PERMITS

The Contractor shall obtain from the relevant authorities all necessary Site excavation and building permits prior to commencing his works.

2 .02 - SITE CLEARENCE

The Contractor shall clear as necessary those areas over which the works are to be constructed and remove all debris and the like.

2 .03 - INSPECTION

The Contractor shall, not later than four weeks before commencing any excavation, submit to the Consultant for inspection, calculations and working drawings for the proposed scheme of strutting and retaining the sides of the excavations and shall not proceed with the appropriate section of the work until receipt of the Consultant's written approval.

The receipt of such approval shall not relieve the Contractor of any of his duties and responsibilities under the Contract.

The Contractor shall report to the Consultant when work to expose soil and prepare the sub-grade for foundation purposes as described herein has been carried out and shall obtain consent before proceeding with subsequent operations.

2 .04 - METHOD OF EXCAVATION

The methods of excavation which the Contractor desires to use shall be at the sole discretion of the Contractor.

Excavation and earthworks shall comply with the drawings and all Specification clauses and include for digging by machinery or by hand as found necessary or expedient in any kind of ground. Rock shall be deemed to be a natural material which necessitates the use of compressed air tools or explosives to excavate and which does not disintegrate when immersed in water. The use of explosives may be permitted only with the written approval of the Consultant.

The final 100mm of all foundation excavations shall be taken out by hand unless otherwise allowed by the Consultant and the bottom leveled and rammed immediately prior to placing concrete.

2 .05 - EXCESS EXCAVATION

In the event of excavations being made larger than the sizes shown on the drawings or directed by the Consultant, the Contractor shall fill in the excavated void to the correct profile with the approved fill or with mass concrete (the mix proportion and the quality of the mass concrete as later described) at his own expense and as directed by the Consultant.

2 .06 - BACKFILLING

Before placing fill materials, all vegetation and organic soil shall be stripped off and the latter

removed to tips on Site for subsequent reuse at positions approved by the Consultant. The sub-grade shall then be consolidated by approved mechanical means so as to give a fully compacted firm sub-grade. Any “soft” areas shall be excavated and filled with approved materials as directed by the Consultant.

2 .07 - DISPOSAL OF SURPLUS EXCAVATED MATERIAL

Surplus excavated material shall be removed from the Site to an approved tip.

2 .08 - KEEPING EXCAVATION FREE FROM WATER

The Contractor shall be responsible for keeping all excavations free from water, from whatever cause arising and shall provide such pumping capacity and other temporary works as may be necessary for this purpose.

The Contractor shall make good at his own expense any damage that may result from his failure to keep the excavation free from water.

2 .09 - SHORING EXCAVATIONS

The Contractor shall shore the sides of excavations for structures, trenches and pits to prevent them from slipping or falling. Should any slips, falls or settlement nevertheless occur they shall be made good by the Contractor at his own expense with selected fill or with mass concrete as may be directed by the Consultant.

In removing the shoring from the sides of excavations care shall be taken to avoid bringing loads on to any concrete until it has hardened sufficiently to carry such loads.

Timber or other material used for shoring the sides of excavations shall be removed as the work proceeds except when ordered to be left in by the Consultant.

2 .10 - TRIMMING OF SLOPES

The slopes of cuttings and embankments shall be trimmed by hand or by approved mechanical means to uniform batten as shown on the drawings or as directed by the Consultant. A tolerance of plus or minus 100mm measured at right angles to the batten will be permitted.

Any rock or boulders appearing in the face of a cutting shall be trimmed back to within the tolerance specified above and in addition any such rock or boulder which in the opinion of the Consultant is unstable shall be completely removed and the resulting void filled with compacted material to the approval of the Consultant.

2 .11 - COMPACTION PROPOSAL

The Contractor shall carry out sufficient investigations and test as required at his own expense in order to submit to the Consultant a detailed proposal of all his compaction procedures including details of compaction equipment to be used and method of usage including the number of passes of rollers and thickness of each compacted layer so as to comply with this Specification.

2 .12 - COMPACTION AND TREATMENT OF EXISTING SUB-GRADE

After clearance of Site and removal of all unwanted materials, the profile of the existing sub-grade

as so exposed shall be treated as though this is the uncompacted profile of a layer of fill material and the same testing procedure, analysis, assessment of optimum moisture content and evolution of compaction procedures shall be arranged for in order to provide proper compaction as specified for at least 250mm below the compacted profile of the existing sub-grade.

Irregularities in profile may be made up to an approximately level grade only following this initial compaction of the existing sub-grade.

2 .13 - BLINDING PREPARED SURFACES

Where specified on the drawings a blinding layer of mass concrete shall be applied of thickness not less than 50mm. The mix proportions and quality of the blinding concrete shall be as described in the Concrete Section. The compacted area shall extend at least 100mm beyond the line of the concrete element.

2 .14 - FILLING MATERIAL

The material for general filling may be locally obtained clean sand or alternatively durable and sound granular material such as to enable a dense and stable filling layer to be provided after proper compaction procedures have been carried out by the Contractor.

Filling material shall not contain an excess of fines or perishable or other deleterious component likely to affect the long term stability and suitability of the material when used for filling beneath the proposed work. The Consultant's approval shall be obtained before any fill material is accepted and the Consultant shall be provided with all information regarding the origin and nature of all materials being proposed for filling purpose.

2 .15 - COMPACTION GENERAL

The Contractor shall carry out the soil compaction as agreed after grading and leveling the surface to be compacted. In areas to be filled, compaction shall include adding necessary soil, water etc., and compacting the first layer in addition to subsequent layers up to the proposed levels.

2 .16 - COMPACTION PROCEDURE

The procedure for compacting the existing sub-grade and any filling material is subject to the approval by the Consultant and shall be generally as outlined below.

The adoption of the procedure outlined below and the giving of the approval by the Consultant shall not relieve the Contractor of his responsibility in providing compacted soil in accordance with sub clause (a) below.

a) Each 250mm layer shall be compacted at optimum moisture content to give a minimum density of 97% of the Maximum Dry Density throughout the whole thickness of the layer or the top 250mm of existing sub-grade. The maximum dry density and optimum moisture content being established by B. S. Standard Tests to BS 1377 : 1975 Test No.13 or AASHTO Test to AASHTO T 180 161.

b) After carrying out the grading, leveling, scarifying, pulverizing etc., of the soil layer to be compacted as per Specification, the Contractor shall add the necessary amount of water to permeate the pulverized soil in the quantity required.

c) The soil shall then be thoroughly mixed after adding each lot of water so as to achieve
d) homogeneous moisture content in the whole thickness of the layer.

e) Before compacting, samples of the pulverized soil will be taken and tested in order to check the natural moisture content and to bring it within the +1 and or 2 percent of the Optimum Moisture Content. When the Material is within this moisture range, it shall be primarily leveled in order to commence earth compaction.

f) After primary leveling, compaction shall be commenced by means of approved rollers depending on the type of soil being compacted in order to obtain the required density.

g) The rolling shall be carried out until the soil reaches the required density. If the surface is super elevated, rolling shall commence from the lower side and continue to the higher side. In order to compensate for the amount of water lost in evaporation in the course of compaction, additional quantities of water shall be added as required.

h) The surface shall thereafter be leveled longitudinally and transversely by motor graders and finally rolled to achieve uniform compaction free from undulations, soft spots and depressions all in conformity with the allowable tolerances for evenness of surfaces.

i) Compaction of sloped sections of embankments and ditches shall be carried out as hereinafter specified with regard to pulverization of soil, addition of the necessary water, shaping and compaction to the required degree of compaction and the required design sections.

j) The Contractor's attention is drawn to the necessity of providing all machinery, equipment and attachments required for the effective and efficient shaping and compacting operations.

2 .17 - DEGREE OF COMPACTION

The density and thickness of any compacted layer shall be ascertained by obtaining a specimen from the soil after completing compaction in accordance with the British Standard or AASHTO Specification and control curves of dry density compaction and optimum moisture content established for each type of soil material being used. In case this specimen does not conform with the required density and thickness, additional test shall be taken to determine the limits of the failing area, after which the Contractor shall scarify, pulverize, water, compact and level the layer again and if necessary, add new material (or otherwise modify the existing material) at his own expense, all in accordance with this Specification, until the required result is obtained. The Contractor shall allow in his daily work programme enough time to permit the performance and checking of the above tests, all in accordance with the instructions of the Consultant and under his guidance.

2 .18 - BACKFILLING

In any sequence of operations the backfilling of all excavated material shall be carried out so as to provide a consolidated layer of filling adjacent to or above the foundation or other installation or any other excavated area where the soil density will be fully up to the standard as set out in various clauses above.

In locations where compacted fill is to overlay concrete foundations, substructure of services, compaction shall be carried out by means of mechanical rammers or other approved means, so

as not to damage the substructure or service element in any way.

In locations where compaction abuts new or existing concrete foundations or other substructure no rolling will be carried out within 500mm of the concrete surface and the remaining space shall be compacted using mechanical rammers to achieve the same degree of compaction.

2 .19 - PROTECTIVE MEMBRANE TO CONCRETE

The substructure concrete is to be protected with protective coatings all as specified later and the Contractor shall ensure that the material for backfilling does not contain particles liable to damage the protective membrane. In addition the Contractor shall take all necessary precautions to ensure that the complete integrity of the protective coating is maintained.

2 .20 - ACCEPTANCE OF EARTHWORKS AND FILLING

Acceptance of earthworks and filling shall be determined by testing the degree of compaction and the levels and evenness of surface of the approved materials as shown below. Such testing and acceptance shall be performed as the work progresses. Each layer shall be tested and approved prior to progressing with additional layers. The Consultant shall have the right to retest any areas at any time and the Contractor shall be responsible for correcting any deficiencies.

2 .21 - LEVELS AND EVENNESS OF SURFACES

The Contractor shall test the levels and evenness of the sub-grade surface and/or finished surface to ascertain their conformity with the drawings and Specification.

The Contractor shall make available to the Consultant a four metre straight edge and a crown template of sturdy and approved design, leveling equipment etc. and the necessary labour to assist in checking operations.

2 .22 - COMPACTION REQUIREMENTS

a) Evenness of surface.

When tested by a four metre straight edge placed at any angle the maximum gap between the sub-grade surface and the testing edge shall not be greater than 75mm.

b) Stability.

The Contractor shall allow in his tender for regular sampling by using soil compaction tests at a rate of one test per 400 sq. m. of finished profile at each level of compacted filling, these tests to be approximately 50% C.B.R. tests and 50% sand replacement (with soil density) tests (all in accordance with BS 1377 : 1990) as directed by the Consultant. Where C.B.R. tests are taken the value of the compacted soil shall give a C.B.R. ratio of not less than 30%.

2 .23 - RELATIVE COMPACTION

The Contractor shall supply figures of relative compaction for each tested sample of accepted compacted profile as the ratio of the field dry density to the maximum dry density obtained in the British Standard compaction test expressed as a percentage and shall keep records of the locations where test samples were taken, together with reference marks as well as the actual relative compaction ratio.

2 .24 - DEWATERING

Where the excavation level is below the natural water table and it is necessary to pump from the excavation or to install a specialist form of dewatering equipment around the perimeter of the excavation, the Contractor shall be responsible for ensuring the safety and stability of all adjoining ground, property, structures, services or utilities above or below the ground level.

The Contractor shall take full responsibility in his tender for all costs in respect of plant, materials and labour etc., for dewatering the Site and excavations to the Consultant's approval and no additional expenses will be subsequently allowed.

Dewatering of the excavation may not be undertaken without the written approval of the Consultant to the work and the methods to be employed.

During the execution of the pumping operations, records shall be kept and agreed weekly with the Consultant of all equipment, pumping times and water levels.

The water pumped from the excavations or well points shall be pumped to disposal points or sumps as approved by the Consultant and authorities.

2 .25 - UNDERPINNING

The Contractor shall submit to the Consultant for approval his method of working giving full details of all materials and procedures.

Before the commencement of underpinning works, the Contractor shall survey in conjunction with the Consultant the structure to be underpinned and record the condition and cracks and provide monitoring points to record any subsequent movements which may occur during the course of the works, and also establish and keep records of the plumb of the walls. The foregoing survey points shall be monitored at regular intervals during the course of the works and any undue movement or distress of any part shall be reported immediately to the Consultant.

Consideration shall be given before underpinning commences to the lateral stability of the building or element and if so required or deemed prudent, is to be restrained laterally by means of raking or flying shores constructed of timber or steel bearing against a solid foundation.

Before underpinning isolated members, the structure to be supported shall be propped by vertical dead shores and provided with wedges or jacks to carry the calculated load. The foundations to the temporary shores shall be adequate to carry the load and not liable to settlement due to the underpinning works or any other cause.

All underpinning operations shall be carried out expediently in blocks in the order agreed and at all times keeping the surrounding soil propped by means of adequate supports to the Consultant's approval.

All underpinning blocks shall be carried up to within 100mm of the underside of the existing structure, which shall have been leveled and cleaned. The void shall be filled with a semi dry 1 : 1.5 : 3, 10mm concrete rammed into position (once the underpinning work has hardened).

No adjoining section shall be commenced until 24 hours after completion of the final pinning up operation.

DIVISION - 3

CONCRETE WORKS

DIVISION - 3 : CONCRETE WORKS

3 .01 - GENERAL

The Contractor shall be entirely responsible for the control of the quality of the concrete manufactured and placed in the Works. Where concrete is required to resist the water pressure the Contractor shall ensure that the concrete remains completely watertight and shall guarantee the water tightness of all such structures. The Contractor shall at his own expense carry out any remedial measures to the satisfaction of the Consultant which may be necessary to make such structures watertight whether leakage is through the concrete or through the joints.

3 .02 - CEMENT

All ordinary and rapid hardening cements used in the works shall comply with BS 12 and with any amendments thereto.

The Contractor shall note that grey and white coloured cement shall be used on this project, all as defined on the drawings.

Sulphate Resisting Cement used in the works shall comply with BS 4027 and its amendments and with the following requirements:

a) The tricalcium aluminate content shall not normally exceed 3.5%. With the express written permission of the Consultant a limiting value of not more than 5% may be permitted in special circumstances.

b) The total alkali content, expressed as the (Na 20) shall not exceed 0.75%. (see also Clause 3.11)

c) The sulphuric anhydride (SO3) content shall not exceed 2.5%.

d) The specific surface (fineness), when determined by the method specified in BS 12 (1992) Appendix A shall be at least 2,500sq.cm per gm.

e) The heat of hydration when determined by the method specified in BS 1370 (1992) Appendix H shall not exceed 70 cals. per gm when tested at 7 days and not exceed 80 cals. per gm when tested at 28 days.

f) The autoclave expansion (soundness), when tested by the method specified in ASTM designation C151 shall not exceed 0.8%.

Samples of cement used in the works shall be deposited with the Consultant for his approval together with the Test Certificate issued by the manufacturer with a further Certificate stating the name and address of the supplier from whom it has been purchased.

Each consignment of cement delivered to the Site shall be kept separately and the Contractor shall use the consignments in the order in which they are received. Cement shall be stored in bags provided by the manufacturers and cement in bags which have been opened shall be removed immediately. At the discretion of the Consultant the Contractor shall provide a separate waterproof stores building with floor raised at least 150 mm above ground for cement on Site and

shall take particular care to protect the cement from damp or other deleterious influences. The Consultant may from time to time take samples of the cement being used in the Work for testing. The Consultant will condemn any cement which fails to comply with the requirements of this Clause or which he considers to have deteriorated as a result of dampness or other causes and the Contractor shall promptly remove such condemned cement from Site.

3 .03 - ADMIXTURES

No admixtures are to be used without the written permission of the Consultant.

If in the Contractor's opinion benefit will be obtained in using admixtures then he is to submit details for approval. Any materials used shall conform to BS 5075 Part 1, Part 2 and Part 3. Alternatively other National Standards (eg. ASTM C260, C494, C618 etc.)

In the event that admixtures are used the supplier / manufacturer local technical representative is to be available on Site prior to the commencement of concrete works to certify that proposals are in accordance with the manufacturer's recommendations. Also if due to the use of admixtures problems develop as work proceeds the similar representation is to be arranged for by the Contractor until the difficulties are resolved.

3 .04 - AGGREGATES GENERALLY

Concrete aggregates shall consist of naturally occuring aggregates or of crushed stone and natural sand, having hard, strong and durable particles. They shall be clean and free from harmful amounts of alkali, organic matter, clay films, lumps or other deleterious substances. They shall not contain an excessive proportion of flaky or laminated fragments. All of the provisions of BS 882 are to be met in addition to the provisions of this Specification. Limits are given in tables 3.04(1) and 3.04(2).

TABLE 3.04 (1)

The maximum total weight of aggressive elements, chlorides and / or sulphates in 1.0 cubic metres of compacted concrete is to be :

Chlorides expressed as equivalent Sodium Chloride (NaCl) from all sources including mixing water – see 3.11	1.0 Kg (0.04%)
Sulphate (as SO3) excluding cement content	5.0 Kg (0.20%)

Special precautions must be taken to control salt and sulphate levels.

The materials including water are to be chemically analyzed to the Consultant's approval when these elements are suspect or present in the mix materials at not less than the following intervals to determine that the limits are not exceeded so as to ensure durable concrete.

Tests are to be carried out at preliminary mix design stage, before any change of source or supply of materials, as directed by the Consultant and at the following intervals:

Coarse Aggregate 1 sample per 50 m^3 delivered.
Fine Aggregate (sand) 1 sample per 25 m^3 delivered.

But in either case not less than 1 sample per day delivery.

The permissible limits for deleterious substances when tested by methods shown below shall be respectively:

TABLE 3.04 (2)

Impurity or Deleterious element	Fine Aggregates	Coarse Aggregates
	Test procedures with maximum amount allowed	Test procedures with maximum amount allowed
Clay lumps	ASTM C142-67 1.5%	ASTM C142-67 2.25%
Organic matter	ASTM C40-66 as indicated by colour test	Separation by hand or decanting – weighing 0.5%
Material finer than 200 sieve	ASTM C117-67 a) 3% b) 15%	ASTM C117-67 1%
Thin flaky or laminated particles (eg. mica)	Dependent on satisfactory mortar test a) for natural sands b) for crushed rock	Separation by hand 10%

The reduction in strength between the unsoaked and the soaked 10% fines value shall not exceed 50 KN.

The soaked test is carried out after immersing the aggregate specimen in distilled water for 24 hours.

The total loss factor for the ten minute immersed rotation test shall not exceed 20% using the following procedure: -

A 50 kg sample of material passing the 20mm sieve and retained on the 5mm sieve is placed in a multi-flow mixer leveled and water added to 50mm above the top surface of the aggregate. The mixer is rotated for 10 minutes, then the total sample washed on a 5mm sieve. The material retained on this sieve is oven dried at 80^0C for 24 hours, then weighed.

The Contractor shall carry out tests in accordance with the Building Research Station Digest No. 35 to confirm that the aggregates to be used do not give a concrete mix with a drying shrinkage exceeding 0.05% for precast concrete.

3 .05 - COARSE AGGREGATE

Coarse aggregate shall comprise naturally occurring aggregate or crushed limestone taken from sources approved by the Consultant. The aggregate shall contain no harmful material in sufficient quantity to affect adversely the strength or durability of the concrete or in the case of reinforced concrete to attack the reinforcement.

Prior to commencing work the Contractor shall if so required submit to the Consultant his proposal

for types of crushing and screening machinery which he proposes to use and shall obtain the Consultant's approval of the same.

Single toggle crushers and rotating screens will be preferred. The jaws of the crushers are to be set by experiment at the commencement of the work and once the setting is agreed it shall not be varied, except with the permission of the Consultant. Screens are to be checked frequently to ensure that the wires have not become bent or damaged.

The Contractor shall ensure that the amount of dust in the aggregate is reduced to a minimum by washing the aggregate as directed by the Consultant.

Prior to the commencement of work the Contractor shall provide the Consultant with samples of each type of aggregate and shall obtain his approval for their use. These samples will be retained by the Consultant for comparison with the deliveries to the Site during the work. All coarse aggregate shall be washed after crushing if necessary to comply with the Specification. The flakiness index when determined by the method described in BS 812 paragraphs 16 and 11 shall not exceed 30%. The grading by weight of the various nominal sizes of coarse aggregate shall be determined by the limits specified in the following tables:-

PERCENTAGE PASSING BY WEIGHT

Sieve mm	Nominal size 38mm to 25mm	Nominal size 25mm to 9mm	Nominal size 19mm	Nominal size 13mm	Nominal size 10mm
76.2	100	-	-	-	-
38.1	95 - 100	100	100	-	-
19.05	30 - 70	95 - 100	85 - 100	100	-
12.7	-	-	-	85 - 100	100
9.52	10 - 35	25 - 55	0 - 20	0 - 45	85 - 100
4.76	0 - 5	0 -10	0 - 5	0 - 10	0 - 20
2.4	-	-	-	-	0 - 5
0.075	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5

The percentage passing through the 0.075mm sieve shall be determined by the method described in BS 812 paragraph 13. (Decantation method)

The aggregates shall meet all of the requirements of Section 7.8 of BS 812 Part 3.

3 .06 - FINE AGGREGATE

Fine aggregate shall either comprise beach sand, natural dune sand or be obtained by crushing

clean hard limestone or be a mixture of these. The sand and / or limestone shall be obtained from a source approved by the Consultant.

Fine aggregate shall contain no excessive quantities of dust, soft or flaky particles, shells, congealed lumps, nodules of soft clay, shale, alkali or other contaminations likely to adversely affect the strength of the concrete or in the case of reinforced concrete likely to attack the reinforcement.

Prior to commencement of work, the Contractor shall provide the Consultant with a sample of fine aggregate he proposes using in the work and shall obtain his approval for its use. This sample will be retained by the Consultant for comparison with deliveries to the Site during the work. The grading of fine aggregate when determined by the method described in BS 812 shall lie within the respective limits specified within the following table:-

PERCENTAGE PASSING BY WEIGHT

BS Sieve Size (mm)	Grading Zone 1	Grading Zone 2	Grading Zone 3	Grading Zone 4
9.52	100	100	100	100
4.76	90 - 100	90 - 100	90 - 100	95 - 100
2.40	60 - 95	75 - 100	85 - 100	95 - 100
1.20	30 - 70	55 - 90	75 - 100	90 - 100
0.60	15 - 34	35 - 59	60 - 79	80 - 100
0.30	5 - 20	8 - 30	12 - 40	15 - 50
0.15 (a)	0 - 10	0 - 10	0 -10	0 -15
0.15 (b)	0 - 20	0 - 20	0 - 20	0 - 20

a) Natural Sands

b) Crushed Rock

3 .07 - ALL-IN AGGREGATE

Where the use of all-in aggregate is permitted by the Consultant, the grading when analyzed by the method of sieve analysis described in BS 812 shall be in accordance with the following table:-

PERCENTAGE PASSING BY WEIGHT

BS Sieve Size (mm)	Nominal Size 38mm	Nominal Size 19mm
76.20	100	-
38.10	95 - 100	100
19.05	45 - 80	95 – 100
04.76	25 - 50	35 – 55
00.60	8 - 30	10 – 35
00.15	0 - 6	0 – 6

Prior to the commencement of works the Contractor shall provide the Consultant with a sample of the all-in aggregate he proposes using in the works and shall obtain his approval for its use. This sample will be retained by the Consultant for comparison with deliveries to Site during Construction of the works.

3 .08 - AGGREGATE CRUSHING

The aggregate crushing value shall be tested in accordance with BS 812. The aggregate crushing value obtained on 13 - 10 mm or smaller sizes shall not exceed 45 percent by weight for aggregate used for concrete other than wearing surfaces. (i.e. roads, paving and similar surfaces)

Coarse aggregate shall show a percentage of wear not greater than 35% at 500 revolutions when subjected to the Los Angeles abrasion test as set out in ASTM Test No. C 131 - 66.

3 .09 - SOUNDNESS

In addition to the tests outlined in 3.08 above, the coarse and fine aggregate when subjected to fine alternation of the Magnesium Sulphate Soundness Test in accordance with the ASTM 088 - 63, the loss by weight shall not exceed 10%. The rate of testing shall be similar to that given in 3.08.

3 .10 - STORAGE OF AGGREGATES

All aggregates for the manufacture of concrete shall be stored on a drained concrete hard standing or other approved surface to prevent the aggregate from being contaminated by the ground or other foreign matter, and each type of grading of aggregate shall be kept separate by the use of partition walls etc., to the satisfaction of the Consultant. The Contractor shall ensure that graded coarse aggregate do not segregate in the storage heaps. Wet fine aggregate shall not be used until in the Consultant’s opinion, it has drained, unless the Contractor measures the moisture content of the fine aggregate continuously and adjusts the amount of fine aggregate and added water in each batch of concrete mixed to allow for the water contained in the fine aggregate. The grading of the coarse and the fine aggregates shall be determined at least once a week to check whether the gradings are similar to the samples used in the trial mixes. Some

variation may occur, and in the case of sands it shall not be unreasonable for the grading to vary by a range equivalent to that of a single grading zone in BS 882.

3 .11 - CONCRETE MIXES

The concrete mixes specified follow the British Standards recommendations for strength.

Details of the proposed mix proportions shall be submitted to the Consultant for his approval prior to the commencement of the concreting work.

The concrete mix to be used in the works in any particular location are as specified on the drawings and as listed below. The required mix is specified by its 28 days characteristic compressive strength in N/mm^2 (=Mpa) and preceded by a :-

'C' for a mix using O.P.C.

'SC' for a mix using S.R.P.C.

'WC' for a waterproof mix using O.P.C.

'WSC' for a waterproof mix using S.R.P.C.

All mixes are to be designed mixes to the provisions of BSCP 8110 and BS 5328 unless followed by:-

'P' denoting a prescribed mix
or
'L' denoting a lightweight mix

Note:-

'O.P.C.' denotes ordinary portland cement to British Standard and / or rapid hardening portland cement to British Standard.

'S.R.P.C.' denotes sulphate resisting portland cement to British Standard.

Details of mix descriptions, grades and cement content are given in tabulated form below.

In addition to the requirements of Clause 4.04 the Contractor shall ensure that in no instance does the alkali content of one cubic metre of compacted concrete exceed 3.0 kg.

TABLE 3.11 (1)

CONCRETE MIX LOCATIONS

Location of work	Mix Grade (Character -istic) see notes a, b, & c	Aggregate size Maximum	Minimum Cement Content Kg/m^3	Maximum Water Cement Ratio see notes b & c
a) Blinding to formation levels	SC20	20	330	0.45
b) Mass concrete below foundations Mass concrete backfill	SC20	40	330	0.45
c) Reinforced bases, pile caps and raft foundations, walls, columns, ground beams, slabs at ground floor level suspended or otherwise, except as noted in (d)	SC40	20	370	0.45
d) Pits, tanks, water retaining structures, retaining walls	WSC40	20	370	0.45
e) Slabs, beams, staircases etc. above ground floor level	C40	20	370	0.50
f) Columns, walls	C40	20	370	0.50
g) Piles	SC40	40	370	0.50

NOTES TO TABLE

a) Concretes are specified as designed mixes in accordance with British Standards based upon characteristic strength. In determining compliance with this Specification BS 5328 shall be used in conjunction with BS 8110.

b) The water cement ratios shown thus 0.45 are not subject to increase for any reason. All w / c ratios specified are however not to be considered subject to possible reduction by the use of an approved admixture.

c) Standard tests as set out in BS 1881 (or similar comparable test in Section C type ASTM Standards or D.I.N. Standards or other authoritative standards adopted), such as Comparation Factor - Vee Bee, Slump, Kelly Ball, Flow Table or other suitable tests as agreed with the Consultant, are to be implemented as a regular and continuous method of Site quality control. The acceptable workability factors are to be derived from preliminary testing procedures to ensure that the concrete when used is capable of being mixed, transported, placed and compacted to give a completely satisfactory end result.

3 .12 - CHANGES IN CONCRETE PROPORTIONS

Regardless of the limitations of the proportions in the previous table at any time during the progress of the works, the Consultant shall have the right to make such changes in the material or proportions or both as he may consider necessary to meet the requirements of the structure.

If in the opinion of the Consultant the materials in use or delivered to Site do not conform to the Specification or to the original approved samples, he may direct that fresh samples be submitted for his approval. Should these samples fail to meet the requirements of the Specification then the materials shall be removed from the Site or otherwise disposed of as directed by the Consultant not withstanding any previous approval given to the materials.

3 .13 - MEASURING MATERIALS FOR CONCRETE

Cement shall be measured by weight only either with an approved weighing machine or by making the size of each batch of concrete such as to require an integral number of complete bags.

The fine and coarse aggregate used in all mixes shall be measured by weight only, unless permission is granted by the Consultant for the aggregates to be measured separately by volume using properly constructed gauge boxes. Gauge boxes shall be soundly constructed of timber or steel contain exactly the volume of the respective materials required for one batch of each mix. They shall have closed bottoms and be of such proportions that their depth does not exceed the cube root of their volume. They shall be clearly marked with the mix and the aggregates for which they are intended. When calculating the size of gauge boxes for fine aggregate an allowance shall be made for the bulking of the fine aggregate due to the average amount of moisture contained in the stock- piles on Site. The Contractor shall obtain the Consultant’s approval of the sizes and construction of all gauge boxes before putting them into use. Weigh-batching machines shall be of a type approved by the Consultant. They shall be kept clean and in good condition and adjustment. At intervals, as the Consultant may require, the Contractor shall check the accuracy of each weigh-batching machine.

Every concrete mixing machine shall comply with the requirements of BS 1305 or BS 4251 where applicable and shall be fitted with a proper water measuring device which the Contractor shall maintain in proper adjustment and check at such intervals as the Consultant may require. When calculating the amount of water to be added to each batch of concrete to give the correct water / cement ratio allowance shall be made for the average moisture content of fine aggregate. From batch to batch the amount of added water shall be adjusted to maintain a constant water / cement ratio in the mixed concrete and the water measuring device on each mixer shall be such as to facilitate such frequent adjustment.

Means shall be provided on the weigh-batcher for variations of settings from time to time and for adjustments to the mechanism to correct for wear and damage. Scales shall be accurate to within one percent under operating conditions.

3 .14 - MIXING CONCRETE

All concrete shall be mixed before being placed in the Works. Concrete shall be mixed with approved mechanically operated mixers of the batch type. Except for quite minor structures, and then with the written approval of the Consultant, no mixer shall be of less capacity than 0.2 cubic metres.

Hand mixing shall not be permitted except in case of emergency, when the Consultant will issue instructions regarding the method of hand mixing to be adopted.

The capacity of the mixing plant shall be such that the whole of any continuous pour shown on the placing diagram can be completed in daylight unless adequate approved lighting is available. Each mixer should preferably be capable of taking whole bag batches. No mixer shall be operated above its rated capacity. “Free Fall” type mixers will not be allowed without the permission of the Consultant.

The mixer shall be of a type which will ensure a uniform distribution of the materials throughout the mass and during the period of mixing shall operate at its designed speed, which shall be not less than twelve and not more than twenty revolutions per minute.

The first batch of concrete materials placed in a clean mixer shall contain a sufficient excess of cement, sand and water to coat the inside of the drum without reducing the required mortar content of the mix.

All concrete shall be mixed for a period of not less than two minutes after all materials, including water are in the mixer. No concrete shall be removed from the mixer until the materials have been mixed for the specified time. The entire contents of the mix shall be removed from the drum before materials for the succeeding batch are placed therein.

Upon cessation of continuous mixing operations, the mixer shall be thoroughly cleaned.

3 .15 - WORKABILITY OF CONCRETE

The requirements for workability of the concrete in the fresh or plastic state shall be decided by or in consultation with the Consultant.

The quantity of water which will be used in the manufacture of concrete is to be the minimum which will produce a plastic mix suitable for the conditions of handling and placing so that after compaction, it surrounds all reinforcement and is worked into the corners and angles of the formwork consistent with maximum density and strength and in no case shall this exceed the specified water / cement ratio.

Workability shall be assessed by means of the slump test, compacting factor test or V B Consisto-meter test generally in accordance with the provisions of BS 1881 or as otherwise directed by the Consultant.

3 .16 - READY-MIXED CONCRETE

Ready-mixed concrete from an approved central mixing plant may be used provided it complies with the requirements of this Specification with respect to materials, properties (including water cement ratio), slump and strength.

These details shall be available to the Consultant in the same manner as if the concrete has been mixed on the Site. Ready-mixed concrete shall be brought on to Site in an approved type of agitator truck. During transport it shall be agitated continuously at the rate specified by the manufacturer of the truck at the agitating speed.

Ready-mixed concrete shall be discharged from the agitated truck within a period of 45 minutes from the time of introducing mixing water to the cement and aggregate or cement to the aggregate.

No commitment is given for the Consultant's approval to use of ready-mixed concrete but the following conditions will be called for before consideration can be given to his alternative to Site batching.

a) The provisions of any relevant BS are adhered to in all respects, where not in contradiction the provisions of ASTM C94 shall also be followed. Specification requirements shall be interpreted in accordance with the provisions given in BS 5328.

b) The source, location and details of batching installation are submitted to the Consultant for his approval and access to the plant is allowed for inspection of general control purposes prior to the commencement and during the progress of the work.

c) The undertaking by the ready-mix suppliers to provide concrete in accordance with this Specification.

d) Ready-mixed concrete shall be fully mixed at the works (prior to loading into an agitator lorry) and delivered to the Site continuously agitated. The delivery ticket must show the mix proportions and the time of mixing. The concrete must be compacted in the formwork within two hours of the mixing time stated on the delivery ticket. No water may be added to the mix in transit or on Site.

e) Ready-mixed concrete may be delivered in an agitator truck mixer and the water added and mixed on Site, when authorized by the Consultant. The amount of water to be added to the mix on Site shall be stated on the delivery ticket and no water is to be added in excess of the quantity.

f) The Ready-mix Company shall work to a standard fully comparable to that achieved in the United Kingdom as generally required by the British Ready-Mixed Concrete Association under the Authorization Scheme as set out in the March 1982 document entitled "BRMCA Authorization Scheme for the production of Ready-Mixed Concrete."

3 .17 - ADDITIVES

The use of so called wetting agents or air-entraining agents shall be permitted only with the written approval of the Consultant. Only approved materials will be allowed and the method of use shall be agreed in writing and shall set out the reduction in water / cement ratio which may accompany the use of such additives. The cost of additives shall be borne by the Contractor who will derive the benefits of increased workability and in some cases reduced cement content.

3 .18 - QUALITY CONTROL OF CONCRETE

A slump test shall be carried out in accordance with BS 1881 whenever the Consultant may require it and in any case not less than the average rate of one test per 25 cubic metres of concrete.

The maximum permissible slump in concrete will be 60mm except where otherwise specified by the Consultant.

Works test cubes of each grade of concrete shall be made whenever the Consultant may require and in any case at not less than the average rate of one set of cubes per 25 cubic metres of concrete. Each set of the works test cubes shall comprise six 150 mm cubes made from a single sample of concrete taken from the point of final deposition of the wet concrete and the cubes shall be made by the Contractor under the Consultant's supervision. The location at which each

sample is taken shall be accurately recorded by the Contractor and a copy of the record shall be supplied to the Consultant whenever he so requires. The sampling, making, curing and testing of works test cubes shall be done according to the methods described in BS 1881. Cubes shall be tested by such persons and at such places as the Consultant may decide from time to time. Two cubes from each set of works test cubes shall be tested seven days after manufacture and two from each set of works test cubes shall be tested twenty eight days after manufacture, to ensure compliance with specified works characteristic strength.

The characteristic strength of concrete is that 28 days cube strength below which not more than 5% of the test results may be expected to fall.

Compliance with the specified characteristic strength will be assumed if:-

a) The average determined from any group of four consecutive test cubes exceeds the specified characteristic strength by not less than 0.5 times the current margin and

b) Each individual test result is greater than 85% of the specified characteristic strength.

The current margin shall be taken as two-thirds of the specified characteristic strength for concrete of Grades 7, 10 or 15 and 15 N/mm^2 for concrete of Grade 20 or above.

Should either of the test cubes crushed at 7 days or that crushed at 28 days or all fail, the Contractor shall on the Consultant's instruction take one or more of the following steps:-

a) They shall alter the design of the mix to increase the average compressive strength.

b) They shall alter their method of making the concrete and controlling its quality to reduce the variability of the concrete.

c) They shall cut out and replace the concrete placed in the works on any day in which the defective cubes were made if in the opinion of the Consultant such concrete is not likely to be capable of fulfilling its purpose.

d) If required by the Consultant three cores shall be taken from the area represented by the test cubes. The actual location shall be decided by the Consultant. If the average of the three cores when reduced to the corrected equivalent test cubes strength at 28 days falls below the specified strength, further cores are to be cut in order to determine the extent of the unsatisfactory concrete. The volume of concrete shown to be below the required strength shall be taken out and replaced at the Contractor's expense.

In estimating the quality of any substandard concrete and in determining the action to be taken the Consultant will establish the following whenever possible.

a) The validity of the test results and confirmation that specimen sampling and testing have been carried out in accordance with the requirements of BS 1881.

b) The mix proportions actually used in the concrete under inspection.

c) The actual section of the structure represented by the test cube or cubes.

d) The possible influence of any reduction in concrete quality on the strength and durability of this section of the structure.

The Consultant may require the Contractor to cut out defective concrete from the works even though test cubes made from that concrete or cores have not failed.

The Contractor shall be deemed to have included in his rates and prices for all work in connection with tests specified and for making modifications in the mixes and cutting and replacing defective work.

3 .19 - ALTERNATIVE MIX DESIGN

At the commencement of the works as an alternative to the mixes specified in Clause 4.11 the Contractor may design a mix for each grade of concrete to suit the gradings of aggregates he proposes to supply, and shall submit full details of the same to the Consultant for his approval. Each design shall fulfill the requirement of this Specification.

Final approval of mix design shall not be given until trial mixes have been prepared and the specified preliminar cube strength obtained.

3 .20 - WATERTIGHT CONCRETE

Where watertight concrete is specified the concrete mix is a special mix grade as specified, the grade being preceded by 'W'.

The Contractor shall take full responsibility for ensuring that the resulting construction is completely watertight and free from penetration of moisture.

When in the opinion of the Consultant damp patches and / or leakage of water in the finished work are due to the failure of the Contractor to comply with this Specification the affected work shall be made good at the Contractor's expense.

Water-bars shall be provided in all construction joints and the type of water-bar will be as specified or to the approval of the Consultant. All water-bars will be jointed by welding strictly in accordance with the manufacturer's recommendations and all multiple joints and special intersections shall be manufactured by the supplier.

Before commencement of the works the Contractor shall obtain the Consultant's approval of the methods to be used to support and maintain the water-bars in the correct location while the concrete is placed and also the layout and form of all additional construction joints other than those shown on the drawings. Unless indicated otherwise on the drawings all construction joints in waterproof concrete shall be formed as indicated in this Specification.

All services holes cast in shall incorporate sleeves with puddle flanges and temporary openings for services should incorporate water-bars.

Care shall be taken at all times to ensure that water-bars are not perforated or damaged in any way and the concrete shall be carefully placed and compacted around the water-bars to ensure dense void-free impervious concrete.

All kickers or starter plinths to walls on the periphery of the watertight construction shall be cast monolithically with the base.

The formwork shall comply with this Specification and in addition any bolt or fastening embedded in or passing through the concrete shall be to the approval of the Consultant and not impair the

watertightness of the structure. The use of through-bolts and sleeves are strictly prohibited.

Special attention shall be given to the elimination of shrinkage or thermal cracking. The size of any bay or slab or wall and sequence of pouring shall be such as to minimize cracking. It is recommended that the size of the bay or the slab be limited to 50 square metres and the length of any wall to 10 metres with a maximum of 4 metres height.

Slotted inserts or sockets cast into the structural concrete shall be provided for all fixings including services. The cutting of holes in watertight concrete is strictly prohibited. In addition to the above the provisions contained in BS 5337 shall be followed where relevant in considering basement type structures as water tanks.

3 .21 - TRIAL MIXES

Before any concreting is carried out on the Site the Contractor shall prepare in the presence of the Consultant, trial mixes of all grades of concrete specified in Clause 3.11 or alternative mix design. Each trial mix shall comprise of not less than half a cubic metre of concrete and shall be mixed in a mechanical mixer of a type approved by the Consultant.

The quantities of all the ingredients of each trial mix including water shall be carefully determined by weight according to the mix design.

Twelve 150mm compression test cubes shall be made by the Contractor, in the presence of the Consultant from each trial mix. The sampling, making, curing and testing of these preliminar test cubes shall be in accordance with the method described in BS 1881, and the cubes shall be tested by such persons and at such places as the Consultant may decide from time to time. Six cubes from each test mix shall be tested seven days after manufacture and the remaining six cubes shall be tested twenty-eight days after manufacture. The average crushing strength of the preliminary test cubes shall be at least one and a half time the works characteristic cubes strength specified in Clause 3.11.

If the average value of the compression strength of the test cubes taken from the trial mix is less than the specified preliminary cube strength, then the Contractor shall alter the mix design and make a further trial mix and test cubes as the Consultant may direct.

The approved mix for each grade of concrete shall be such trial mix for the grade as the Consultant may approve after any modification required by the Consultant has been made. The Contractor shall allow ample time in his programme for making trial mixes and testing compression test cubes obtained therefrom.

3 .22 - TRANSPORTATION OF CONCRETE

The equipment used for mixing and transporting concrete shall be clean and free from any foreign material and hardened lumps of concrete. The concrete shall be transported to its place in the Works, as soon as it is mixed, in metal barrows, trucks or by approved means. It shall be transported in such a manner so as to prevent segregation or loss of ingredients.

Concrete shall be deposited as near as possible to its final position in the Works so as to avoid double handling. It shall be placed in its final position before setting commences and shall not be subsequently disturbed. Where concrete is required to be lowered more than 1.2 metre it shall not be dropped into its final position, but shall be fed through a pipe or trunking. The lower end of the pipe or trunking shall be kept in or near the freshly deposited concrete and shall be of such a size that it will be kept full whilst concrete is being deposited.

Where authorized to, concrete may be placed in position by means of properly constructed metal or metal lined chutes. The discharge end of the chute shall be fitted with a baffle to prevent segregation and the chutes, pipes, trunking and other equipment shall be kept clean and free from foreign matter and hardened concrete.

Concrete regardless of the type of transporting vehicles used shall have, when deposited in the formwork, the quality specified.

3 .23 - PLACING AND COMPACTING CONCRETE

Concrete shall be deposited in layers not exceeding 300mm thick or other such thickness as may be approved by the Consultant and each layer shall be well consolidated before the subsequent layer is placed. Unless otherwise authorized, the concrete shall be compacted by mechanical vibrators of an approved type and shall be well worked round the reinforcement and other embedded fixtures and corners of the formwork.

Mechanical vibrators shall be of the immersion and of the exterior type and shall be demonstrated to be of sufficient power for the work. The number and size of the vibrators shall be such as to ensure vibration throughout the entire volume of the concrete and shall be applied at points uniformly spaced and at such distance apart that their cones of influence shall overlap and the whole mass of the concrete shall become plastic.

With immersion vibrators the tubular part of the tool shall be struck vertically into the full depth of the concrete to be vibrated at points 450mm apart and at least 100mm away from any other formwork. The vibrators shall be kept constantly moving whilst in action to prevent segregation. Vibration shall not be applied directly or through the formwork or reinforcement to sections or layers of concrete which have taken their initial set or to concrete which has ceased to become plastic under vibration. Vibration shall be stopped after the decrease in volume is no longer apparent or before localized areas of gout or laitance are formed.

The Contractor shall ensure that the supply of concrete from the mixer or mixers is adequate to permit compaction to proceed without interruption. Should the supply cease, vibrators will be lifted clear from the work.

No workman shall be permitted to operate a vibrating tool without having received training in its use.

Concreting shall be carried out continuously and no concrete shall be placed on concrete which has sufficiently set as to cause the formation of the seams or planes of weakness within the section. Where concrete cannot be placed continuously, construction joints as specified shall be formed only where shown on drawings or approved by the Consultant.

For the purpose of this Specification concrete shall be deemed to have commenced to set 15 minutes after placing in position.

Canvas, hessian or other approved screen shall be erected at all points where concrete is being placed to shade the concrete from the direct sun or drying winds and such screens shall be kept in position until the surface of the concrete is ready for curing as specified in Clause 3.29, “Curing”.

If by virtue of the inaccessibility of concrete to compaction it should be necessary to adjust the mix slightly to give improved workability, any increase in water content is to be accompanied by a corresponding increase in the cement content in order that the specified ratio is not exceeded.

Pumping of concrete will only be permitted on receipt of written approval by the Consultant. Before such approval is granted full details of the pumping system proposed (and concrete mix details) are to be submitted which shall generally accord to the recommendation in ACI 304 ZR 71 except that piston type pumps will not normally be acceptable for the conditions anticipated.

3 .24 - TEMPERATURE

No concrete shall be mixed or placed while the temperature is above 40 degrees centigrade on a rising thermometer or above 43 degrees centigrade on a falling thermometer. The Contractor shall supply an accurate maximum and minimum thermometer and hang it in an approved position in the Works.

The Contractor shall plan the day's concrete in such a manner as to ensure that each bay or panel is completed at a proper construction joint before the temperature rises above the permissible limit.

The Contractor shall allow in his rates for any additional expenses incurred by complying with this Clause in order to complete the works within the "Time of Completion".

3 .25 - HOT WEATHER CONCRETING

The maximum temperature of wet and unset concrete is to be limited to 32 degrees C at all times to prevent excessively rapid setting times, loss of moisture, shrinkage and / or any other deleterious effects.

The following precautions should be adopted as necessary to comply with the above limit.

a) Shading of aggregate stock piles.
b) Insulation of water tanks and pipelines and formwork.
c) Refrigeration of mixing water.
d) Shading formwork and reinforcement from the sun and drying winds.
e) Cooling of formwork and reinforcement prior to and ahead of casting of the concrete by mist spray.
f) Concreting during the cooler part of the day.

Refer to ACI Standard 305 - 72 for Recommended Practice for Hot Weather Concreting.

3 .26 - SURFACE FINISH AND DEFECTIVE CONCRETE

All surfaces not requiring shuttering shall be tamped or trowelled to a consistent dense finish with the minimum of cement and fine material being brought to the surface and shall be free of irregularities. The surface finish shall be ridged or plain as directed by the Consultant.

If specified elsewhere the surface described above shall be further treated as follows: -

Class U1 : After the concrete has hardened sufficiently, the concrete surface shall be floated by hand or machine sufficiently only to produce a uniform surface free from screed marks.

Class U2 : When the moisture film has disappeared and the concrete has hardened sufficiently to prevent laitance from being worked to the surface as described, the concrete shall be steel trowelled under firm pressure to produce a dense smooth uniform surface free from trowel marks.

Class U3 : For the car parking areas the surface finish as described above shall be floated with a ball float and subsequently scored with a wire broom to give a uniform skid resistant surface.

Class U4 : Any other surface finish as described elsewhere.

The finish for formed surfaces shall be as directed by the Consultant and the Contractor shall ensure that permanent exposed surface finishes are protected from rust marks, spillage and stains of all kinds.

Shuttering of concrete which will always be in contact with the ground may be cast against the sawn timber shuttering. All other exposed shuttering surfaces including pre-cast concrete work shall be cast against steel or planed wrought timber formwork and shall be carefully rubbed down with carborundum to remove all the imperfections and irregularities. Concrete surfaces which are to receive finishes such as plaster, wall tiles etc. may be cast against the sawn timber. Prior to casting the joint surface is to be cleaned, well soaked with water and fresh concrete well consolidated against and onto the joint face to form a homogeneous member and extra care is to be taken in forming horizontal joint by limiting the initial depth of the concrete poured.

Where water-bars are present extra care is to be taken in forming the joint to prevent displacement of the water-bar from the true line and ensure void free fully compacted concrete. Water-bars at the base of wall panels and elsewhere are to be held in position by clips and / or wire ties. No nail or fixing may pass through a water-bar except for profiles formed with fixing holes or nailing zones along the edge.

Horizontal construction joints formed as previously described in columns and walls will occur at floor level, a 75mm kicker formed of the same mix as the member will be permitted at the base of the columns and walls to facilitate positioning of formwork.

The top surface of any column or wall may project unless other joint positions are dictated by fair face concrete requirements, 20mm above the soffit levels of any beam or slab except in the case of plate floors where the projection must not exceed 5mm and any excess must be cut down to this dimension.

3 .27 - EXPANSION JOINTS

All expansion joints shall be positioned and formed as shown on the drawings. The approved joint filler materials shall be continuous over the whole area of the joint and the joints taped to prevent ingress of grout and the formation of hard spots. In vertical joints in suspended beams and slabs, anchors shall be attached to the filling materials to prevent it falling out when the joint opens.

In tropical climates the specified normal size of the joints shown on the drawings will be reduced by 5mm in the hot summer season and increases by 5mm in the cold winter season, with the specified normal size being used during all other seasonal conditions or as directed by the Consultant.

Dowel bars where specified on the drawings across expansion joints shall be straight mild steel round bars positioned at mid joint depth perpendicular to the face of the joint and supported on chairs or spacers with one half solidly embedded in the concrete and the other half coated with bitumastic paint and provided with an end cap with 25mm of compressible filling.

3 .28 - LIMITS OF CONCRETE PLACING

In placing concrete containing sulphate resisting cement in floor slabs suspended or on grade, the maximum area to be placed in any single operation and isolated by approved control or expansion joints (provided in accordance with the working drawings and Specification or otherwise provided by the Contractor at his own expense to meet the requirements given in this clause), shall not exceed 200 square metres and neither shall the length of any such element of slab exceed 20 metres in any direction. If the Contractor wishes to submit for consideration alternative areas or lengths to those given above, then he shall submit with his written proposal full written details of his method, statement covering all aspects of concrete work including batching, mixing, transportation, shuttering, fixing, reinforcement, placing concrete, compaction, curing and protection together with full information on joint forming (ie. sawing, crack inducing or other like features). Particular emphasis is to be given to achievement and maintenance of the correct minimum water / cement ratio, full compaction, accurate location of reinforcement in finished work, strict maintenance of all cover dimensions, achievement of fully dense and impervious sound uncracked concrete, proper and complete curing and the correct application of any protective membrane called for.

3 .29 - CURING

As soon as the concrete has hardened sufficiently to avoid its surface being marred it shall be covered completely with hessian, cotton, damp sand or other approved materials. Such material shall remain on the concrete for ten days, and during this time it shall be kept permanently saturated by spraying to the satisfaction to the Consultant.

A waterproof membrane may be used for curing at the Consultant’s discretion but such materials as is approved shall not be bituminous and shall be coloured to show its presence. The Contractor shall apply the membrane immediately the concrete is sufficiently set for him to do so and ensure that it is not damaged during the curing period.

Alternatively, the Contractor may cure the concrete by ponding in which case he shall maintain at least 75mm depth of water on the entire surface of the concrete at all times from the time the concrete is placed until seven days thereafter.

During concreting work all shuttering which is to remain in position longer than 24 hours shall be kept thoroughly wetted during the period it is in contact with the work.

3 .30 - TOLERANCE FOR CONCRETE CONSTRUCTION - GENERALLY

As work proceeds on Site the Contractor shall control and monitor all operations so as to provide a continuous check on the dimensional and layout conditions of the building works. In the case of all elevations, the Contractor shall provide an updated drawing or drawings showing the degree of compliance with the Specification and dimensional and layout matters for the information of the Consultant, and for the authorized use of any sub-Contractor or supplier engaged upon the manufacture, supply and or installation of components to be fixed or constructed upon all facades in question. Allowances shall be made for the above record to be provided on a weekly basis or shorter if specifically called for. Similar periodically updated records covering internal elements such as ground floors, suspended floor slabs, beams, columns, walls, stairways and the like elements shall be provided on a two-weekly period or as agreed otherwise as work proceeds on Site.

The Contractor shall be responsible for setting and maintaining concrete forms sufficiently within the tolerance limits so as to ensure completed work within the tolerance specified herein.

Concrete work that exceeds the tolerance limits specified herein shall be remedied or removed and replaced at the expense of and by the Contractor after agreement with the Consultant on the procedure to be adopted.

3 .31 - TABLES OF TOLERANCE FOR REINFORCED CONCRETE STRUCTURES

The deviations given below and elsewhere in this Specification will be permitted in the construction of the concrete work.

(Note : The tolerance is twice the deviation specified.)

These deviations are not to be regarded as cumulative and where two or more deviations apply the total deviation is to be the square root of the sum of the square of each deviation unless specifically stated otherwise in this document.

These deviations are a general guide to the limiting deviation and the Contractor may be required to work to a specified finer tolerance where pre-cast cladding units, windows, glazing or other items are to be fitted between columns, beams or other similar details. The Contractor should refer to the specialist sub-Contractor or supplier involved for the appropriate construction tolerance.

Where more than one tolerance limit is applied to any point or location the composite value shall be obtained as above and as illustrated on sketches. Illustrations of tolerances on edge beam are also shown on sketches.

For all tolerance applications on the reinforced concrete structure the accurate theoretical setting out grid as at structural ground floor level shall be taken as basis and all dimensions and tolerances calculated and co-ordinated from that level and the grid thereon.

TABLES OF TOLERANCES FOR FINISHED INSITU CONSTRUCTION

Note : Where differing limits are given by two or more of Tables 1 to 5 below, the lesser limit permitted deviation value shall be adopted in the cases governed by Tables 2 (a) and 2 (c) and also Tables 2 (b) and 2 (d).

Where tabulated values are to be calculated to relate to actual dimensions, they shall be rounded up to whole numbers of millimeters when related to individual tolerances. In calculating combined tolerances the working out shall be based upon the actual calculated values.

TABLE 1: THE PLUMB

Items to be controlled	Related Dimension	Permitted Deviation
a) In the lines and surfaces of internal column piers, walls and arrises in same	i) In any height not exceeding 3m	6mm
	ii) In any height between 3m & 6m	6mm to 18mm *
	iii) In any height exceeding 6m but not greater than 11m	18mm to 23mm *
	iv) In any height exceeding 11m including the overall height of the structure	25mm
b) For exposed edges, external and corner columns, external walls and other conspicuous lines on external elevations including the outside faces of external beams and floor slabs edges where these occur upon or immediately adjoining external elevations	i) In any height not exceeding 3m	4mm
	ii) In any height between 3m & 6m	4mm to 10mm *
	iii) In any height exceeding 6m but not greater than 11m	10mm to 15mm *
	iv) In any height exceeding 11m including the overall height of the structure	15mm

* To be pro rata with related dimensions

TABLE 2: LEVELS OR GRADES

Items to be controlled	Related Dimension	Permitted Deviation
a) Discrete levels on floors, ceilings, beam soffits and as in arrises except required in (b) below	i) In any height not exceeding 3m ii) In any height between 3m & 6m iii) In any height exceeding 6m but not greater than 11m iv) In any height exceeding 11m including the overall height of the structure	5mm 8mm 8mm to 18mm * 20mm
b) Discrete levels in all elements in external elevations including lintels, cills, parapets, conspicuous horizontal lines, grooves, top and bottom arrises of beams or slab edges including where all such immediately adjoin the elevation	i) In any height not exceeding 3m ii) In any height between 3m & 6m iii) In any height exceeding 6m but not greater than 11m iv) In any height exceeding 11m including the overall height of the structure	4mm 6mm 6mm to 11mm * 15mm
c) Relative levels for all items as in (a) above	i) In any span bay or length between identifiable features not exceeding 3m ii) As above but exceeding 3m but not greater than 11m iii) As above but exceeding 11m but not greater than 26m iv) As above but exceeding 26m including the total length of the blocks or structural units	6mm 6mm to 22mm * 22mm to 32mm * 35mm
d) Relative levels for all items as in (b) above	i) In any span bay or length between identifiable features not exceeding 3m ii) As above but exceeding 3m but not greater than 11m iii) As above but exceeding 11m but not greater than 26m iv) As above but exceeding 26m including the total length of the blocks or structural units	5mm 5mm to 17mm * 17mm to 27mm * 30mm

* To be pro rata with related dimensions

TABLE 3: LINEAR BUILDING LINES

Items to be controlled	Related Dimension	Total Tolerance
Variation of the linear building lines from an established position on plan and related position of columns, walls and partitions	i) In any bay span or identifiable length between features not exceeding 3m	3mm
	ii) In any length exceeding 3m but not greater than 11m	3mm to 13mm *
	iii) In any length exceeding 11m but not greater than 26m	13mm to 28mm *
	iv) Throughout total length of the block or structure	30mm

* To be pro rata with related dimension.

TABLE 4: SLEEVES

Items to be controlled	Related Dimension	Permitted Deviation
Variation in the sizes and location of sleeves, floor openings and wall openings	i) For every 1m of size and or location up to 20m	1mm
	ii) Above 20m	25mm

Note : Combined tolerance of size and location according to square root rule in Clause .33 above

TABLE 5: CROSS SECTIONAL DIMENSIONS

Items to be controlled	Related Dimension	Permitted Deviation
Variation in cross sectional dimension of columns and beams and in the thickness of slabs and walls	All dimensions	Minus 6mm plus 6mm but not cumulative with cover tolerance given in Table 8

TABLE 6: FOOTINGS

Items to be controlled	Related Dimension	Permitted Deviation
a) Variations of dimensions in plan	Minus Plus	12mm 50mm
b) Misplacement or eccentricity	2% of the footing width in the direction of misplacement but not more than	50mm
c) Variation in thickness	Minus Plus	2.5% specified thickness 5.0%

TABLE 7: STAIRWAYS

Items to be controlled	Related Dimension	Permitted Deviation
a) In a flight of stairs	Rise Tread	3mm 6mm
b) In consecutive steps	Rise	2mm

TABLE 8: PLACING REINFORCEMENT STEEL

Items to be controlled	Specified Cover	Permitted Tolerance
a) Variation of concrete covering	With 20mm 25mm 35mm 40mm 65mm	3mm 3mm 4mm 5mm 9mm
b) Variation from indicated spacing		25mm

See also Clause .02
BS 4011
BS 5964
PD 6444
DD 22
DD 51

In the event that any requirement in these Standards is more stringent than the tolerance contained in this Specification then they shall be followed as applicable.

3 .32 - FORMWORK

Formwork shall be of steel or timber provided it is constructed so as to be rigid during casting of concrete and sufficiently watertight to prevent loss of the liquid from the concrete and it shall be capable of being removed without shock vibration or damage to the concrete. All forms shall be adequately propped and braced in their correct position and shall be sufficiently strong to resist distortion by the pressure of the wet concrete, construction loads, wind and other forces. The deflection shall not exceed 3mm. Bottoms of beam boxes shall be erected with an upward camber of 10mm for each 5.0 metres of span. If so instructed the designs for shuttering shall be submitted to the Consultant for approval before construction. Shuttering shall be provided for the top faces of sloping work and anchored to prevent floatation where the slopes exceeds 15 degrees from horizontal.

The inside faces of all forms shall be treated with mould oil of a type approved by the Consultant which gets onto reinforcements or other embedded fittings. Before any concrete is placed shavings, dirt and rubbish shall be removed from the formwork and whenever required by the Consultant this shall be done with compressed air. Formwork shall also be wetted with water before concreting.

Forms are to conform to the shapes, lines, grades and dimensions of the concrete shown on the drawings and to the Consultant's approval. Suitable temporary openings shall be left in all formwork to facilitate cleaning out of the Works before placing of concrete. In deep section's provisions is to be made for placing concrete in such a manner that no concrete shall have to drop more than 1.20 m.

Where concrete is to be poured in successive lifts care shall be taken to ensure that the formwork is set tightly against the concrete of the preceding lift to prevent the formation of lips and loss of grout or liquid between the formwork and the concrete.

On exposed concrete faces no method of fixing the forms shall be used which involves any kind of fixing in the concrete or any patching of the concrete face.

No concrete shall be placed anywhere until the Consultant has inspected and approved the formwork and the reinforcement and the Contractor shall give him reasonable notice to enable this to be done.

The Contractor shall be responsible for properly supporting all concrete until it is sufficiently strong for the formworks and the props to be removed. No formwork shall be removed without the Consultant's prior approval and in no case shall any shuttering be removed until the following times have elapsed after placing the concrete:

Shuttering	Portland cement concrete & Sulphate resistant cement concrete
Beams sides, walls and columns	2 days
Slabs (props left under)	4 days
Slab (removal of props) beams	7 days
Beams Soffits (props left under)	7 days
Beams Soffits (removal of props)	21 days

The shuttering for beams and slabs shall be erected so that the shuttering on the sides of the beams and of the soffit of slabs can be removed without disturbing the beam bottoms. Re-propping of the beams shall not be done except when with the approval of the Consultant, props be reinstated in anticipation of loads in excess of the design loads. Vertical props shall be supported on adjustable heads or other approved measures shall be taken whereby the props can be gently lowered vertically when commencing to remove the shuttering.

Props for an upper storey shall be placed directly over those in the storey immediately below and the lowest prop shall bear upon work sufficiently strong to carry the load.

Belts and other metal fittings used in formwork erection shall be constructed so as to permit their easy removal to a depth of at least 50mm from the face without injury to the concrete and so that upon their removal the cavities left are of the smallest possible size.

If during a concrete pour, undue settlement, bulging or other defects become apparent in the formwork, the Contractor shall cease pouring and shall take all necessary steps to the satisfaction of the Consultant to remedy such defects.

Where wrought formwork is specified the Contractor may alternatively use lined formwork, but whichever formwork is used, then immediately after the removal of the formwork the exposed faces of the concrete shall be rubbed down and stopped with the cement and sand (1 : 2) as necessary to remove irregularities and defects and leave the surface smooth and even. Pre-cast concrete described fair finished shall be cast in wrought formwork.

See also Clause 3.26 for further details of formwork for concrete surfaces subsequently to be rendered.

3 .33 - REINFORCEMENT

All steel reinforcing bars shall comply with the requirements of BS 4449 and the steel fabric reinforcement to BS 4483.

Subject to the written approval of the Consultant steel manufactured to an equal internationally accepted standard will be accepted but full independent sampling and testing shall be carried out to justify the quality. Should the tests prove unsatisfactory then the reinforcement may not be used in the Works and must be removed from the Site immediately.

Unless specially instructed to the contrary all rod reinforcement and mesh reinforcement to be included in the works shall be coated with a fusion-bonded epoxy coating all in accordance with ASTM A775-81 Standard and shall be supplied by an approved manufacturer. All cutting and / or bending of reinforcement shall be to his recommendations and instructions all as agreed with the Consultant. The manufacturer shall be required to attend the Site at regular intervals to supervise all aspects of the work to ensure his product is used fully in accordance with his recommendations.

When the epoxy coating is damaged (cut ends, accidental damages etc.), the coating shall be repaired with patching material confirming to ASTM A775-81 and shall be carried out in accordance with the manufacturer’s recommendations.

Reinforcement of all types shall be stored on Site in racks above the ground in an approved manner so as to avoid damage.

The number, size, form and disposition of bars shall be strictly in accordance with the drawings

and bending schedules or as directed by the Consultant. Reinforcement shall be checked after being fixed and no concrete shall be placed round the reinforcement until such checking has taken place. Epoxy coated bars shall be handled and stored in a manner to prevent damage to bars or coating.

Equipment for handling epoxy-coated bars shall have padded contact areas. Bundles shall be lifted with a strong back or have multiple supports to prevent bar-to-bar abrasion from sags in the bundle. Bars or bundles shall not be dragged or dropped. Any coating damage due to handling, shipment and placing shall be repaired as described above. All chairs, tie-wires or other devices used to connect, support, secure or fasten epoxy-coated reinforcement shall be made of, or coated with, a dialetric material. All bundles shall be identified at the factory with durable tags to allow checking of coating quality control at Site.

Reinforcement shall not be straightened or re-bent in a manner which may cause injury to the material. Bars with kinks or shapes not shown on the drawings shall not be used.

The Contractor shall ensure that all reinforcement indicated on the drawings is accurately called up and dimensioned for length, size and bending to ensure that it will fit into the concrete profile to the specified tolerances.

All reinforcing bars shall be bent in accordance with British Standards. In particular, no reinforcement shall be heated before bending. All reinforcement shall be rigidly fixed in position to the concrete cover specified by approved means. If it is necessary to provide “Chairs” or other subsidiary reinforcement not shown on the drawings to keep the reinforcement in position, the Contractor shall not be entitled to additional payment for providing the same. The concrete cover to such subsidiary reinforcement shall not be less than that over the reinforcement as specified in the Clause headed ‘Cover to reinforcement’.

All uncoated reinforcement shall be free from loose scale, rust, oil, grease or any other matter that may impair the bond between the concrete and the reinforcement. If required by the Consultant, the uncoated reinforcement shall be thoroughly cleaned with wire brushes. At intersections any uncoated reinforcement bars shall be bound together with annealed soft iron wire No.16 S.W.G. The ends of all wires shall be turned towards the inside of the member.

The Contractor shall provide adequate scaffold boards or similar to ensure that the reinforcement is not displaced by being walked upon during the placing of the concrete or other operations. Prior to concreting, the Contractor shall ensure that the reinforcement is cleaned of all concrete from previous pours.

For tolerance in placing reinforcement steel, see Table 8 of clause 3.31.

Welding – no weld shall be allowed in any reinforcement without the permission in writing of the Consultant.

Reinforcement connectors may be used subject to the written approval of the Consultant. They shall be of approved proprietary manufacture and obtained from an approved supplier. Their installations shall be strictly in accordance with the manufacturer’s operating instructions using personnel specifically trained for such work and using purpose designed equipment fully compatible with the coupler.

If used with the epoxy-coated bars the coupler shall be coated with patching material after suitable surface preparation.

Where noted on the drawings, right hand / right hand screwed couplers capable of developing the full tensile strength of the reinforcing bar and as generally specified above, and the size described, shall be installed as shown. The open end of the coupler shall be plugged and wrapped in a waterproof self-adhesive tape to prevent the ingress of cement paste onto the open end.

3 .34 - COVER TO REINFORCEMENT

Unless otherwise specified or shown on the drawings, the following gives the minimum cover, which shall be maintained to main reinforcement in work above ground.

Slabs – 20mm
Beams – 25mm
Columns – 40mm and Pile Caps – 75mm

Unless otherwise specified or shown on the drawings the minimum cover to the main reinforcement in work below ground shall be 60mm.

Concrete spacers to be of the same concrete quality for that part of the structure in which they are being used or otherwise to the approval of the Consultant.

3 .35 - PILING WORKS

a) ADJOINING PROPERTY

The Contractor shall carry out the piling work in such a manner as to avoid damage of any form to the adjoining buildings and the property and he shall be held responsible for any claims from adjoining owners due to the piling works.

b) UNDERGROUND SERVICES

The Contractor shall acquaint himself with all the existing underground structures, drains, cables and other utilities above and below the ground on and adjoining the Site and he will be held responsible for any claims arising from damage to these services and utilities.

c) REGULATIONS

All piling shall be carried out in accordance with the recommendations of the British Standards and Codes of Practice and to the approval of any relevant Authority, the Consultant and this Specification.

d) RECORDS

Records shall be kept and agreed with the Consultant as work proceeds for each pile constructed giving the pile shaft diameter, base diameter, excavated length, concreted and empty bore lengths, ground levels and founding levels, theoretical and actual volumes of concrete, test tubes, pile test and integrity test results. Records shall also be taken of the types and levels of the strata through which the piles have been constructed.

The format of all pile records, pile tests and integrity test results are to be to the approval of the Consultant. One copy of all records shall be submitted to the Consultant.

e) PILE DESIGN

The Contractor shall carry out a comprehensive soil investigation and report his findings to the Consultant prior to the commencement of any structural works on the project. The Contractor shall arrange to carry out such soil investigation by an approved specialized company. The type of investigation, location of bore holes, depth of boring, sampling, testing and subsequent laboratory work shall be submitted for the Consultant's approval. On completion of the Site investigation, the Contractor shall verify that the pile design is capable of withstanding the proposed building working and test loads. Revisions of pile loadings and pile cap sizes required by the Site investigation are deemed included in the Contractor's offer. On the Consultant's approval of the Site investigation and revised design, the Contractor may commence the related works.

The Contractor may submit in addition alternative designs and tenders for the pile foundations to that shown on the scheme drawings that will result in a saving of cost or an accelerated construction programme. The Contractor will also be responsible for any variations in concrete profiles to the structure resulting from the design.

All tenders for piled foundations must be accompanied with drawings if different from the proposed scheme.

The design calculations for the piles proposed to carry the working loads specified shall show the type of pile, pile shaft length, diameter, reinforcement, concrete mix and pile spacing together with a method statement of the pile construction sequence and plant proposed.

The design calculations shall show the assumed soil characteristics, friction and end bearing values, ultimate and working loads, factor of safety and any reduction factors due to group action and or negative skin friction. The final approved design shall include all the above information for approval.

f) PILE GUARANTEE

The Contractor shall provide a guarantee that the piles as constructed shall carry the 'working load' as specified by the Consultant without differential settlement occurring so as to adversely affect the structural integrity and performance of the building carried on the piles.

g) WORKING LOAD

The 'Working Load' is the load on the pile due to the self weight of the building above pile cap level, the self weight of the cap, the super imposed load for which the building has been designed, including live load reductions plus load eccentricity and wind and horizontal load effects.

The design load for a single pile in a group shall be the working load modified, as agreed with the Consultant to allow for group action and pile spacing.

h) PILE SIZE

The Contractor is responsible for the adequacy of the piles installed to carry out the working loads specified and or as shown in the drawings. The size of the pile shaft and / or pile base is dependent upon the permissible stress in the shaft under design load and the load carrying capacity of the shaft and base of the pile.

The actual size of the pile shaft and base will be nominated by the Contractor subject to the Consultant's approval and based upon: -

i) The calculated ultimate load shall be reduced by 12.5% to allow for local soil variations unless substantiated by preliminary pile test.

ii) The factor of safety for the design loads shall be 2.5 when preliminary pile tests are carried out.

iii) The maximum working stress in the concrete shall be not more than 25% of the characteristic cube strength of the concrete used in the pile.

The pile size shall be taken to mean the outside diameter or size of the permanent or temporary casing where used or the outside diameter of the excavating tool. Where a pile is cased for part of its length the least diameter shall be taken as the pile size.

The diameter or size of the finished pile shall at no point be less than 300mm except in the case of special small diameter piles. The maximum reduction in size permitted is minus 10% of nominal diameter or half the reinforcement cover, whichever is the lesser.

i) PILE SPACING

The minimum centers of end bearing and friction piles is to be 3 times and for friction piles 3 times the shaft diameter, unless otherwise stated.

The Contractor is to notify the Consultant of any pile which is too close to an adjoining pile or any underground obstruction or utility.

j) PILE LENGTH

All piles should be founded at a common level and any variation in the average founding level or strata is to be notified to the Consultant before proceeding with the pile construction.

k) CONCRETE

The concrete mix for piles shall be grade SC 40 in accordance with Clause 3.11.

Concrete shall be transported from the mixer to the pile position without segregation and placed in the pile bore by an approved method to avoid contamination within half an hour after mixing.

Waterlogged piles or piles constructed with drilling must be concreted by means of a Tremor Pipe, with the base of the pipe maintained within the fresh concrete.

Test cubes shall be taken at regular intervals and made and tested in accordance with British Standards.

l) REINFORCEMENT

All piles shall contain a minimum of 10 No. T 22 diameter number high yield longitudinal bars or a minimum area of 1.0% of the cross section full length with suitable helical binding of 0.2% of the section. The bars are to project a minimum of 1.6m above the specified cut-off level. The actual quantity and size of the reinforcement bars are to be specified by the Contractor and are to be dependent upon the loading conditions of the pile shaft.

The minimum cover to reinforcement is 70 mm and this shall be maintained by approved spacers.

Any reinforcement contaminated by soil, salts, chlorides, sulphates, rust or other deleterious materials will not be approved.

m) TEMPORARY LINING

Adequate precautions shall be taken by the use of temporary and / or permanent lining tubes of sufficient length to prevent the entry of ground and surface water, loose materials etc. and to maintain the pile shaft to its specified size for cast insitu concrete piles until the concrete has thoroughly hardened.

For piles cast insitu using a drilling mud the method of construction shall be agreed with the Consultant.

Lining tubes shall be cleaned of all adhering concrete and soil before reuse and damaged lining tubes shall not be used.

n) SETTING OUT

The Contractor will be responsible for setting out the gridlines and column centres and establishing the datum levels.

The Contractor will be responsible for setting out the piles in relation to the given gridlines and column locations and the cut-off levels of the piles from the datum levels.

Upon completion of the piling works, the Contractor shall prepare the layout drawings on which shall be indicated for each pile, its exact location in relation to its specified position and the final top level of the concrete and shall submit two paper copies and one negative copy of all such drawings to the Consultant for approval.

o) LOCATION

i) All piles shall be positioned within 75 mm of the location shown on the Consultant's drawings.

ii) All piles shall be vertical, unless specified otherwise on the drawings. The limiting deviation is 1 in 75 from the vertical over the pile length or 40 mm in any 3.0m length.

Any additional costs involved in enlarging or strengthening pile caps and or providing additional piles in consequence of exceeding the above deviations shall be borne by the Contractor.

p) CUT-OFF

All piles shall be terminated in faultless concrete at the cut-off level specified on the drawings, with a deviation of +300 mm –0.0 mm. The allowance for cutting down of the piles to level is 450 mm plus an additional allowance of +10% of the cut-off depth below 2.0m below piling table levels. The Contractor will be responsible for any additional cost in cutting down or making up piles outside this tolerance or for replacing defective concrete up to "cut-off" level.

q) PILE SHAFT

Upon completion of the excavation of the pile shaft and prior to concreting, the base of the pile or

bell shall be cleaned of all loose materials and / or water.

r) INSPECTION

Each pile excavation shall be inspected upon completion for plumb, loose material and water from ground level by the supervisory staff and the Contractor shall provide all necessary facilities to enable the Consultant to make similar inspections.

s) SPOIL

All excavated materials from the pile boring shall be deposited in stock piles and removed by the Contractor.

Where drilling muds are used the surplus mud shall be ponded or kept in tanks and all surplus mud drained from the excavated material before stock piling. The removal from Site of all the drilling mud and contaminated material is the responsibility of the Contractor and no mud must be allowed to drain or be deposited into the local drainage system or any river or water course.

t) CONSTRUCTION

All insitu concrete piles are to be cast in one continuous operation without construction joints. A construction joint will be permitted in piles above 1.25m diameter if due to breakdown of plant or material supply, and in these circumstances the top surface is to be cleaned of all laitence, soil, loose material and standing water.

When temporary lining tubes are used care is to be exercised during withdrawal to prevent damage to partially set concrete.

u) GENERAL TESTING

The 'Test Load' (T. L) for preliminary or non working piles is twice the 'Design' or 'Working Load' whichever is the greater and for working piles one and a half times the 'Design' or 'Working Load' (W. L.).

The test load will be applied by hydraulic jacking against kentledge or tension piles, with the load being measured by tested and certified pressure gauges or load cell to the Consultant's approval.

Working piles may not be used as tension piles in a pile test.

The pile settlement will be recorded by means of dial gauges registering against a datum beam or subject to the approval by means of an optical level.

Piles will be tested by Increment Loading as follows, with records kept and agreed with the Consultant of time, load and settlement readings with the result presented in tabular and graphical format.

Unless authorized by the Consultant, a minimum of one preliminary test pile will be constructed and tested in accordance with this clause for each pile size or design load type before the construction of the working piles commence.

During the course of the Works, at least two working piles shall be selected and tested in accordance with this clause.

The Contractor shall allow for carrying out a suitable integrity test on each of the piles to ensure that each pile as installed is of sound construction. The type and method of testing employed is to be approved by the Consultant prior to the commencement of testing, and shall comprise an electronic measuring procedure such as the sonic or echo rebound method to ensure the complete integrity of the pile throughout its length. Method of integrity testing is given later in this Specification.

v) TESTING PROCEDURE

i) Zero to W. L.

The load will be applied in 5 or 10 tonne increments (but not greater than 10% of W. L.) each increment being held for 10 minutes or until settlement ceases. The W. L. will be held for 24 hours with the load maintained if falling below 95% of W. L. with settlement reading being taken at hourly intervals and plotted as load settlement and time settlement curves.

ii) W. L. to Zero

The load will be reduced in reductions similar to the increments in (i) in 5 minutes stages until unloaded and the recovery noted for 1 hour.

iii) Zero to T. L.

The load will be applied in the same increments as (i) till the test load is reached and the load held and maintained with 95% of T. L. for 24 hours with load and settlement readings taken hourly.

iv) T. L. to Zero

The load is to be reduced in reductions as in (ii) in 5 minutes stages until unloaded and the recovery noted over 4 hours.

w) PILE TEST RESULTS

If any working piles fail the test, the Contractor shall replace the piles with additional piles at his expense and bear all additional costs.

The remainder of the piles constructed prior to the working pile test shall stand condemned as unsatisfactory until demonstrated by the Contractor that the quality of bearing capacity of each individual pile on the Site is acceptable.

A pile will be deemed to have failed the test if the test load cannot be reached and/or the residual settlement after the test load is removed is greater than 0.025 mm per tonne of the test load or that it continues to settle under test load conditions with a settlement larger than 0.25mm per hour.

x) INTEGRITY TESTING TO PILES

The Contractor shall cut down the top of each pile a minimum of 300 mm, but not below the specified cut-off level, and shall prepare the resulting surface of the concrete as required by the integrity testing method approved by the Consultant. All broken out concrete and other materials shall be removed from Site.

y) PROTECTIVE SHEATHING TO PILES

All piles shall be constructed with a protective sheathing to the top 3.0m length of pile below cut-off level. All materials and method of installation shall be submitted to the Consultant for his approval prior to commencement of work.

3 .36 - CO-ORDINATION OF BUILDERS' WORK

The Contractor shall co-ordinate the requirements for holes, fixing and other similar builders' work.

The Contractor shall ensure that such builders' work as shown on the drawings is in accordance with his requirements. Any builders' work not shown on the drawings but required by the Contractor or any of his sub-Contractors shall be forwarded to the Consultant for his written approval at least four weeks before being formed, cast or fixed into the works.

No holes or fixings shall be provided without the prior written approval of the Consultant. In the event of the Contractor failing to obtain in due time or failing to provide the builders' work required no adjustment will be made to the Contract price and the Contractor shall be entirely responsible for any additional costs which may arise in completing the works to the satisfaction of the Consultant.

3 .37 - PROTECTION OF CONCRETE BELOW GROUND

The substructure elements of concrete and reinforced concrete in contact with the ground are to be protected by their being covered with an approved material of proprietary manufacture and applied strictly in accordance with the manufacturer's instructions. The protection is intended to prevent the ingress of moisture and / or to give protection against concrete deterioration due to sulphate or other chemical attack from aggressive agents in the ground or ground water.

The Contractor is to ensure that the surface of all substructure concrete (including blinding concrete) is clean, smooth and regular suitable to receive the particular protective membrane.

3 .38 - TREATMENT OF DIFFERENT SURFACES

The substructure concrete surfaces in contact with the ground shall be protected in accordance with the following classifications: -

(a) Non suspended ground floor slab in contact with the ground.

(b) Concrete in contact with the ground and described as concrete of mix quality SC 40.

(c) Concrete described as WSC 40.

3 .39 - CARE OF THE PROTECTED SURFACE

All subsequent back filling and other operations including concreting are to be carried out carefully and in such a manner as not to impair the efficiency of the protective system described in this Section of the Specification.

3 .40 - DETAILS OF PROTECTION

(a) For elements described in 3.38(a) above (non-suspended slabs) an approved polythene

damp-proof membrane of 1,200 gauge shall be laid under all slabs in contact with the ground. Joints between sheets at sides and ends shall be double welded formed by placing the edges together and folding over twice. The joints shall be prevented from opening prior to concreting by approved means. Alternatively, the manufacturer's proprietary system of joining, if made, may be employed subject to the Consultant's approval. The damp proof membrane shall be lapped with (75mm minimum) and bonded to the protective membrane applied to the reinforced concrete work as described below.

(b) For elements described in 3.38(b) above (concrete of mix quality SC 40) the surfaces shall be coated with two coats of brush applied solvent based bituminous protective system to the approval of the Consultant and fully in accordance with the manufacturer's instructions.(which shall be available on Site for confirmation). All surfaces to be treated shall be prepared as required by the manufacturer.

For all horizontal surfaces to the underside of the pile caps, ground beams etc., the protective membrane shall be applied to the upper surface of the blinding concrete over an area greater than the actual concrete area by at least 75mm on all sides. Special care shall be taken at all arrises to ensure the protective layer is fully continuous around these. The protective membrane shall comprise an applied cut bitumen solution.

(c) For elements described in 3.38(c) above (concrete of mix quality WSC 40) the surfaces shall be covered with a flexible self adhesive waterproof membrane as described below and obtained from an approved manufacturer and the whole installation of the membrane shall be fully in accordance with the manufacturer's written instructions.

The membrane which shall be laid using 25% lapped joints shall be applied to the suitabl prepared concrete surfaces, primed as required by the manufacturer of the membrane system, with adhesives and sealers all as called for in the written instructions (which shall be available on Site for confirmation) and shall be fully protected during the progress of the Works until completion.

For horizontal surfaces to the underside of construction, the membrane shall be applied to the top surface of the blinding concrete over an area 100 mm greater than the actual concrete area and protected with a board 6 mm thick. Vertical faces shall be similarly protected with the protective boards.

3 .41 - <u>PRECAST CONCRETE - GENERAL</u>

Unless otherwise specified or directed by the Consultant all the preceding concrete clauses shall be applicable to precast concrete.

The concrete in each precast unit shall be placed in one operation. No unit shall be removed from the mould or erected until sufficiently matured to ensure that no damage shall be done to the unit. A unit shall be suspended or supported only at the points described on the working drawings and a unit that is cracked or otherwise damaged during, before or after erection shall be removed from the Works and replaced by the Contractor free of charge. Precast units shall be bedded or otherwise fixed on their permanent positions as shown on the drawings or instructed by the Consultant.

The surface of all panels when erected in their final position shall be fully protected during the remaining construction period to maintain the accepted finish.

Indelible identity, location and orientation marks shall be put on precast units as and when necessary.

Temporary supports shall be used to ensure that no damage occurs to units from construction or other loads likely to be encountered during the completion of joints between any combination of precast and insitu concrete structural elements.

3 .42 - TOLERANCES

Tolerances for precast elements are to correspond in all aspects to the requirements given in Clause 3.32 both when finally installed and / or erected and in manufacture.

In addition to above, further tolerance requirements on individual elements are given below on the basis that final as erected / installed cumulative tolerances do not exceed those given in 3.32 above.

TABLE OF TOLERANCE FOR PRECAST CONCRETE

		Permitted Deviation
1) Length	Up to 3 m 3 to 4.5 m 4.5 to 6 m Additional for every subsequent 6 m	+/- 6 mm +/- 9 mm +/- 12 mm +/- 6 mm
2) Cross section each direction		- 6 mm +6 mm
3) Straightness or row deviation from intended	Up to 3 m 3 m to 6 m 6 m to 12 m Additional for every subsequent 6 m	6 mm 9 mm 12 mm 6 mm
4) Squareness When considering the squareness of a corner, the longer of the two adjacent sides shall be taken as the base line. The shorter side shall not vary in its distance from a perpendicular so that the difference between the greater and shortest dimension exceeds : -	Where shorter side do not exceed 1.2 m long Where shorter sides are between 1.2 and 1.8 m long Where shorter sides are over 1.8 m long	6 mm 9 mm 12 mm

		Permitted Deviation
5) Twist Any corner shall not be more than the tolerance stated from the plane containing the other three corners	Up to 600 mm wide and up to 6 m in length Over 600 mm wide and for any length	6 mm 12 mm
6) Flatness The maximum deviation from a 1.5 m straight edge placed in any position on a nominally plane surface shall not exceed :		6 mm

3 .43 - BEARING MATERIALS TO EXPANSION JOINTS

The bearing pads to be incorporated into the structural expansion joints shall be purpose made load bearing units also capable of horizontal displacement designed to carry the loads as specified. They shall be supplied by SK Bearings Limited of Pampisford, Cambridge, England, or alternative approved equivalent.

The prepared bearing unit shall cover the full width of the concrete bearing surface, which shall be of steel trowelled finish, with the bearing pads centrally placed within the unit.

Generally, SK Glide Bearings shall be provided in slab joints and SK Sliding Bearings in beam joints and shall be designed to carry the vertical loads specified.

The 25 mm wide vertical joint shall have compressible filler board incorporated during the construction stages which shall be securely attached to one side of the joint to prevent it falling out when the joint opens.

3 .44 - SURFACE HARDENER TO CONCRETE SLABS

Where specified on the drawings an approved surface hardener shall be applied to concrete slabs in accordance with the manufacturer's instructions to provide a permanent hardened and dust-proof surface to the finished concrete. The compound shall be of an approved proprietary manufacture and the Contractor shall ensure its compatibility with the concrete materials (e.g. OPC or SRPC) and the proposed usage of the element.

3 .45 - PRECAST ARCHITECTURAL CONCRETE

Precast elements shall strictly conform to the tolerances and very high standard as per the Specification.

Work of this section includes, but is not limited to the design, casting, erection of all precast architectural concrete panels including all labour, materials, equipment, transportation and sealing of panels for permanent shapes to act as structural support of interior finishes or as required on drawings.

3 .46 - QUALIFICATION OF PRECAST CONCRETE MANUFACTURER

All precast concrete shall be a product of a manufacturer who has demonstrated the capability to produce architectural precast concrete products of the quality specified. The manufacturer must be able to show that he has experienced professional personnel and well equipped precast factory, and a management capability sufficient to execute the Contract. When requested by the Consultant, the manufacturer shall submit written evidence of the above requirements.

3 .47 - PRECAST DESIGN REVIEW

The Contractor shall review the design of the precast panels and verify that they are designed to satisfy all the following: -

a) Tailoring the precast panels to suit the building shape and specified profiles. The Contractor shall note that all corner units are handed.

b) Lifting and handling stresses.

c) Wind pressure shall be calculated in accordance with ANSI A–58, 1–1972 or CP3:Chapter V part 2, assuming exposure C and a basic wind speed of 130 kph.

d) Fixing details.

The Contractor may propose other panel sizes to those shown on the drawings but the overall design of precast units shall be maintained.

3 .48 - SHOP DRAWINGS

The Contractor shall submit for approval complete shop drawings showing product location, fabrication details, member identification marks, reinforcement, connection details, dimensions and relationship to adjacent material in sufficient detail to cover manufacture, handling an erection. Identification marks coordinated to the shop drawings shall be on all units manufactured to facilitate hauling and erection together with the date of casting.

The Contractor shall be responsible for project schedule, dimensions and coordination with all construction phases. The precast units shall not be manufactured prior to receiving approval of the shop drawings by the Consultant.

The shop drawings shall be prepared by a qualified precast specialist who has a minimum of ten years experience in the field of designing and preparing shop drawings for precast elements and panels.

3 .49 - ALLOWANCE TOLERANCE

a) Dimensional tolerances shall be as outlined in PCI MNL 117-68, Manual for Quality for Plant and Production of Architectural Precast Concrete Products.

b) Length of precast elements not to vary from design length by more than + / - 5 mm.

c) Cross sectional dimensions of precast elements not to vary from design dimensions by more than + / - 3 mm.

d) Deviations from straight lines not to exceed 3 mm in 3 m.

e) Precast elements not to vary by more than +5 mm from true overall cross sectional shape as measured by difference in diagonal dimensions.

3 .50 - SAMPLES

A minimum of two samples for each type of connection shall be submitted to the Consultant for approval prior to the commencement of manufacture. Samples shall be at least 300 x 300 mm in size and of appropriate thickness, representative of the proposed finished product.

All approved samples shall be initialed by the Consultant and one sample shall be retained by the Consultant on Site as a control specimen for the permanent works.

3 .51 - INSPECTION OF PRECAST PLANT AND PRODUCTION UNITS

It shall be the responsibility of the Contractor to visit the precasting plant for inspection and review of the first production units. Precast products which do not meet the texture range or the dimensional tolerances of this Specification shall be rejected at the instruction of the Consultant.

3 .52 - MATERIALS

Unless otherwise stated, all materials shall comply with the respective Specification, standards and codes.

White cement if used shall be in accordance with BS 12 or equivalent.

Plates and angles cast into precast concrete products shall be of an approved material and quality and shop painted. Inserts, bolts and other accessories shall be electroplated and painted with epoxy paint. Lifting hooks will not be permitted.

3 .53 - QUALITY CONTROL

The precast concrete manufacturer shall have an established quality control programme in effect prior to letting of the Contract.

An outline of this programme shall be submitted along with the shop drawings.

Manufacturing and testing procedures shall be in general compliance with the PCI recommendations in MNL 117-68.

All tests shall conform to methods described herein or in reference material. Tests for compliance with Contract Specification shall be conducted by a qualified testing laboratory. Duplicate certificate copies of test results shall be transmitted to the Consultant and the precast manufacturer by the Contractor.

3 .54 - FORMWORK AND FALSEWORK

Formwork and falsework for precast concrete shall be rigid and constructed of materials that will result in finished products conforming to the shape, lines and dimensions shown on the approved shop drawings.

3 .55 - CONCRETE

Concrete mix designs shall be established by tests on trial batches to achieve the required

specified strength. These tests may be done either at the precast plant or in a commercial testing laboratory. Water content shall remain as constant as possible during manufacture.

Concrete shall be deposited and vibrated to ensure proper consolidation, elimination of unintentional cold joints and to minimize entrapped air on vertical surfaces.

For testing the cube strength daily, the Contractor shall have a cube crushing machine at his precast factory.

3 .56 - REINFORCING STEEL

All reinforcing steel shall have a minimum cover of 25 mm and shall be accurately located as indicated on approved shop drawings. Metal chairs, with or without coating shall not be used.

3 .57 - EMBEDDED ITEMS

Embedded anchors, inserts, plates, angles and other casting items shall have sufficient anchorage and embedment to support applicable loads. All weldments including tack welds shall be made in accordance with the applicable provisions of the AWS.

3 .58 - FINISH

The finished surfaces of the precast concrete elements shall be uniform and shall match the approved samples within the limits established by the Consultant. No patching shall be permitted.

The units shall be finished in accordance with the details given on the architectural drawings.

3 .59 - CURING

Curing shall be in accordance with the recommendations made by ACI Committee 533.

3 .60 - HANDLING AND TRANSPORTATION

Precast concrete units shall be lifted and supported during manufacturing, storage, transportation and erection operations only at the lifting or supporting points, or both, as shown on the shop drawings. Blocking shall be clean and non-staining. Lateral support shall be sufficient to prevent excessive bowing and warping. Edges of the units shall be adequately protected by padding or other means to prevent staining, chipping or spalling of the concrete.

Lifting hooks shall not be permitted.

3 .61 - RECORDS

Plant records for all production shall be kept available for the Consultant’s inspection upon request.

3 .62 - CO-ORDINATION

It shall be the responsibility of the Contractor to coordinate delivery and erection of precast concrete products with other operations.

3 .63 - CHECKING DIMENSIONS ETC.

Prior to installation of precast units, the erector shall check at the Site all dimensions affecting the work under his Contract. Any discrepancies between the design dimensions and field dimensions which could adversely affect installation in strict accordance with the Contract documents shall be brought to the Contractor's attention.

If such conditions exist, installation shall not proceed until such conditions are corrected or until installation requirements are modified to the Consultant's written approval.

Only competent workmen who are properly trained to handle and erect precast concrete units shall be employed. All precast concrete units shall be erected level, plumb, square and true within the allowable tolerances. They must be positioned so that cumulative dimensional error is not exceeded. Horizontal and vertical joints shall be correctly aligned and uniform joint width shall be maintained as erection progresses. Each panel shall be securely fastened in place as indicated on the approved drawings. Adjustments or changes in connections, which could involve additional stresses in the products or connections shall not be permitted without the written approval of the Consultant.

Unless otherwise stated, dimensional tolerance of the erected units shall be as recommended in PCI MNL 117-68.

3 .64 - DAMAGE TO PRECAST UNITS

The Contractor shall be responsible for any chipping, spalling, cracking or other damage to precast units.

No damaged precast units shall be incorporated into the structure. If, in the opinion of the Consultant, the damaged precast units can be repaired, this shall be done prior to erecting and to the entire satisfaction of the Consultant.

3 .65 - PROTECTION OF WORK

The Contractor shall protect the units from damage by field welding or cutting operations and provide non-combustible shields as necessary during these operations.

All work and materials of other trades shall be adequately protected by the Contractor.

3 .66 - INSPECTION

After all precast units have been set in place and before joint treatment, cleaning or waterproofing, the work shall be inspected by the Consultant. Units found to be slightly damaged may be authorized for repair at this time. All repairs shall conform to the Consultant's requirements and shall be structurally sound.

3 .67 - JOINTS AND JOINT SEALANTS

In all instances the edges of the precast concrete units and of adjacent material shall be sound, smooth, clean and free of all contamination prior to joint treatment.

Sealant and primer shall be white in colour and applied in accordance with the Specification and manufacturer's printed instructions.

DIVISION - 4

BLOCK WORK

DIVISION – 4 : BLOCKWORK

4 .01 - MATERIALS

a) Cement

Ordinary portland cement shall be as described under concrete work. White or coloured cement shall comply with the physical requirements of BS 12.

b) Lime

Lime shall be hydrated lime complying with BS 890 Class B to be soaked in water for not less than 16 hours before use.

c) Water

Water shall be as described under Concrete Work.

d) Sand

Sand shall comply with BS 1200 Table 1 and shall be washed and mechanically graded.

e) Concrete Blocks

Blocks shall be of local manufacture of cement and sand 1:5 mix (300 kg cement to one metre cube of sand) made in vibrated pressure machines. They shall be hard, sound, square and clean with well defined arrises and shall be to the sizes shown on the drawings.
The tolerance of thickness shall be +3 mm.

Unless otherwise shown on the drawings, blocks shall be hollow blocks and shall be of approved design.

Immediately after moulding, blocks shall be placed on clean, level non-absorbent pallets and shall be steam cured.

Blocks shall be tested for compressive strength whenever required by the Consultant. For each test twelve blocks will be selected by the Consultant. The average compressive strength for the gross area of hollow blocks shall be not less than 25 kg/cm^2 and the minimum compressive strength for the gross area of any hollow block shall be 20 kg/cm^2.

Should a test not meet the above requirements, the batch of blocks from which the sample was taken will be rejected and shall be removed from the Site.

Generally blocks used in the substructure shall be manufactured using sulphate resisting cement and those used in superstructure using ordinary portland cement.

f) Concrete blocks with coloured outer facing

Blocks shall be manufactured as described in sub-clause (e) but shall have a minimum 20 mm thick outer facing manufactured of white cement and block cavities filled completely with styropore insulation.

4 .02 - MORTAR

Mortar shall consist of 1 part cement to 4 parts of sand by volume. For work not in contact with earth or sand, one part lime may be added to the mix. Mortar for pointing facing concrete blocks shall be prepared using white cement. When blockwork is constructed below ground level sulphate resisting cement shall be used.

Should the Contractor wishe to use a plasticiser with mortar, then the mortar shall consist of 1 part cement to 4 parts sand with plasticiser added and used strictly in accordance with the manufacturer's instructions. The plasticiser must be approved by the Consultant before use.

Mixing shall be carried out by means of an approved mechanical batch mixer. The mortar shall be mixed dry until a uniform mix is obtained. Sufficient water shall then be added and the mixing continued until a homogeneous mix is obtained. Excess water shall not be used in the mix.

All mortar shall be used before the initial set has taken place and on no account shall mortar which has commenced to set be re-mixed with water or new batches and used.

4 .03 - WORKMANSHIP

Blockwork shall be set out and built to the respective dimensions, thickness and heights shown on the drawings and / or as instructed in writing by the Consultant.

Unless otherwise ordered, hollow blocks shall be used in all closures, end blocks such as at door jambs, window openings etc. and blocks of special lengths or size shall be solid. The blocks shall be well soaked before being used and the tops of walls left off shall be wetted before work is commenced.

Blocks shall be laid in true and regular courses on a full bed of mortar of 10 mm average thickness, exclusive of any key in the jointing surfaces of the blocks. Sufficient mortar shall be used in bedding and jointing to ensure that all keys are solidly filled. Where blocks abut against concrete each third course shall be tied thereto by means of approved galvanized steel ties.

All horizontal joints shall be properly level. The vertical joints shall be properly lined and quoins, jambs and other angles plumbed as the work proceeds.

All walls shall be plumbed vertical.

Standard sized blocks shall be used wherever possible. Broken blocks shall not be used except where required for bonding purposes. Walls and partitions shall be bonded to one another at angles and junctions.

Joints on faces of block walls which are to be rendered or plastered shall be raked out for depth of 10 mm as the work proceeds.

Walls shall be carried up regularly without leaving any part more than one metre lower than another unless the permission of the Consultant is first obtained. Work which is left at different levels shall be raked back.

The Contractor shall cut and fit blockwork as required, leave or form chases for edges of concrete slabs, steps, ends of partitions etc., cut chases for pipes, conduits etc. and generally perform all cutting away for all trades. Wooden plates and door and window frames shall be bedded and exposed edges pointed in mortar and cramps shall be built in.

4 .04 - CAVITY WALLS

The blockwork skins of cavity walls including cavity walls with precast concrete units shall be tied together with galvanized mild steel butterfly pattern wall ties to B. S. 1243 Fig. 2, spaced at the rate of one every 800 mm horizontally and vertically, staggered and every 400 mm vertically at ends, jambs and quoins.

4 .05 - PROTECTION OF CAVITIES

The Contractor shall submit to the Consultant for his approval a method for protecting the cavities of hollow blocks and cavities of cavity walls against mortar droppings and concrete falling into these cavities while casting floor slabs and edge beams.

The layers of felt between the underside of the concrete edge beam and top of the wall is for the purpose of separation of these members and they are not designed for protection against concrete filling into cavities.

4 .06 - LOAD-BEARING WALLS

Load-bearing walls shall be constructed in accordance with B. S. C. P. l l l Part 2.

Where a horizontal or vertical joint is not solidly filled or where it is found that the Contractor has used blocks other than the blocks specified, the whole panel of wall will be considered suspect and will be removed and rebuilt at the Contractor's expense.

4 .07 - NON LOAD-BEARING WALLS

Non load-bearing walls shall not be constructed at the same time as the load-bearing walls but built at least two weeks after the roof or upper floor structure is completed. Toothing into load-bearing walls will not be permitted.

4 .08 - FAIR FACED WALLS

External and internal walls where described as "fair face" shall be built with blocks having unblemished surface with good clean arrises to all exposed edges and shall be pointed with a neat flush joint as the work proceeds.

4 .09 - PROTECTION OF FINISHED BLOCKWORK

The Contractor shall ensure that the finished blockwork walling is not damaged by subsequent operations.

The Contractor is to protect the newly or partially built walling against it being dried out too rapidly by the sun's heat or from any other adverse climatic effects and is to follow the Consultant's instructions in this matter.

The Contractor shall in all cases cover all newly erected walling with hessian or other material approved by the Consultant and shall keep the same wet for at least three days.

4 .10 - COMPRESSIBLE JOINT FILLERS

Compressible joint fillers shall be used where specified at joints on drawings or requested by the Consultant. Filler shall be cut to exact widths and shall have all edges neatly trimmed. All fixing

shall be strictly in accordance with the manufacturer's printed instructions.

4 .11 - PARTITIONS

Blockwork partitions over 3 metres high shall be stabilized as follows: -

- Provide steel angle cleats to be fixed at head at 1.5 metre centres using galvanized mild steel angles. When this type of fixing is utilized a partition started in any one day shall be completed the same evening.

- For a partition taken between or passing in front of a reinforced concrete column provide two round steel bars laid in the bedding mortar at 1 metre centres and fixed to column using threaded bars locked into cast in "Split Rock" dowels.

- Provide rebates, toothing and the like at all vertical intersection of walling every metre of height.

All internal block-walls and partitions shall extend up to the underside of the concrete slab, soffits, beams and the like.

4 .12 - POLYSULPHIDE SEALANT

Gun quality sealant shall be used where specified on the drawings or where requested by the Consultant including external joinery and metal work bedded against block work or concrete. The colour shall be to the approval of the Consultant.

The primer shall be supplied by the same manufacturer as the sealant. The joints will first be thoroughly cleaned to the satisfaction of the Consultant and shall be primed before sealing with sealant. Application of these materials shall be strictly in accordance with the manufacturer's printed instructions.

4 .13 - LINTELS

Prefabricated lintels shall comply with the requirements of B. S. 5977, Part 2. All lintels shall be bedded on cement and sand mortar and the Contractor shall allow for a minimum bearing at each end of 150 mm.

4 .14 - REINFORCEMENT

Totally embedded metal reinforcement shall be used every second course in the mortar joints. The width of reinforcement to be such that it is 10 mm from the inner face and 20 mm from the outer face of the block.

DIVISION - 5

METALWORK

DIVISION – 5 : METALWORK

5 .01 - STANDARDS

The Specification of materials used shall comply with the British Standards Institute, the British Codes of Practice, DIN Standards, American Standards and American Society for Testing and Materials or Local Authority Standards and Codes whichever are the more stringent.

Applicable provisions of the following British Standard Institute publications shall apply to works of this Section as follows: -

a) Mild Steel : shall comply with BS 4360, sections generally shall comply with BS 4 : Part 1, hollow sections with BS 4848 : Part 2 and angles with BS 4848 : Part 4. Steel plate and sheet shall comply with BS 1449 : Part 1 steel tubes to BS 1775.

b) Stainless Steel Tubes : shall comply with BS 3014 and stainless steel plate with BS 1449 : Part 2.

c) Aluminium alloy extruded sections : bars and round tubes shall comply with BS 1161 or BS 1474 and aluminium alloy drawn tube with BS 1471. Anodizing process when applicable to comply with BS 3987.

d) Brasswork : as indicated on the drawings shall comply with various appropriate Standards.

e) Fastenings : unless otherwise specified shall be of the same metal as the item being fixed, with matching coating or finish. Wood screws shall comply with BS 1210. Bolts, screws and nuts to BS 4138 and self-tapping screws to BS 4174.

f) Plugs : proprietary fibre or plastics or other approved type.

g) Bitumen solution : for cold application shall comply with BS 3416 Type 1.

5 .02 - WORKMANSHIP

a) Co-ordinate and provide details of the work as necessary to ensure co-ordination with related building elements and services. Liaise as necessary to help ensure co-ordination of the work with related building elements and services, provide fabrication / installation drawings and other information requested, submit sufficient copies of drawings etc. for approval. Make any necessary amendments in accordance with any comments of the Consultant and re-submit sufficient copies of final version of drawings etc. for distribution to all parties.

b) Drawings must be submitted at least four weeks before starting fabrication, showing elevations, plans and full size sections, proposed methods of fixing, proposed methods of forming joints, any proposals for fabricating large components in more than one place.

c) After finalization of all details, prepare control samples as requested and obtain Consultant’s written approval before proceeding with manufacturing.

d) Fabricate metalwork carefully and accurately to ensure compliance with design and performance requirements, using types and grades of metal appropriate for the purpose.

Finished work must be free from distortion and cracks. Use proprietary products to manufacturer's recommendations.

e) Pre-finished metal may be used if the finish complies with these Specification, the methods of fabrication do not damage or alter appearance of finish and the finish is adequately protected during fabrication.

f) Cold formed work : Use brake presses or cold rolling to produce accurate profiles with straight arrises. Unless specified otherwise, mitre junctions of identical sections and remove all burrs and sharp arrises which would be visible after fixing or a hazard to the user. After thermally cutting stainless steel grind off material which is liable to corrode.

g) Moving parts : When assembled all moving parts must move freely and without bending.

h) Prepare surfaces of metal to receive adhesives by degreasing abrading mechanically or chemically and form bond under pressure. Use adhesives in accordance with manufacturer's written recommendations.

i) Mechanical joints shall be tight with no visible gaps. Where screw heads will be visible after component is fixed, or raised screw heads would interfere with any moving part of the component, use countersunk machine screws unless specified otherwise. Mechanical joints of components which will be located externally shall be bedded in bedding compound, including all matting surfaces, cleats and other fixings.

j) Site dimensions must be taken before manufacture.

k) Welding and brazing generally : Thoroughly clean surfaces to be welded and ensure accurate fit using clamps and jigs where practicable. Use tack welds only for temporary attachment unless specified otherwise. Make joints with parent and filler metal fully bonded throughout with no inclusions, holes, porosity or cracks. Completely remove all traces of flux residue and slag. Prevent weld spatter falling on surfaces of materials which will be self finished and visible in completed work. But welds which will be visible in completed work shall be finished smooth, flush with adjacent surfaces.

l) Metal arc welding shall be to BS 5135 or other methods subject to approval. Welding of stainless steel shall be TIG welding to BS 3019 : Part 2, or other methods subject to approval. Use double bevel butt welds, backing bars to remove heat, jigging, tack welds and any other measures necessary to minimize distortion. Remove slight distortion by light hammering, taking care not to damage surface finish. Welding of aluminium alloys shall be TIG welding to BS 3019 : Part 1, or MIG welding to BS 3571 : Part 1, or gas welding to BS 1126, or other methods subject to approval. Welding of copper alloys shall be fusion welding to BS 1077 for copper, or other methods subject to approval.

m) Apply metal coatings after fabrication is complete and all fixing holes have been drilled, unless otherwise specified. Before applying coating remove all welding slag, weld spatter, anti-spatter compounds, paints, grease, flux, rust, burrs and sharp arrises and make good all defects which would show after application of coating and finish surfaces smooth.

n) Galvanizing shall comply with BS 729, sherardising to BS 4921, zinc spraying of iron and steel surfaces shall comply with BS 2569 : Part 1 and vitreous enameling of steel surfaces with BS 3830. Anodizing of aluminium alloys shall be as specified hereinafter. Obtain certification from the anodiser that the Specification grade has been applied and submit copy to the Consultant.

Surfaces of stainless steel, bronze and brass which will be visible in the completed work shall be finely polished.

o) Protection : prevent distortion of metalwork during transit, handling, storage and fixing and damage to arrises, projecting features and surfaces which will be exposed in the finished work. Prevent contact with mud, ashes, plaster and cement and provide protective coverings as necessary and remove on completion. Before fixing, apply two coats of bitumen solution or mastic impregnated tape to surfaces of components which will be in contact with cement or plaster based materials.

p) Position metalwork accurately, plumb, level and true to line. Fix securely to prevent pulling away, deflection or other movement during use. Do not distort when tightening fastenings and the like.

q) Loading : do not use railings or balustrades as strutting or supports after fixing. Do not weld, braze or solder on Site without approval.

r) Fastenings shall be concealed where practicable. Thickness of metal and details of assembly and supports shall give ample strength and stiffness. Joints exposed to weather shall be formed to exclude water. Do all cutting, punching, drilling and tapping required for attachment of hardware and of work by other trades.

s) General metal work shall conform to all Local Authority By-laws and in lieu of other specific legal requirements, shall support any live loads which may normally be imposed plus a safety factor of 2.5. In addition, stairs, gratings, platforms etc. shall be designed to safely support a design live load of 5 KN/M2.

5 .03 - SAMPLES

a) Submit duplicate samples of all finished materials for approval by Consultant. The samples will show the full range of finishes and mechanical properties to be expected in the finished product. Where physical samples would otherwise be too large, examples will be given that can be readily inspected locally or the Contractor will provide facilities for the Consultant’s inspection at the Contractor’s expense.

b) Unless specifically called for, size and form of each sample shall be as directed by the Consultant.

5 .04 - INSPECTION AND TESTING

a) The Contractor shall provide certified test results from independent testing laboratories for all materials of this Section.

b) Where the manufacturer or supplier of specified items is unable to provide the above mentioned test results, the Contractor shall make available samples to the Consultant prior to their approval for use on the project so that he can have them tested to verify compliance with the Specification. All samples and tests will be at the Contractor’s expense.

5 .05 - STORAGE AND PROTECTION

a) All materials will be stored in protected areas on Site and will be fully protected against the effects of weather.

b) All materials shall be carefully handled and stored under cover in a manner to prevent deformation and damage to the materials and to shop finishes and to prevent rusting and the accumulation of mud, dirt or other foreign matter on the metal work. All such damage and accumulation shall be corrected prior to erection.

5 .06 - MANUFACTURER'S GUARANTEE

a) The Contractor shall furnish to the Consultant a written unconditional Manufacturer's Guarantee for all work on this section against faulty materials or workmanship for a period of ten years from the date of issue of the Final Certificate.

b) The Guarantee shall state that any fault in workmanship or materials which may develop within the Guarantee period shall be made good or replaced and reinstalled promptly, including the making good or replacement and reinstallation of adjacent work disturbed without additional cost.

c) This Guarantee shall be in addition to and not in lieu of other obligations of the Contractor under the Contract.

d) The text of the Guarantee shall be subject to the Consultant's approval and will be submitted prior to the approval of shop drawings or samples of specific items intended for incorporation into the works.

5 .07 - MATERIALS

All materials shall be new stock, free from defects, impairing strength, durability or appearance and of best commercial quality for each intended purpose.

Provide all anchors, bolts, sleeves, spigots and other accessories required for securing each item of this Section to the permanent Works, including furnishing to concrete workers all required inserts and sleeves for use in concrete and furnishing to masons of all anchors, bolts and other items required to be built-in masonry.

All exposed fastenings shall be of the same material finish as the metal to which they are applied unless otherwise noted.

Welding rods shall conform to British Standards and the recommendations of the metal welding rod manufacturer.

5 .08 - SHOP PAINTING MATERIALS

Shop paint for un-galvanized ferrous surfaces shall be a high quality, lead free, rust-inhibitive primer equal in quality and performance to products specified and approved by the Consultant.

Shop paint for galvanized metal shall be high quality, zinc rich, metal primer especially formulated for use on galvanized metal, equal in quality and performance to products specified and approved by the Consultant.

Shop paint for aluminium shall be dichromate based primer.

5 .09 - SHOP COATINGS FOR FERROUS AND GALVANIZED SURFACES

a) Galvanizing

i) All ferrous metal under this Section for exterior use in addition to any other interior items specifically so specified shall be hot dip galvanized including all bolts, nuts, washers and other related ferrous metal items used therewith.

ii) Hot-dip galvanizing process shall comply with BS 729 as applicable. After galvanizing, processed items shall be straightened free of all warpage and distortion caused by hot dip process.

iii) Galvanized surfaces to receive paint coatings shall be given hot phosphate (bonerizing) shop pretreatment.

iv) Furnish to the Consultant, a certified statement that galvanizing and hot-phosphate pre-treatments comply fully with this Specification.

b) Shop Painting

i) All materials, plain and galvanized (including non-ferrous where specified for paint finish) under this Section shall be given a shop coat of primer as specified, using the appropriate primers specified and approved by the Consultant.

ii) Immediately before painting, remove all rust, loose mill scale, dirt, weld flux, weld spatter and other foreign material with wire brushes or steel scrapers. Remove all grease and oil by use of detergent or solvent recommended by the paint manufacturer. Sandpaper exposed surfaces as required to produce smooth, even finishes. Allow surfaces to thoroughly dry before applying paint.

iii) Apply paint by spray process in strict accordance with the manufacturer's printed instructions to dry film thicknesses recommended. Apply thoroughly and evenly and work well into corners and joints taking care to avoid sags and runs.

iv) Do not paint surfaces to be embedded in concrete or to be welded in the field.

v) After erection, sand smooth and retouch all portions of the shop coats chipped or damaged during erection and coat all field welds and connections with the same paint used for all the shop coat.

vi) All aluminium surfaces in contact with cement or concrete surfaces are to be given two coats of bitumen before being fitted.

5 .10 - INSTALLATION

a) Work shall be erected square, plumb and true, accurately fitted and with tight joints and intersections. All anchors, inserts and other members to be set in concrete or masonry shall be furnished loose to be built into concrete and masonry as the work progresses. Later cutting and drilling shall be avoided wherever possible.

b) All metal work shall be rigidly braced and secured to surrounding construction and shall be free of rattle, vibration, waviness and noticeable deflection after installation.

c) Where member other than expansion bolts or inserts are fastened into concrete, set in carefully for pipe sleeves in proprietary expanding grout, manufactured specifically for such purpose and used strictly in accordance with manufacturer's directions.

   Holes to receive grouted members shall be formed with galvanized sheet metal sleeves to provide a uniformly wide, approximately 15mm clearance around the entire perimeter. At exposed applications, hold expanding grout back 25mm from finish surface and fill void with portland cement grout to match colour and texture of surrounding concrete surface, slightly beveled to shed moisture.

d) Carefully review all drawings and provide all miscellaneous metal items required by all the various trades but not specifically hinted above, such as clips, angles, bracketing, steel framing at suspended ceiling, steel framing to receive marble supports and all other anchor devices as indicated on the drawings or reasonably implied as being necessary for the thorough completion of the Work.

e) The Contractor shall provide all necessary down-stand / up-stand beam arrangements behind insulated glass panels in order to satisfy the requirements of the Local Authorities and Consultant.

STRUCTURAL STEELWORKS

5 .11 - SCOPE OF WORKS GENERALLY

The Structural Steelworks comprise the design of connections, supply of materials, fabrication, surface preparation, delivery to Site, unloading and storage on Site and erection onto concrete foundations together with all bolts and assemblies including templates where necessary, shop and Site welds, lifting tackle, temporary bracing and cleats, packs, wedges, special scaffolding, surveying tackle, labour and other equipment necessary for the careful and accurate completion of the Structural Steelwork to the satisfaction of the Consultant.

5 .12 - STEEL SECTIONS AND QUALITY

The Contractor is responsible for determining the availability of and delivery periods for all the steel sections to ensure no disruption of the building programme.

5 .13 - FABRICATION DRAWINGS

The Contractor shall submit to the Consultant for approval prior to the fabrication of the steelwork two copies of each fully detailed and dimensioned shop fabrication drawing including setting out details showing the location and size of all bearings, holding down bolts, drillings and other fixings whether for his use or for later use by others. Where called for, calculations for connections shall be included with these details. Copies of approved drawings and calculations shall subsequently be submitted to the appropriate authority for local ratification as may be required. It is intended that shop connections may be made using welding, bolting or riveted procedures but that Site connections are to be bolted with 4.6 or 8.8 grade bolts to British Standards. H.S.F.G. bolts are to be used only as approved by the Consultant.

Approval of detail drawings shall not in any way relieve the Contractor of his responsibility for any error subsequently discovered in his work.

5 .14 - MATERIALS

All steel sections, bolts and fittings shall comply with the appropriate British Standard for steel quality as specified on the drawings, profiles and or manufacture.

The Contractor shall obtain and submit to the Consultant for approval copies of all certificates for the actual steel section being supplied. The Consultant may call for samples of any steelwork to be submitted for an independent laboratory analysis test.

Unless otherwise noted all rolled steel sections are to be supplied in mild steel grade 43 A to BS 4360 but the grade designation modified to provide an equivalent permissible stress level according to metal thickness and welding requirements if so involved.

The steel grade for hot rolled hollow sections is to be 43 C to BS 4360 with similar provisions obtained.

Steel elements shall be parallel and straight to +/- 10 mm but the tolerance on the gauge shall override these requirements in cases where the gauge would otherwise be out of tolerance. The beams shall be true in section, free from twist and if more than one beam is used in the same run, all beams are to be from the same rolling unless specifically authorized otherwise.

5 .15 - WORKMANSHIP GENERAL

All steelwork including connections shall be designed and fabricated in accordance with the appropriate British Standard to the tolerance specified using BS 449 Part 2 1969 as a basic standard (see also Clause .24).

All holes shall be drilled to the appropriate size for types and diameter of bolt being used, for H.S.F.G. bolts the clearance shall not exceed 2 mm excepting where approval is given for the adoption of oversize holes required for tolerance reasons and in this case special oversize washers will be supplied. No punched holes will be allowed.

All bolts shall have steel washers between the nut and the member being fixed.

The head and / or nut of all bolts shall have taper washers as necessary to give a bearing without bolt distortion. Load indicating washers shall only be used in locations permitted by the Consultant and when used shall bear against a hardened steel washer or the head of the bolt.

Site connections will be formed with H.S.F.G. bolts to the appropriate British Standard of such size and quality as to carry the loads specified on the drawings unless specified otherwise.

Bolts will be to BS 916, 2708 or BS 4190 set in 2 mm clearance holes. Alternatively H.S.F.G. bolts will be supplied to BS 4395 or BS 3139 and shall be installed to the requirements of BS 3294 respectively with holes drilled to a clearance not exceeding 2 mm (except as otherwise directed). Faying surfaces for these connections are generally to be as required in BS 3294 or BS 4604 except as directed otherwise.

All bolts shall show at least two turns of complete threads beyond the nut face and shall be fitted with the correct flat or tapered washer required.

The threaded portion of any connecting bolt other than H.S.F.G. bolts shall terminate clear of any shear plane to ensure the full value of the shank is developed in resisting shearing effects on the connection concerned.

Stud welding of fixings (other than composite action studs on beams) and shot fired fastenings will not be allowed unless authorized in writing by the Consultant subsequent to satisfactory performance tests and trials.

Contact faces between members which are to be formed with H.S.F.G. bolts shall be cleaned and treated as directed by the Consultant and after fabrication the surfaces protected until time of assembly. Contact faces between normally bolted connections are to be cleaned and protected locally with red lead paint or other approved means prior to final erection and subsequent protection.

5 .16 - WELDING

All welding at works and if permitted in writing on Site shall be carried out in accordance with British Standard requirements. All welding operatives employed shall be tested and qualified welders in accordance with British Standard recommendations and the Contractor shall submit to the Consultant when required evidence of qualification. Additional testing by an independent inspection company (as specified hereinafter) will also be implemented to verify the operative standard.

All weld connections shall be accurately made and the joint faces formed in accordance with British Standard for metal type and thickness as appropriate and any necessary pre-treatment due to metal thickness or type shall be undertaken. All welding electrodes shall be of the appropriate type to be compatible with the metal being welded.

5 .17 - WELDING INSPECTION

The Contractor shall employ to the approval of the Consultant an independent inspection company to carry out regular inspections and non-destructive test which will include for ultra-sonic tests, dye penetration tests and visual examinations, whilst the fabrication and erection are in progress to ensure compliance with the Specification and the British Standard requirements and an adequate standard of workmanship and supervision for the Works. The Contractor is to allow in his Tender for these inspection costs based upon the above requirements and the amount of welding being employed in the Contract. The Contractor is to allow unrestricted access and facilities at his work or on Site for authorized personnel to carry out inspection procedures on behalf of the Consultant in respect of the fabrication, erection and welding of the steelwork in the Contract. The Contractor is also to include for the cost of testing welding operatives to verify their standard as in Clause .16 above.

The independent weld inspection company to be employed will be subject to their status being established to the satisfaction of the Consultant. Any such company shall operate and conform fully to the provisions of ASTM E 329. Similar conditions are to be obtained if Site welding is permitted.

5 .18 - INSPECTION DURING FABRICATION

In addition to inspection for welding purposes the Consultant shall be entitled at all reasonable times during the fabrication work to inspect, examine and if required call for tests on the Contractor’s premises of the materials and workmanship of all elements to be supplied under the Contract and if part of the said elements are being fabricated on other premises to inspect, examine and if required test as if the said elements were being manufactured on the Contractor’s premises. Such inspection, examination or testing if made shall not release the Contractor from any obligation under the Contract.

Inspection duties may also be delegated by the Consultant to the same company as called for in .17 above and the Contractor shall make due allowance for covering costs so involved.

The Contractor shall give the Consultant reasonable notice in writing of the date and the place at which elements will be ready for inspection and examination and / or testing as provided on the Contract so that the Consultant can attend at the date and place so named if required.

Where the Contract provides for test on the premises of the Contractor or of any sub-Contractor, the Contractor shall provide such assistance, labour, materials, electricity, fuel, stores, apparatus and instruments as may be requisite and as may be reasonably demanded to carry out such inspections and tests efficiently. In the event of fabrication work taking place in any factory or workshop at a distance greater than 80 kilometres from the Site then the Contractor shall also be responsible for all travelling costs and accommodation costs for the Consultant involved in the examination procedure. For the Contractor's guidance a minimum of two such inspection visits of duration of two full days (with three nights local accommodation) should be allowed for or alternatively at approximately 42 days intervals during the currency of the fabrication work of the Contract, with travelling expenses from the Site for not more than two representatives.

5 .19 - DELIVERY

No elements of the Contractor's work shall be shipped or delivered to the Site until an approval in writing has been applied for and obtained by the Contractor from the Consultant that the element has been fabricated to the correct standards.

The Contractor shall also provide during these inspections all materials and equipment necessary to enable the Consultant's Representative to check and establish the level of surface cleaning and dry film thickness of priming paint coats applied prior and subsequent to fabrication.

All sections are to be fully marked and all attachments and fittings securely attached thereto to prevent loss or misplacement. All elements are to be supplied in a manner that will prevent loss and damage due to mishandling of the fabricated sections and fittings during transportation and loading or unloading at any point.

5 .20 - CONNECTIONS

In all instances the Contractor shall design and supply connections to withstand the load, forces and bending moments. The design and details of all connections shall be the responsibility of the Contractor and shall be in accordance with the relevant sections of BS 449, BS 153 and BS 5135 as applicable.

The Contractor shall submit detailed calculations for all connections for approval by the Consultant.

5 .21 - PROTECTION GENERAL

The Contractor will be responsible for the whole of the surface preparation of steelwork and the protective scheme. The materials and workmanship generally are to be in accordance with the recommendations of BS 5493.

5 .22 - CLEANING

All steelwork whether cased or painted is to be cleaned by shot blasting to the same standard as set out in BS 4232.

Prior to shot blasting all steel is to be degreased and any foreign material removed so that shot blasting and subsequent painting process will be fully effective.

After preliminary treatment as above all steel work is to be shot blasted so as to achieve a surface finish standard equal to the described as Secondary Quality Finish in BS 4232 or alternatively SA 2.5 as designated in the Swedish Standard SIS 055900 – 1962, three such coupons are to be provided.

Shot blasting will normally be carried out prior to fabrication and the Consultant's written permission will be required if it is proposed to shot blast after fabrication.

5 .23 - PAINTING

As soon as possible after shot blasting an approved and compatible prefabrication primer coat is to be applied both to cased steel and painted steel elements, i.e. all the steel for the project. Any Contact surfaces for H.S.F.G. bolted joints are to be excluded from this paint coating.

The prefabrication primer shall have an average dry film thickness of 25 microns and must be suitable for all subsequent welding, fabrication and painting processes.

Subsequent to cleaning, prefabrication priming and fabrication, all steel described as painted steel shall have the surfaces prepared suitably to receive two coats of an approved quick drying primer to give a minimum finished dry film thickness for these coats only of 75 microns. Contact surfaces between metals to be connected in the workshops or later to be cleaned and protected in the case of H.S.F.G. bolted joints, for all other types of surfaces for steelwork described as cased steel shall be treated in the same manner.

Following erection, plumbing and leveling steelwork shall generally be painted with suitable primer coats followed by undercoat and finish coat of micaceous iron oxide paint as described in BS 5493 as type SF 7 to give a minimum dry film thickness of 200 microns not including the prefabrication primer.

Light gauge steel elements such as purlins or sheeting rails shall also receive paint protection in addition to any galvanized coating and a primer under the finish coat shall be applied to give a total minimum dry film thickness of 125 microns. The primer coat (and any pre-treatment recommended by the paint manufacturer) shall be specially formulated and applied to take account of the galvanized surface, the following coats being compatible with the priming / pre-treatment system.

The Contractor is to supply with his Tender details of the paint manufacturers and type he is proposing to use.

The Contractor will be responsible for all preliminary cleaning and priming at the works prior to delivery and all making good of the initial protective film on Site due to damage in transit or handling prior to commencing the Site painting works. In addition he shall also provide for paint protection on all cleats, bolts, lugs and fittings not less than the standard of the main steelwork elements involved.

5 .24 - TOLERANCE FOR STEELWORK ELEMENTS

The Contractor's attention is drawn to the provisions of Clause .32 as regards tolerance generally. In the event that more onerous or rigorous tolerances are required for adjoining and / or

connected elements of other material (including concrete casing to steelwork) then the most sringent requirement is to be the criterion.

The following deviations will be permitted in the construction of the steel frames (note: the tolerance is twice the deviation specified).

These deviations are not to be regarded as cumulative and where two or more deviations apply the total deviation is to be the square root of the sum of the square of each deviation.

The following are a guide to the limiting deviation but the Contractor will be required to work to a specified finer tolerance where precast cladding units, windows or other building elements or items are to be fitted between the structural steel columns, beams or similar items or the casting thereto when these tolerances are finer than those given below. The Contractor should refer to any specialist sub-Contractor's drawings for the appropriate construction tolerance.

A. Deviation of overall building dimensions horizontal or vertical :

In 30 m…… 20 mm
Over 30 m…… 20 + 0.25 (L – 30) mm

B. Deviation of location of any columns to establish position on plan at any level

…….. 5 mm

C. Deviation of position of any beam to establish position

…….. 5 mm

D. Bow of any column or beam between supports

Percentage of length…… 0.15%

E. Eccentricity of ends of column between floors

Percentage of storey height…… 0.20%

F. Deviation in level of any beam to specified level

…….. 5 mm

G. Deviation in position of beam bearing on column to specified location

…….. 5 mm

H. Deviation in position of any fixture attached to a beam or column

…….. 5 mm

I. Deviation in level of bearing surface on column

…….. 5 mm

J. Deviation in Contact of bearing surface over 300 mm gauge

…….. 1 mm

5 .25 - SETTING OUT

The Contractor shall be responsible for accurately checking all setting out of the works to the specified positions, dimensions, level and building lines and level accuracy and reporting any discrepancies before erection commences. Any errors in position, level dimension or alignment of any part of the Works at any time shall be rectified by the Contractor at his own expense. The Contractor shall provide the equipment and labour to enable the Consultant to check the setting out and levels of the works at all times. The checking of any setting out point, line or level by the Consultant shall not in any way relieve the Contractor of his responsibility. All setting out points shall be clearly marked and protected from damage or disturbance during the execution of the works.

5 .26 - ERECTION

Structural steelwork is to be set on foundations and erected in such a manner so as not to distort or overstress any part or connection due to the erection activities. Steel wedges and solid packs and shims shall be used to level up bases. The Contractor's attention is drawn to the manner in which holding down bolts provide stability only after the grouting up process has been carried out and special provision must be made therefore by the Contractor to provide stability to the unfinished framework at all times during and after erection right up to the time that the structure is self stable. Safety and stability in these intermediate phases prior to completion shall be considered and the provisions given in B S C P 5531 adhered to. The provisions of B S 449 covering erection shall also be followed. Details of the bracing proposed to provide stability are to be provided by the Contractor within fourteen days of his being appointed. (See also Clause .13 for standard documents obtaining).

5 .27 - SUPERVISION OF ERECTION WORK

The whole of the erection work is to be carried out under the direct control of a fully qualified and experienced Erection Supervisor who shall be directly responsible to the Contractor's management. The Erection Supervisor will also have a Senior Erection Foreman who will be in charge of all day to day erection work as this progresses on Site, who shall be responsible for not more than four gangs each of skilled and experienced steelwork erectors, each gang with its own sub-foreman in charge.

5 .28 - ERECTION EQUIPMENT

The Contractor is to provide all the cranes, hoists, generators, compressors or any other mechanical equipment necessary for his erection work including any pneumatic tools and all small handle tools.

This equipment shall be maintained in a safe and satisfactory condition throughout the time erection work progresses and an inventory of such equipment shall be maintained at all times, recording quality, quantity, capacity and condition at all times.

When crane and hoist are used the provisions of BS CP 3010 are to be adhered to at all times.

Where ladders and scaffolds are required for access to connections these shall be provided by the Contractor and shall be safe and secure and rigidly fixed. Rope ladders will not be allowed.

5 .29 - INSPECTION OF ERECTED STEELWORK

All main connections and any connections formed with H.S.F.G. bolts will require inspection and checks by the Consultant and the Contractor shall provide all necessary ladders, scaffolds or other suitable access for this purpose.

When H.S.F.G. bolts are used the method of identifying fully tightened connections (e.g. agreed colour spot of paint) shall be determined prior to the erection of steelwork. Connections shall be subjected to 10% random inspection and if any are defective then a further 10% shall be checked. If any of these are defective then the steel erectors shall check all connections again, after which the inspection procedure shall be repeated but on 20% of the connections.

The Contractor shall be responsible for the immediate replacement and making good at his own expense of all connections rejected at the inspections and for the removal from the Site of all the bolts, nuts etc. concerned. The Contractor should ensure that the steel erectors are available on Site until satisfactory completion of the aforementioned inspections.

5 .30 - H.S.F.G. BOLTS

These shall be used only if permitted by the Consultant but the equipment to be used and the method of tightening is to be submitted for approval as well as the bolt locations proposed.

When installing bolts additional lubrication shall be used with the Consultant's approval to ease the tightening of bolt assemblies. The Contractor shall ensure that no lubrication gets between plates and piles of the steelwork. Final tightening of the bolt assemblies shall be done in staggered pattern and where there are more than four bolts in a joint, they shall be tightened from the centre of the joint outwards.

5 .31 - TOLERANCES

The Contractor's attention is drawn to the provisions of Clause .14 above and shall take cognizance of his Contractual duties, obligations and requirements for the steelwork erection work to ensure proper compatibility with other building elements.

5 .32 - SURFACE FINISH TO STEELWORK

Upon completion of all erection work the Contractor shall ensure that the priming paint system applied by him is all sound and suitable for the subsequent application of the undercoat and finish coat with all damaged and defective areas made good accordingly.

In addition, all Site bolted or welded joints shall, after erection, be painted as the remainder of the steelwork. If permission is given for the use of load indicating washers with H.S.F.G. bolts, particular care is to be taken to fill and seal the gap between the washer and the fittings created by the indicating nibs.

Any steelwork to be cased is also to be left in a clean condition with no loose rust or flaking paint so that only a light surface treatment is required prior to concrete pouring to achieve satisfactory cased steel / concrete construction.

5 .33 – GROUTING OF STANCHIONS

When the steelwork area in question has been satisfactorily erected, lined, leveled and plumbed the stanchion base plates and H. D. bolt pockets (or sleeves, if used) are to be filled with a

shrinkage compensated grout material which will provide shear strength not less than that of the concrete base upon which the stanchion is supported with a minimum 28 days cube strength of 30 N / sq. mm. The shrinkage compensated grout shall be supplied by an approved manufacturer and shall be shuttered, poured, protected and cured as directed thereby. The provisions of the recommendations given by A.C.I. Committee 223 'Recommended Practice for the Use of Shrinkage Compensated Concrete' published in A.C.I. Standard 223.77 are also to be followed except where in direct variance with the manufacturer's instructions in which instance the Contractor shall report the matter to the Consultant for his ruling.

5 .34 - CLEARING UP

Subsequent to the completion of erection work, the Contractor shall allow for clearing up the Site of his work with the removal of all unwanted equipment and materials.

Any temporary braces, straining wires or other items provided for stability during erection prior to the frame being self stable shall be removed and marks or damaged areas made good as required.

DIVISION - 6

CARPENTRY AND JOINERY

DIVISION – 6 : CARPENTRY AND JOINERY

6 .01 - TIMBER

All timber used for the Works shall be of the best quality and subject to the approval of the Consultant. Any timber piece not meeting the requirement of the Consultant shall be removed from the Site. The Consultant's decision in this respect shall be final and binding on the Contractor.

The Contractor may use any timber for temporary works and shall be entirely responsible for the safety and sufficiency of such works.

However, this timber shall be free from any decay and insects. Softwood shall be of European Redwood, Longleaf Pine, Douglas Fir, Cedar or any other coniferous timber approved by the Consultant.

Hardwood shall be first quality seasoned Burma or Dandeli Teak, Red Meranti or any other as approved by the Consultant (weighing not less than 720 kg / m^3).

All timber shall comply with B. S. 1186 as regards quality and acceptable defects.

All timber shall be sawn square straight and true and shall hold the full dimensions shown on the drawings. Sizes shown on the drawings are finished sizes unless otherwise specified.

Structural timber shall be grade 52 / 50 (stress graded) or equivalent as required by B. S. C. P. 112 : Part 2 : 1971 and shall be painted with two coats of clean wood preservative such as Cuprinol or equivalent unless otherwise directed by the Consultant.

6 .02 - SEASONING

All timber shall be fully seasoned, if necessary in kilns and the Contractor shall produce satisfactory proof of the same. All timber shall have a moisture content acceptable according to its nature and usage as approved by the Consultant.

6 .03 - PROTECTION

All joinery and timber shall be protected during the course of construction as directed by the Consultant.

All surfaces in contact with the masonry or concrete, and in general all surfaces hidden from the view shall be treated with two coats of red lead (or with two coats of an approved wood preservative).

6 .04 - PLYWOOD AND BLOCKBOARD

Plywood shall be to B. S. 1455 and shall be obtained from an approved manufacturer. Plywood shall be bonded in phenol formaldehyde and shall have commercial or decorative face veneer as specified. Selection and matching of veneers shall be to the Consultant's satisfaction. Plywood shall be exterior grade for all uses unless otherwise stated. The Contractor shall not make up thickness by glueing together sheets of thinner plywood.

Blockboard shall be to B. S. 3444 and generally to the Specification for plywood above.

6 .05 - CHIPBOARD

Chipboard shall be to B. S. 5669 1979 Type III.

6 .06 - GLUES

Glues shall be phenolic resin adhesives to B. S. 1204, Type B 100.

6 .07 - PLASTIC LAMINATES

Plastic laminates shall be 1.5 mm Formica (complying to B. S. 3794, Class 1) or equivalent in approved colour and pattern and shall be fixed with approved adhesives strictly to the instructions of the manufacturer.

Balancing laminates shall be fixed to the reverse side of the plywood or blockboards to which Formica is applied, and the cost of applying plastic laminate shall include at all times for applying balancing veneer to the opposing surface of the core material.

Laminates to be bent to profile shall be 1.3 mm Formica post forming grade and shall be fixed strictly in accordance with the manufacturer's instructions.

6 .08 - PLUGS

Plugging shall be done with 'Rawlplugs' or other equal and approved patent fibre plugs or with 'Rawlplastic' or other equal and approved plastic fittings used in accordance with manufacturer's instructions. Hardwood plugs cut on the twist may be used if approved by the Consultant, but soft wood plugs shall not be used.

6 .09 - JOINERY

All joinery work shall be carried out in accordance with drawings and in the best workmanlike manner.

All joiners' work shall be prepared and framed up as soon as details are received, but shall not be glued and wedged until it is required for use.

Joinery shall comply with B. S. 1186 Part 2. Butted, screwed, nailed or halved joints will not be accepted.

Joinery which does not require to be built in as the work proceeds shall be brought to the Site for fixing as late as possible to avoid damage. Should any joinery warp or sag more than 1.5 mm or show any other defect before the end of the Defects Liability Period, the work shall be removed and new work fixed in place together with any other work affected by the replacement at the entire expense of the Contractor.

For all joinery work not required to be built in as the work proceeds all dimensions shall be taken from the structure as actually built.

All skirtings, architraves (of approved hardwood) and other joinery shall be accurately cut and fitted to the actual contours of the surface against which they abut.

All built in joinery shall be fixed plumb and true and shall be temporarily boxed during construction

against damage. All built in frames or grounds will be secured to blockwork concrete by a sufficient number of non corrosive metal holdfasts 40 mm x 4 mm x 250 mm long. Where grounds are specified, frames shall be countersunk screwed to them. Wood screws shall be of brass confirming to B. S. 1210 and shall have dome heads with cup washers wherever directed.

Screw heads in the work to be painted shall be countersunk and stopped. Screw heads in the work to receive clear finish shall be pellated with the grain of the pellat in the same direction as the grain of the member and matching in colour. Additional beads, architraves etc. shall be mitred at corners.

All joinery to receive finish shall be finished smooth and clean by rubbing down with fine glass-paper. All exposed edges shall be pencil rounded and true.

6 .10 - JOINTING OF CARPENTRY

All carpentry work is to be framed and trussed up properly and fitted with all necessary bolts, screws, straps, ties etc.

Wherever possible and where specified, timbers are to be in one piece of the length required. Where joints in the length are unavoidable, timbers up to 75 mm in depth are to be halved and timbers exceeding 75 mm in depth are to be splayed scrafed.

Joints are to be so constructed that they will resist the stresses and transmit the loads to which they will be subjected. The jointing surfaces of all connections exposed to the weather are to be thickly primed with an approved priming paint immediately before the joint is made.

Wherever possible in brandering, battening and similar members length joints shall be formed over the points of support.

6 .11 - DOORS

a) General

All timber for doors shall comply in all respects with the quality specified previously for joinery, but in addition it shall be kiln dried with a moisture content of not less than 10% and not more than 12%. It shall be free from all knots, except sound and tight knots not exceeding 10mm diameter and it shall be free from all sapwood.

The softwood shall be as previously specified for joinery.

The adhesive to be used in constructing doors shall conform with B. S. 1204 for cold setting synthetic resin adhesives or with B. S. 1444 for cold setting case in glue for internal doors only. The joining shall be as previously specified for joinery, except that all joints shall be put together with adhesive as specified above and hydraulic or other approved mechanical pressure immediately applied until set.

b) Flush Doors

Internal doors shall be solid or semi-solid cored flush doors as scheduled, faced both sides with 4.5 mm thick plywood for painting or veneer for clear finish hardwood lipped on edges and shall comply with B. S. 459 Part 2.

Fire resisting doors shall be solid cored flush doors faced both sides with plywood for painting or veneered for clear finish hardwood lipped all round and shall comply with B. S. 459 Part 3 and B. S. 476 Part 8.

T or M doors shall be flush doors faced both sides with teak veneered plywood kept clean for clear finish. T or M lipped all round and shall comply with B. S. 459.

Doors with open panels for glazing or glazing apertures shall be fitted with two sets of loose hardwood glazing beads, mitred at angles. The glazing beads shall match the door facings and for fire resisting doors shall be fixed with brass cups and screws.

All doors shall have a minimum 10mm thick hardwood lipping twice tongued and grooved all round. When doors are hung folding or double with rebated meeting stiles, the lipping is not to be less than the minimum stated.

The dimensions of doors shall be as shown on the drawings or scheduled in the Contract documents.

Stiles and top rails where forming part of the core construction shall be a minimum width of 80mm and bottom rail a minimum width of 200mm. Both stiles are to be widened by 55mm giving a total minimum width of 135mm for a length of at least 750mm in the centre of the stiles for lock rails.

All flush doors shall be manufactured by and obtained from an approved manufacturer. All doors shall be guaranteed by the manufacturer for at least two years.

Each door shall be supplied with hinges, locks and other furniture as specified in the Contract and / or approved by the Consultant.

Doors may be supplied primed or unprimed and shall be adequately protected from exposure to prevent deterioration while stored on Site and shall be stacked horizontally in piles. They shall not be stacked leaning in an upright position.

c) Fire Resisting Doors

Doors described as fire resisting doors shall meet the requirements of the relevant British Standards regarding testing. Half hour fire resisting doors shall be 30 / 30 rating, one hour fire resisting shall be 60 / 60 rating, two hour 120 / 120 etc. Fire check doors with 30 / 20 and 60 / 40 rating etc. shall not be acceptable. All fire resisting doors shall be self-closing. Where intumescing materials are required to meet the fire resisting rating, they shall be to the approval of the Consultant.

d) Overpanels

The construction of fixed overpanels above doors shall be similar in all respects with the construction of the door below.

e) Intumescent Strips

All one hour fire doors shall have approved intumescent fire seals let into the frame around the edges.

6 .12 - IRONMONGERY

All ironmongery is to be supplied with matching screws and fixed according to manufacturer's instructions.

The Contractor shall cut all mortices, rebates etc. and form bolt sockets in the floor slabs and cut and make good for floor springs and door closures. Ironmongery described as brass shall be solid brass and not brass finish. Chromium plated articles shall be plated satin finish on solid brass or other approved metal.

The Contractor shall oil, grease and adjust all ironmongery in perfect working order. The use of nails for fixing ironmongery will not be permitted whatsoever.

Unless otherwise specified, all locks shall be provided with three keys which shall be properly tagged and handed over as instructed by the Consultant.

The Contractor shall at his own cost, replace all ironmongery lost, stolen or damaged before building is finally handed over to the client. All ironmongery shall be carefully protected and wrapped during construction. Samples of all ironmongery shall first be shown to the Consultant and got approved before orders are placed.

6 .13 - BUILT-IN FURNITURE

a) Cabinets

All cabinet works shall be constructed as shown on the plans or ordered by the Consultant. All dimensions will be verified for job measurements.

Work shall be fabricated as far as possible to the best standards of furniture making and carefully fitted on Site. Shop drawings shall be submitted to the Consultant for approval. The work shall be entirely to the Consultant's satisfaction.

b) Kitchen Units

These shall be of proprietary make, first quality as specified. The Contractor will be held responsible for checking all dimensions of units against finished Site dimensions. Colour, finish, fittings and optional features, if any, shall be to the Consultant's approval.

The Contractor shall be held entirely responsible for ordering proprietary units holding the correct dimensions suitable for installation in the finished structure. If necessary, filler pieces exactly matching the proprietary units shall be ordered from the manufacturer or special units having the correct Site dimensions shall be ordered.

The Contractor shall submit catalogues, samples and detailed shop drawings prior to placing the order, for the Consultant's approval.

i) Carcasse

18mm thick plywood coated with 80 g/m^2 melamine on both sides.

The front edge to have hardwood edging glued-on. Stained in patina colour.

ii) Doors

Solid oak : Thickness of the frame : 19.0 mm
Thickness of the laminated panel : 15.2 mm
Lacquer : Front : 220 g/m^2 acid hardening lacquer
The door to be stained. Stain No. W 950 225.

iii) Worktop with Post. Formed Integral Splash Back

Shall be made of high performance homogeneous, non-porous, densely mineral filled Methyl Methacrylate with colour all the way through. It should not delaminate and should offer a smooth finish and be easy to maintain. Should be joint free and capable of receiving rounded edge detail. It should be stain resistant, withstand higher than average temperatures, non-porous, high-impact resistant, waterproof and unaffected by condensation.

iv) Plinths

Veneered plinths : 15 plywood veneered on the front with a 0.7 mm thick veneer. The back to be coated with a 0.15 mm thick basic foil. The plinth to be lacquered / stained. Plinth height to be 14 cm.

v) Base Units

The base units be provided with holes set in a system of two parallel lines which allow a movement of 30 mm for the internal shelf or basket. They must be equipped with an internal shelf at a variable position and the screw-on legs allow for adjustment of the base units if the floor surface level is not true. Base units should be 68.8 cm in height and 59.2 cm deep.

vi) Wall Units

The wall units must be provided with holes in order to position the shelves on various levels. The wall units will be fixed to wall by means of brackets which can be regulated and these brackets fixed onto the fixing bar. Wall units to be 67.8 cm high and 31 cm deep.

DIVISION - 7

THERMAL & MOISTURE PROTECTION

DIVISION - 7: THERMAL AND MOISTURE PROTECTION

7 .01 - GENERAL

Material shall be of the best quality and to the approval of the Consultant all in accordance with the relevant British Standards and Agreement Board Certificates.

Workmanship shall be to the highest standards and codes of practice.

7 .02 - TESTING

The Contractor is to test to the satisfaction of the Consultant, all areas of roofing, waterproofing, terraces, bathrooms and the like for water penetration. These tests are to be carried out after the membrane has been laid.

The Contractor is to allow in his rates for such areas to be flooded with water and left for a minimum of 48 hours.

On completion of the roofing works, the Contractor is to leave the roof in a sound and watertight condition to the approval of the Consultant and in a satisfactory state for handing over.

7 .03 - GUARANTEE

The Contractor is to provide the Consultant with a written guarantee to cover improper materials or faulty workmanship for a period of ten years from the date of issue of the Final Certificate at the completion of the maintenance period. The Contractor is to bear the cost of any of the consequential damage as is provided for in the same guarantee. The text of the guarantee shall be to the Consultant's approval.

7 .04 - PREPARATION OF SURFACES

All surfaces shall be clear of all deleterious matter and dry all in accordance with the manufacturers written instructions. Prior to the application of any waterproofing / roofing material or primer, the Contractor shall grind the concrete surface using a mechanical grinder to ensure all surface irregularities are removed and gain the Consultant's written approval that he may commence the said works, without the same, all works will be rejected and replaced at the Contractor's expense.

7 .05 - PROTECTION

Finished and part finished surfaces shall be suitably protected to ensure no damage by other trades. Any roofing or waterproofing so damaged due to non-protection shall be removed and replaced at the Contractor's expense. The Contractor shall submit to the Consultant his proposed methods of protecting the various surfaces and locations prior to their completion or application of finishing layers, i.e. tiling and the like.

7 .06 - ROOFING

a) The roofing shall be as per the drawings and generally comprise the following layers :-

i) One layer self adhesive waterproofing membrane, Bituthene 1200 or other equal and

approved with end and side laps, applied as per the manufacturer's written instructions for roof areas, edges, upstands, parapets and dressing and sealing around rainwater outlets, pedestals and the like. Prior to fixing waterproof membrane apply primer as recommended by the waterproof membrane manufacturer.

ii) Light weight concrete screed, minimum thickness 50 mm, laid to falls and cross falls, laid in bays not exceeding 10 square meters and sealing to Consultant's approval.

iii) 50 mm thick closed cell extruded polystyrene insulation layer, butt jointed.

iv) 500 x 500 x 40 mm thick precast concrete tiles with rebated edges laid on either spacers or squares of roofing felt.

b) Sika Tiles System

The Standard Sika Tiles shall be 800 mm x 800 mm x 40 mm. The tiles shall be manufactured by a Specialist Roofer having at least ten years of experience and waterproofed with the appropriate additive and shall be of a strength capable of taking live roof load. The tiles shall have a special section formed at their edges so that when laid against each other, two adjacent edges will form a special joint section that will hold the PLASTIJOINT or IGAS BLACK Mastic.

c) Sika Skirting and Corner Elements

These elements shall be laid as indicated on the drawings along the periphery and in the corners of the roof. They shall rest on the concrete against the upstands or parapet to ensure a continuous covered skirting. The skirting and the corner elements shall provide the same profile as that of the slabs. The elements shall have rounded corners and shall be waterproofed as for the Sika tiles and shall have PLASTIJOINT or IGAS BLACK Mastic at all of their edges.

d) Joint Sealing

After laying the tiles and the skirting to falls and cross falls, joints between tiles, skirtings, corners shall be properly cleaned primed and filled with a plasto-elastic material / Bitumen Rubber base such as PLASTIJOINT or IGAS MASTIC, torch heated and flattened in order to obtain a perfect adhesion to the joints sides.

7 .07 - WATERPROOFING TO BATHS, TOILETS, KITCHENS, BALCONIES & TERRACE

Waterproofing membranes under floor tiling of baths, toilets, kitchens and balconies shall be one coat of BITHUTHEN 1200 or EQUAL membrane supplied and fixed by specialized sub-Contractor to a minimum thickness of 4 mm.

7 .08 - FLASHING

a) General

Surfaces to receive flashing shall be smooth, dry, free from projections, dust or other foreign materials. If surfaces contain projections or rough spots, such conditions shall be corrected to the satisfaction of the Consultant before application of flashing.

All flashing material stored on Site shall be protected from damage.

b) Material

Flashing material shall be stainless steel and shall conform to BS 1449, Part 2, mill finish No. 1 or 2D, minimum thickness 0.376 mm (28 gauge).

Solder for stainless steel to be 50 - 50, half tin and half lead.

Fasteners shall be stainless steel with large washer under head (11 mm).

c) Installation

All seams are to overlap in the direction of the water flow. The finished size of all lock seams must not be less than 25 mm wide. Over vertical surfaces and built-in flashing, all lap seams must overlap at least 80 mm.

On continuous runs of flashing, provide expansion joints at three metres centers.

In general, all soldered joints shall be lapped a minimum of 25 mm and completely soldered the full width.

After soldering, all acid flux residue must be completely removed from the stainless steel surface. Wet the soldered area with clean water and scrub with a soft bristle brush. Neutralize the entire work area with a 5% washing soda solution or ammonia water. Rinse with running water and wipe dry.

If phosphoric base fluxes are used for soldering stainless steel, there is no need to neutralize the surface.

DIVISION - 8

DOORS AND WINDOWS

DIVISION - 8: DOORS AND WINDOWS

ALUMINIUM DOORS AND WINDOWS

8 .01 - GENERAL

Aluminium works will include provision of all labour, materials, equipment and all other related items to furnish and install the work of this Section as shown on drawings specified herein and required by the job conditions including but not limited to :

a) Extruded aluminium framing members, built up composite sections and any required reinforcement for all doors, screens, windows and roof lights.

b) All anchorage to the structure, backer rods within and between framing members, sealants and flashings and the like where required.

c) All necessary steel inserts, glazing, ironmongery, fly-screens and any other required fixing devices.

8 .02 - PRODUCT AND FABRICATION

a) Material extrusions generally shall comply with the sections, sizes, shapes and dimensions shown on the drawings or as required by the job conditions and approved by the Consultant during execution.

b) Aluminium moldings must be given caustic etch followed by an anodix oxide treatment to obtain an architectural class 1 anodic oxide coating. Anodization should be not less than 25 microns thickness.

c) All aluminium works shall be finished to the required colour in the particular Specification and drawing as per DIN Standards 53151, 53152, 53153, 53156 or equal and approved to Ral colour subject to the Consultant’s approval.

d) All aluminium surfaces that are to be in contact with cured concrete, mortar, steel and other metals shall have the contact surfaces protected wherever they may entrap moisture or corrosive elements. Metals that are to be in contact with mortar or concrete shall be protected with a two coat bituminous coating.

   Prime paint steel parts of anchors, anchor inserts, reinforcement supports and all parts after field welding or bolting with zinc chromate. Minimum dry film thickness of 1 mm for zinc chromate.

e) All aluminium finishes shall match in colour the samples approved by the Consultant. Finishing of aluminium shall be in strict accordance with the standard, procedure and quality control plan established by the approved aluminium manufacturer.

f) Fastener type, size, alloy, quantity, spacing and anchorage devices will be as per design by the manufacturer and approved by the Consultant.

   Exposed fasteners if approved by the Consultant, shall be stainless steel with counter sunk oval head finished to match adjacent finish.

All screws, bolts, nuts, washers, rivets and the like in wet locations shall be non-wet locations cadmium plated or equal approved may be used. Lock washers or other locking devices at all bolted connections must be provided all to the Consultant's written approval.

g) All elements shall be new and free from defects that would impair their strength, durability or appearance and to the full satisfaction of the Consultant.

h) All ironmongery is to be obtained from a manufacturer approved in writing by the Consultant and to match in colour, finish and quality.

i) Thermally broken aluminium sections shall be manufactured from one outer aluminium section, one inner aluminium section and a special rigid PVC insulator. The manufacturing shall be carried out on a special machine which ensures the compact and rigid connections and provides the necessary strength in the profile system.

j) The tensile strength and the shear strength of the profiles shall be submitted in a test report which shall comply with DIN 17615 or BS equivalent.

k) Thermally insulated aluminium section shall comply with DIN 4108 (Thermally insulated), frame material group 2.2, i.e. the heat transition coefficient shall be 3.1 W / M2 K or less with double glass.

The Contractor shall submit test certificates to indicate that his proposed system meets with these thermal insulation requirements.

l) Aluminium elements shall be mechanically jointed by means of corner cleats or T cleats, the cleats having to correspond to the inner cross section profile. Mechanical joints shall be made with aluminium alloy pins or pressed with corner crimping machine. Joints shall be glued to ensure air and watertight joints.

m) Coefficient of air-infiltration shall be as per DIN 18055 or BS equivalent (0.10 m^3/H), the DIN air infiltration value must be maintained with a test pressure difference of 0.6 KN/m^2 2.0 m^3/H (7m^3/H).

n) Non-visible central neoprene gasket (APTK - material as per DIN 7863 and NAAMM Standard Specification, APTK – Acetylen, Propylen, Tarr, Kautscuk - India Rubber) shall be provided for all opening windows to prevent water penetration and infiltration and shall not be exposed to sunlight.

o) Waterproofing against driving rain shall maintain DIN Standard 18055, Stress Group B. C. Drainage should be direct to outside or through the cavity.

p) Sound insulation shall be in accordance with DIN 4109 and thermal insulation shall maintain the Standards of DIN 4108 or equal approved.

8 .03 - <u>WINDOWS AND SLIDING DOORS</u>

All opening windows and sliding doors shall be fitted with neoprene - APTK seals and wool pile weather-stripping in groves extruded within the sections. Windows shall be supplied complete with all necessary glazing beads, gaskets, fixing lugs and the like. Sliding elements shall be fixed with fly-screens. All ironmongery shall be from a single manufacturer's range and shall match in colour, finish and the like with samples previously approved by the Consultant.

The aluminium profiles shall be extruded of the tested alloy AL MGSI 0.5, 22 as per DIN 17615 and size-tolerance shall maintain DIN 1748, Part 4. Corners shall be performed by special machines so as to obtain a tight fit without damaging the surface.

All sections shall present clean, straight and sharply defined lines and shall be free from defects and imperfections that may impair their strength.

The finished surfaces shall present a clear surface free from alloy defects, die marks, scratches, streaks or other surface blemishes.

Glass shall be fixed into frames by means of extruded neoprene glazing gaskets of proper profiles, sections and sizes to fit the various aluminium sections and to ensure a tight and waterproof seal against the glass.

Glass must rest on purpose made PVC glazing blocks which suit sections design.

All units shall be installed in the positions assigned to them plumb, square and level and in alignment with the surrounding work. They shall be securely fixed and all opening parts shall function properly without there being any need to use force for operating them.

All glazing work has to comply with DIN 18361, 18545, 18055 or BS equivalent.

8 .04 - INSTALLATION

a) Aluminium work shall be installed, adjusted and glazed by experienced workmen all in accordance with the manufacturer's installation instructions and in full conformity with the approved shop drawings, samples and other submitted data. Under no circumstances shall materials be installed on surfaces that contain condensation, dirt, grease or other foreign encountered materials that would hinter or prevent proper installation and functioning for the use intended.

b) Aluminium work shall be carefully and accurately assembled with proper and approved provisions for Contraction and expansion and set in correct locations as per approved detailed shop drawings, all level, square, plumb and aligned with other work. All joints between framing and structural building shall be sealed in order to be watertight and weatherproof and to satisfy all other requirements of the Consultant.

c) Frames to be designed and manufactured with a maximum 2.5mm tolerance around the opening in the structure. These joints are to be finished by applying an approved sealant into a polystyrene foam backing strip.

d) All aluminium works are to be fully protected for the duration of the Contract from damage by other trades. The Consultant shall approve the method of protection.

8 .05 - STORAGE AND HANDLING

a) Delivered materials shall be identical to the Consultant's approved samples in every respect with regard to colour and finish and in accordance with the shop drawings.

b) Materials shall be stored under cover in a dry, protected and clean location off the ground. All materials that are disfigured, cracked, chipped, scratched or not suitable for installation shall be removed from the Site and replaced with new material at the Contractor's expense.

c) Special care shall be exercised when handling and erecting aluminium to avoid abrasion or
d) any other damage to the finished surfaces.

e) Stacking and storing of the components during delivery or at the Site shall be done using softeners and timbers to keep individual members free from contact with the ground and with each other.

f) The Contractor shall be responsible for the assignment of safe and secure storage area for all materials for work under this section.

8 .06 - ADJUSTMENTS, CLEANING AND PROTECTION

a) If for any reason the final finishes become scratched, abraded or damaged during transport, delivery, storage or erection, it shall be the Contractor's responsibility to remove or repair those defective areas or components as directed and to the complete satisfaction of the Consultant.

Repair work shall be identical to the manufacturer's applied finish with regard to gloss, finish and visual appearance. Field touch up of painted aluminium is permitted only with the written permission of the Consultant. Where touch up is not an authorized means of repair, the damaged materials must be replaced by new.

b) Glass breakage caused by any reason shall be replaced at the Contractor's expense. To avoid delay a reasonable extra quantity of glass shall be available at the Site.

c) Upon completion of work all protective coverings on all exposed surfaces shall be removed. All surfaces shall be cleaned using soap or detergents as recommended by the aluminium manufacturer to remove sealants, discolouration and any other foreign material. Defection of any type determined by the Consultant shall be repaired at the Contractor's expense.

d) Extreme care shall be taken when cleaning the exterior portions to protect other adjacent works.

8 .07 - SHOP DRAWINGS, SAMPLES AND TESTING

a) The Contractor shall submit complete sets of shop drawings, structural calculations, documentation, test results and other related certifications, samples and any other details required by the Consultant for review and approval prior to any fabrication.

b) Shop drawings shall include but not be limited to plans, elevations, sections and full size scale details for the work covered by this Section.

The full size details shall show and note aluminium, glass, steel, wood and all other related materials, their respective thicknesses and gauges, types, insulation, finishes, areas to be sealed and sealant, gaskets and tapes, direction and magnitude of thermal expansion, direction and expansion of applicable building movement, type of construction including but not limited to joinery, fastenings, welds, bolts, anchorage assemblies and components, fabrication and erection tolerance for the work under this Section.

The shop drawings shall also indicate full size details of adjoining work even though they are not included in this Section to ensure co-ordination.

The shop drawing details shall make reference to the detail numbers and drawing numbers

used by the Consultant to assist in reviewing them.

c) Detailed instructions shall be submitted for installation of glass and any special requirement regarding specific area.

d) Details describing the design and structural framing elements shall be fully documented on the shop drawings.

e) The Contractor will be fully responsible for all structural calculations to be submitted regarding this Section even though accepted by the Consultant.

f) All samples under this Section must show the extremes of colour range, texture variation, accessories and all other features required by the Consultant.

g) Test reports certified by an independent test laboratory for structural performance, water penetration and air infiltration. Visual approval will be based on finish, match and uniformity, flatness, construction, joints and seals.

h) Test report in (4) four copies shall be submitted to the Consultant for his final review and approval.

8 .08 - GUARANTEES

a) The work included under this Section shall be fully warranted for appearance, performance, materials and workmanship for a period of not less than ten years from the date of issue of the Final Certificate.

b) Written warranties shall be delivered to the Consultant in triplicate, on the Contractor's official stationery and shall be executed by an authorized officer of the manufacturer of each material system and shall be dated and notarized by a fully authorized notary public.

c) An agreement shall be included in warranties to repair and / or replace at the Contractor's expense defects that develop during the warranty period. The warranty shall include for the costs of all required labour and materials.

d) The warranty shall include but not be limited to :

i) Assemblies and components specified complying with the Contract documents and local restrictions.

ii) Premature material failure due to improper product design, fabrication or installations.

iii) Abnormal deterioration, aging, weathering or malfunctioning either fully or partially.

iv) Structural failure.

v) Failure of anchorage metals due to oxidation, electrolytical damage and deterioration of protective coatings.

vi) Loose or missing parts.

vii) Failure of operating and moving parts and components to function properly.

viii) Failure of tapes, gaskets, sealants or any other parts or details that cause leakage of water, air noise and vibration.

ix) Glass breakages for which the cause of breakage can be determined, secondary glass breakages due to falling glass fragments.

x) Dust, vapour or film formation on internal glass surface.

xi) Failure to conform to manufacturer's recommendations and industry standards as they apply to various elements.

xii) Failure to conform to profile, location, arrangements, details and Specification shown on the shop drawings.

xiii) Deterioration or discolouration and fading of design, pattern, engraving, colours, finishes or any other deficiencies of metalwork and glazing.

GLAZING

8 .09 - GENERAL

Glass shall be in accordance with the British and American Standards. It is to be entirely free of waves, scratches, bubbles, airholes, smoke wanes or similar defects.

The Contractor shall produce on request all invoices or advice notes from suppliers to confirm that the glass is of the standard specified.

Any scratched, broken or otherwise defective glass is to be removed and replaced by the Contractor at his cost during or on completion of the Works.

8 .10 - STANDARDS

Except as modified by governing codes and by the Contract Documents, comply with the applicable provisions and recommendations of the following :

a) Flat Glass Manufacturing Association "Glazing Manual" 1980 edition.

b) Aluminium Manufacturer's Association Booklet Vol. 6, September 1972.

8 .11 - SUBMITTALS

The Contractor shall submit samples of each type of glass and glazing gasket to be installed in the Works. Samples will be reviewed for colour and texture. On receipt of the Consultant's approval of glass type and manufacturer the Contractor shall commence procurement of the same.

The Contractor shall submit the following information from the manufacturer :

a) Statement that each product to be furnished is recommended for the application shown.

b) Complete instructions for handling, storing, mixing, priming, installing, curing and protecting each glazing material.

A copy of a statement signed by the Manufacturer and Contractor shall be submitted, stating that the glazing materials comply with these Specification and that the installation methods comply with the manufacturer's printed instructions for each condition of use on this project.

Submit a ten year guarantee against material obstruction of vision as a result of dust or film formation on the internal glass surfaces as a result of the failure of the hermetic seal. Provide guarantee for all single glazed units due to obstruction of vision. The guarantee shall be valid from the date of issue of the Final Certificate. Upon notification of such defects, within the guarantee period make the necessary replacements at the convenience of the Employer at the Contractor's expense.

Furnish maintenance instructions for each type of glass for use during construction and for use by the Employer after acceptance of the Work.

8 .12 - MOCK-UP

Prepare sample panels of varying glass types as instructed by the Consultant prior to finalizing glass type and order.

This shall be completed as early in the Contract as possible so as not to cause delay to the programme of work. Glass including sealants and the like to be provided.

8 .13 - PRODUCT HANDLING

Deliver glazing materials to the Site in manufacturer's unopened containers, fully identified with trade name, colour, size, hardness, type, class and grade. Store each item in accordance with manufacturer's written instructions.

Deliver, store and handle glass in accordance with manufacturer's recommendations protected from weather, staining and damage. During storage and handling of glass provide cushions at edges to prevent impact damage. Protect glass from scratches and abrasion. Any glass broken or damaged as a failure to comply with the aforementioned shall be replaced at the Contractor's expense.

8 .14 - MATERIALS

a) Sheet Glass

Sheet glass shall be flat-drawn clear sheet glass complying with BS 952, Section 1, ref 4(a), 'Ordinary Glazing Quality'.

b) Plate Glass

Plate glass shall be cast, rolled or drawn glass ground and polished on both surfaces complying with BS 952, Section 1, ref. 6a (1), 'Glazing Quality for Glazing'.

c) Obscured Glass

Obscured glass shall be figured rolled glass complying with BS 952, Section 2, ref. 14b of approved type.

d) Wired Glass

Wired glass shall be polished Georgian wired glass having both surfaces ground and polished and with square mesh inserted during rolling complying with BS 952, Section 4, ref. 21b.

e) Heat Absorbing Glass

Heat absorbing glass shall be floated glass substantially opaque to infra red radiation complying with BS 952 Section 4, ref. 23. Tint and manufacturer to Consultant's approval.

f) Toughened Glass

Toughened glass shall be tempered or heat treated and comply with BS 952, Section 4, ref. 25. Tint and manufacturer to Consultant's approval.

g) Laminated Glass

Laminated glass shall be as complying with BS 952, Section 2, ref. 26c. Tint and manufacture to Consultant's approval.

h) Particular Requirements

The Contractor shall install the glass in accordance with the above Specification and to the type and thickness stated on the drawings.

8 .15 - GLAZING MATERIALS

Glazing Gaskets

- Closed Cell Gaskets : Continuous extruded expanded foam neoprene with Shore A durometer hardness and profile adequate to fulfill the performance requirements specified and complying with ASTM C509, Type II. Provide adhesive or mechanical key on one side.

- Solid Gaskets : Continuous extruded neoprene with a Shore A durometer hardness and profile as required to provide pressure adequate to fulfil the performance requirements specified and complying with the applicable provisions of ASTM C542.

- Fully vulcanize gasket corners where compatible with installation procedures.

Setting Blocks

Neoprene blocks, 80 to 90 Shore A surometer hardness, set as recommended by glass manufacturer.

Edge Blocks

Neoprene blocks, 60 to 70 Shore A durometer hardness, set as recommended by glass manufacturer.

Joint Cleaner, Primer and Sealer

The products recommended by the manufacturer.

8 .16 - GLASS OPENINGS

The glass framing shall both structurally support and adequately cushion the glass. To prevent mechanical and thermal stresses on the glass, the framing system shall provide openings that are within the tolerances for squareness, corner offset and bow. These tolerances are listed below.

Squareness : 3 mm difference in lengths of the diagonals.

Corner Offsets : 0.8 mm maximum offsets at corners.

Bow : 1.6 mm bow in a 1.22 m length of frame.

If the variations from these tolerances are anticipated, details of the same shall be advised to the Consultant. If Site conditions are found to be outside these tolerances corrections must be made before the openings are glazed.

8 .17 – INSTALLATION

Workmanship shall generally be in accordance with CP 152 and respective British Standards.

The glass is to be delivered to the Site with adequate protection to prevent damage and where possible it is to be fixed in position immediately after delivery. When fixed the Contractor is to take all necessary precautions to prevent damage during succeeding building operations and will be entirely responsible for the replacement of any damaged glass at his own cost.

The Contractor is to be solely responsible for determining the exact sizes of glass required, including a tolerance of 2 mm to each edge and he is recommended to check the necessary dimensions on Site.

No glazing is to be carried out until rebates have been painted with primer. Timber beads are also to be primed before fixing.

All mastic is to be neatly struck off to agree exactly with Site lines inside and out.

Rates are to include for all necessary springs, clips, setting blocks, location blocks and distance pieces and for taking off and later re-fixing loose beads.

Glass apertures in timber doors are to be bedded in chamois leather glazing strip, black ribbon velvet or P. V. C. glazing strip to the approval of the Consultant.

The Contractor shall provide all necessary down-stand / up-stand beam arrangements behind insulated glazed panels in order to satisfy the requirements of the Local Authorities and the Consultant.

8 .18 - CLEANING

All glass is to be thoroughly cleaned and polished on both sides and all paint spots and the like completely removed to the satisfaction of the Consultant.

8 .19 - GUARANTEE

All materials shall be covered by a guarantee from the Manufacturer / Contractor for a period of ten years, in all respects from the date of issue of the Final Certificate.

METALWORK SUNDRIES

8 .20 - ACCESS LADDER

Access ladders are to be formed from aluminium of welded or bolted construction to the satisfaction of the Consultant and paint finished as detailed elsewhere in these Specification.

Vertical ladders are to comprise 6 x 75 mm strings 450 apart with 25 mm diameter rungs at even centres not less than 300 mm and not greater than 380 mm. Strings are to extend not less than 900 mm above upper platform level and where the height exceeds 5m a back guard is to be provided comprising 6 x 25 mm hoops 600 mm diameter at 300 mm centres. The whole is to be secured to the structure at not greater than 900 mm centres vertically with 6 x 75 mm cleats and expanding anchor fixed to the structure and giving unobstructed toe space between rungs and structure of not less than 150 mm.

8 .21 - BALUSTRADES AND HANDRAILS

Horizontal and raking balustrades, balusters, handrails and the like to staircases, landings and parapets shall fully comply with British Standards and Codes of Practice. All components shall be properly assembled and jointed by welding or screwing. All anchorages shall be cast into concrete where possible and if not bolt fixed to the Consultant's approval. Galvanized mild steel balustrades and handrails all as shown on drawings paint finished. The balusters shall be set at centres as indicated on the detailed drawings.

At balconies with precast panels, provide 50 mm diameter tubular aluminium white powder coated railing fixed into concrete.

8 .22 - ACCESS PANELS

The Contractor shall provide access panels to service ducts as required by the Consultant. The access panels shall generally conform to the following all to the Consultant's approval.

a) Access panels shall be the flush mounted type to be finished the same as the surrounding materials. Complete details for fixing, operating and finishing of these panels shall be submitted for the Consultant's approval.

b) The panels shall be manufactured from 20 gauge steel, frames being equipped with anchors and bolts for fixing. Type of fixings will depend on the surrounding structure.

c) Panels shall open to a full 175 degree and shall close always squarely in place.

d) Panels shall swing open on a pin hinge for easy operation and be furnished with an automatic latch and closer, an interior latch release device is included so that the panels can be unlocked from inside.

e) Panels shall have minimum 7.5 mm of insulation in sandwich type construction.

f) Hinges shall be continuous concealed stainless steel pin type to allow for flush appearance.

g) Locks shall be flush types allowing for wall covering to be applied over panel faces with no obstruction.

h) The steel panel shall have a chemically bonded prime coat of baked on electrostatic powder finish.

8 .23 - MIRRORS

Mirrors shall be of uniform thickness, free from waviness, air bubbles and the like. Representative samples of mirror shall be submitted for the Consultant's approval. The mirror glass shall be clear and silvered by nitrate precipitation, protected by copper plating with a protective plastic coating on the reverse side. The mirrors shall be 6 mm thick and cut to sizes as shown with ground and polished edges. The mirrors shall be set on 20 mm thick plywood backing plugged and screwed to wall.

DIVISION - 9

FINISHES

DIVISION 9: FINISHES

FLOOR, WALL AND CEILING FINISHES

9.01 CEMENT

The cement is to be as described in “Concrete Work”.

9.02 SAND

The sand is to be clean, sharp, river or pit sand free from earth, loam, saline materials or other impurities and well graded from coarse to fine.

For use in plastering, sand is to comply with the requirements of BS 1198 Table I.

For use in beds, granolithic finishing, tile bedding and jointing, etc., sand is to comply with the requirements of BS 1199 Table I.

9.03 LIME

The lime used in plasters is to be hydrated complying with BS 890 Class B.

9.04 COLOUR PIGMENTS

The colour pigments are to comply with the requirements of BS 1014, and they are to be lime proof and non fading.

9.05 PLASTERBOARD

Plasterboard is to be self-finished gypsum wallboard, or gypsum lath or baseboard where to receive a skim coat, complying with the requirements of BS 1230.

9.06 METAL LATHING, STOPS AND BEADS

Metal lating, stops and beads are to suit the plaster and tile thickness and are to be supplied by an approved manufacturer and are to be fixed with nonferrous nails to walls and the like strictly in accordance with the manufacturer’s instructions.

9.07 MARBLE TILES

Marble floor and wall tiles are to generally comply with the requirements of BS 4131 and they are to be supplied by a manufacturer approved by the Consultant. The floor tiles are to be laid on a cement and sand screed to make up the total floor finish thickness. The wall tiles shall be dry fixed.

9.08 CERAMIC TILES

Unglazed ceramic floor tiles and coved skirting are to comply with the requirements of BS 1286.

The glazed ceramic wall and floor tiles are to comply with the requirements of BS 1281.

9.09 ADHESIVES AND SEALANTS

The Contractor is to insert “Bal Sealant” between glazed ceramic wall tiles and all sanitary fittings. The ceramic wall tiles are to be fixed with “BAL FLEX” adhesive, the ceramic floor tiles with “BAL CEM”, both are to be grouted with coloured “BAL GROUT”. All “BAL” products are to be as manufactured by Building Adhesives Ltd., or equal approved, used strictly in accordance with the manufacturer’s instructions.

The Contractor shall use water proof and steam proof adhesives and sealant in the applicable locations and as directed by the Consultant.

9.10 ANTI-DUST SEALANT

The Contractor shall treat the surfaces of cement and sand screeds with an epoxy anti-dust sealant applied strictly in accordance with the manufacturer’s instructions.

9.11 WORKMANSHIP GENERALLY

Workmanship is to conform to the recommendations of the appropriate Codes of Practice. The Contractor is responsible for the provision of all labour, scaffolding, materials, tools, plant, etc, required for the execution and completion of the Works, to the full satisfaction of the Consultant.

9.12 STORAGE

All branded materials delivered to Site are to be properly stored in a watertight location on a dry floor, or in equivalent conditions to avoid deterioration prior to use. Any materials which do deteriorate or become damaged before use are to be removed from Site and replaced at the Contractor’s expense.

9.13 PREPARATION OF SURFACES

Surfaces to receive plastering, beds, etc., are to be dry brushed to remove all loose particles, dust, efflorescence, etc,., and any projecting fins on concrete surfaces are to be hacked off. All traces of mould oil are to be removed from concrete surfaces by scrubbing with water containing detergent and rinsing with fresh water.

Surfaces are to be re-wetted as required to equalise suction before the first coat of plaster or the like is applied. Particularly dense, hard concrete surfaces are to be wetted as required before bonding plaster is applied.

Where surfaces are out of line, they are to be brought to level by hacking or dubbing out in similar mix to the undercoat prior to commencement of finishing.

9.14 PLASTERING AND RENDERING

Internal Plastering is to comply with BS 5492.

The plaster for use internally is to be composed of one part of cement, one quarter part of lime and four parts of sand, and is to be applied in two coats to an 18 mm minimum

finished thickness. On ceiling a third coat shall be applied containing gypsum powder which shall be used as a leveling and smoothing coat.

The render for use externally is to be composed of one part of cement and four parts of sand, and is to be applied to an 18mm finished thickness externally. A small quantity of lime may be added to this mix at the Consultant's discretion.

Plaster or render is to be mixed in clean buckets and gauge boxes. All tools are to be kept clean and fresh plaster or render is not to be contaminated with set plaster or render.

The ingredients for the plaster or render are to be mixed three times dry and three times while water is added. Alternatively mixing may be done by approved mechanical mixers, which are to be cleaned before use.

The working time permissible after the addition of water to the plaster or render mix is to be thirty minutes. Mixed plaster or render that has exceeded this limit is to be removed from the Site and not retempered and used in the Works.

The Contractor is to ensure that before plastering or rendering commences the junctions between differing base materials are reinforced with a strip of galvanised expanded metal lath secured at both edges.

All angles, beads and the like shall also have been fixed.

All surfaces to be plastered or rendered are to be sprayed with water, which is to be allowed to dry out before a key coat of cement slurry is applied.

All undercoats are to be scratched to form an adequate key for the next coat. The setting coat is not to be applied until the floating coat has been left in a moist condition for at least three days.

Plasterwork is to be finished with a smooth, trowelled face, free from blemishes and fit to receive decoration. Render is to be finished with a wood float. Any blown, cracked or otherwise damaged plaster or render will be condemned by the Consultant and is to be hacked off and made good with quick setting plaster at the Contractor's expense.

Full use is to be made of grounds, rules and angle trowels to ensure that all wall faces finish plane and true to line in all directions and that all angles are straight, true and plumb. Prices for plastering and rendering are to ensure that work to walls and ceilings is effectively "cut" at the joint so as to minimise damage due to movement.

Externally applied finishes as noted shall be applied with an approved machine in not less than two coats to a minimum of 6mm finished thickness. The surface finish is to be either "rough textured" or "pressed", and the render is to be cured after application of the second coat.

9.15 ANGLE BEADS

All external angles in walls, and at openings such as doors and windows and the like

shall be protected with galvanised mild steel angle beads complying with BS 1246.

Work shall also include the supply and fixing of galvanised mild steel plaster stops to finish the plaster at meeting with skirting leaving 10mm joint groove.

9.16 BEDS FOR FLOOR TILING

Beds for floor tiling shall be composed of 1 part of cement and 4 parts of sand by volume mixing, all as previously described.

Prices shall include surface preparation, temporary rules, laying to falls and cross falls as required by the room location, making good and the like.

9.17 SAND CEMENT SCREED

Floor screeds are to compose of one part of cement and three parts of sand and are to be smooth and level to the thickness stated on the Drawings. Should the said proportions be insufficient for the design mix at the stated thickness, the Contractor shall add at his expense aggregate to ensure that the screed strength is maintained for the given thickness required. Final difference in levels in any part of the building shall not exceed 2mm, otherwise the Contractor shall be required to apply an approved self leveling screed to finish the surface.

Apply dust inhibitor in accordance with manufacturer's instructions to screed areas to receive finish by others.

Where beds are to be laid direct on to a concrete sub-floor that has set, the surface of the sub-floor is to be thoroughly cleaned and prepared to ensure a good bond, the surface being chipped with a pick if necessary, brushed well and washed out to remove all dust and dirt and thoroughly soaked with water left on overnight. Surplus water is to be mopped up and immediately prior to laying the bed, the sub-floor is to be coated with a grout of neat cement wash well brushed on as the work proceeds. The grout must not be permitted to set before the bed is laid.

The beds are to be protected from excessively rapid drying out by means of tarpaulins or polythene sheeting for a minimum of 7 days after laying.

Laying beds is preferably to be carried out when the building is fully protected from adverse weather, however, the Contractor shall protect all beds as necessary from damage by wet weather.

9.18 WALL TILING

General

The surfaces to which tiles are to be fixed are to be thoroughly dry before fixing commences and free from all defects. Any such defects are to be made good before work commences. Wall tiling shall be carried out in accordance with CP 212.

Tiles are to be fixed to wall surfaces by bedding in an approved adhesive, extreme care

being taken in the setting out, lining and leveling of tiles and all external angles are to be mitre jointed. The adhesive is to applied strictly in accordance with the manufacturer's instructions.

The agreement of the Consultant to the setting out of tiles is to be obtained before commencing work. Tiles shall be fixed with true horizontal and vertical joints of an even width of 1-2mm.

Adequate time is to be allowed to enable complete setting of the tile bedding before joints are grouted. The whole of the tiled surface is to be thoroughly cleaned down on completion and left in perfect condition. Any cut tiles are to be neatly and cleanly cut using an approved method and cut tiles are to be used only at internal corners or in other locations to be approved by the Consultant.

9.19 FLOOR TILING

General

The Contractor is to satisfy himself that the surface on which the tiles are to be laid is satisfactory to receive the tiles. It is the responsibility of the Contractor to provide a satisfactory surface and or bedding and any remedial work necessary shall be carried out at the Contractor's expense.

Before laying commences the base is to be free from dust, loose material, grease, plaster and the like.

Care shall be taken in cutting and fitting tiles around stacks, pipes and the like. The setting out of tiles and colour patterns are to be as shown on the drawing or as directed by the Consultant. Any adhesive on tiles surface or any other finished surface is to be completely cleaned off. The tiles shall be laid with true aligned joints of an even width of 1-2mm and grouted up on completion.

The work is to be set out from the centre of rooms using whole tiles and working outwards. Rates are to include for the all cut margins and make up pieces at limits and boundaries.

The flatness of tiled or paved floors must be such that a two metre rule moved in all directions shows no bump or hollow of over 2mm.

The Contractor is to store ceramic floor tiles in such a way that they are protected from moisture until laying in a cement and sand bed, with even joints not wider than 2mm. The tiles are to be grouted with a tinted mortar mix to match the tiles a minimum of twelve hours after completion the tiling.

The terrazzo tiles are to be soaked in clean water immediately before laying and allowed to drain, before laying to the levels and grades shown on the drawings.

When the bed is sufficiently firm to prevent disturbance of the tiles, they are to be grouted up with neat cement slurry well worked into the joints, with any surplus grout being removed from the face of the tiles. On completion all terrazzo surfaces are to be ground

to an approved polished surface using a No.140 carborundum wheel.

9.20 MARBLE AND GRANITE WORK

General

Samples of all marble and granite to be used in the Works are to be submitted to the Consultant for approval prior to commencement of same on Site.

The Contractor is to ensure that all marble and granite delivered to Site is stored on a raised platform in a water free area and is protected with suitable sheeting.

Any chipped or stained pieces are to be removed from Site and replaced at the Contractor's expense.

Marble or granite for use as wall cladding is first to be shown on shop drawings submitted by the supplier via the Contractor for the Consultant's approval. These drawings are to detail the key numbers of each slab together with details of anchorages, and no marble or granite is to be worked until these drawings are approved. Layout of marble and granite as flooring shall be similarly presented.

The Contractor is to supply all necessary stainless steel fixings, dowels and continuous stainless steel supports at the base of wall linings as required, and all in accordance with C.P.298. All fixings are to be concealed when the work is complete.

All external angles are to be rebate jointed. Where marble abuts door frames and the like the edges shall be chamfered.

The Contractor is to use the following table as a guide to the minimum number of anchors required to support each slab.

Slab Size	No. of anchors per slab
Not exceeding 0.60m2	2
Over 0.60 but not exceeding 1.20 m2	3
Over 1.20 but not exceeding 3.60 m2	4
Over3.60 but not exceeding 6.00 m2	6
Over 6.00 m2	One extra anchor for each additional square metre of slab

The Contractor is to be solely responsible for the provision of sufficient fixings.

Unless otherwise instructed wall linings are to be set 30mm clear of the structural backing and the rear of each slab is to be coated with shellac or bitumen paint to prevent staining from behind.

In addition to anchors and the like, internal work is to be bedded on plaster or non-

staining cement mortar spots, and the joints are to be neatly pointed in non-staining cement mortar. External work is to be set as internal work, but non-staining, quick-setting cement is to be used. Provide slurry backing to all marble and granite wall cladding up to 1500mm from finished floor level.

Marble and granite flooring slabs are to be tamped onto a cement and sand screed with a suitable mallet, until firmly bedded. The floor is then to be roped off for 24 hours, after which the slabs are to be grouted with water and neat non staining coloured cement.

Agglomerate marble shall be manufactured using selected marble chips which are bound together with a special high resistance cement. The agglomerate marble shall be supplied to the dimensions stated herein. The floor tiles shall be pointed up using white cement or as directed by the Consultant.

Marble and granite cladding is to be protected at the corners with non-staining wood formwork, and floors are to be protected by suitable boarding or slurry as approved by the Consultant.

On completion of work, all marble and granite is to be thoroughly cleaned by scrubbing with fibre brushes and mild alkaline solution, to the entire satisfaction of the Consultant.

9.21 SUSPENDED CEILINGS

General

The Contractor shall prepare and submit for approval, fully dimensioned shop drawings prepared from the general working drawings of the Consultant and from a Site survey. Setting out points common to all trades shall be established early in the manner described and shown on the working drawings.

Rod type suspension system hangers and hook bolts for suspension systems shall be fixed to structural concrete soffits. Self-drilling threaded metal sockets of an approved type shall be used for fixing to concrete.

Suspension and framing shall be of metal sections only. No timber framing will be accepted.

Finished ceiling heights shall be rigorously respected; they shall be measured for the finished floor levels.

The ceiling shall be left perfectly flat and shall not show a deviation of more than 3mm from a 3 metre straight edge. The Contractor shall take all possible precautions to eliminate any defects.

Prices shall include for cutting and fitting ceilings around obstacles and neatly finishing the edges of the work.

Proprietary suspended ceiling systems shall be installed in strict accordance with the manufacturer’s instructions, by workmen skilled in this work in a rigid and secure manner so that the final surface is free of any waves, buckles or sag.

Tiles and ceilings forming a grid or pattern shall be set out on the axes of the room in both directions.

Suspended ceilings shall not be erected until the windows have been glazed, the building closed in, the plasterwork dried out, all wet work completed and the building suitably air conditioned; relative humidity must not exceed 70% and the temperature must be maintained within the range 15-30 Degrees Centigrade.

The design of and dimensional tolerances set by the manufacturer for accessory items such as formed wire hangers, spring spacer clips, tile retainers, and spacer bars shall be such as to assure satisfactory performance of their intended function in the suspension system. Failure attributable to such accessories to control alignment, prevent undesirable rotation or other unsatisfactory performance which results in unfavorable appearance will be cause for their rejection.

General installation procedures shall be as follows:

a) The area to receive treatment shall be dry and be satisfactorily colsed against excessive traffic and be protected against weather before work is started.

b) Installation shall be in strict accordance with manufacturer's specifications except as modified by this Specification.

c) Install units in a true and even plane, in straight line courses laid out symmetrically about centre lines of ceiling or panel, continuing pattern, through wall openings or as indicated. Border tile shall not be less than 15cm wide.

d) Fit border units neatly against vertical surfaces.

e) Seal joints in units around pipes, ducts, and electrical outlets with acoustical sealant.

f) Carefully coordinate and fit units to grilles, lighting fixtures and other related items of work. In determining spacing and locations of hangers for main runners and carrying channles, take into consideration the weight of grilles, fixtures, etc. that are to be installed in conjunction with acoustic ceilings.

9.22 PAINTING AND DECORATION

General

All paint materials shall be obtained from an approved manufacturer. All sealers, primers and under-coatings shall be obtained from the makers of the finishing materials and shall be in accordance with their recommendation for the particular finish required.

All materials shall be delivered on Site, intact in the original drums or tins, and shall be mixed and applied strictly in accordance with the manufacturer's instructions and to the approval of the Consultant. All paints, emulsion paints, etc., shall be applied by means of a brush.

The only additions which will be allowed to be made locally will be liquid thinners and dryers supplied or recommended by the manufacturers and none shall be thinned more than approved by the Consultant.

Priming, undercoats and finishing coats shall each be of differing tints and the priming and undercoats shall be of the correct types and tints to suit the respective finishing coats in accordance with the manufacturer's instructions. All finishing coats shall be of colours and tints selected by the Consultant. All paint for external work shall be of exterior quality only.

Each coat of paint shall be dry and shall be well rubbed down with fine sandpaper and dusted before the next coat is applied. The paint work shall be finished smooth and free from brush marks.

The Contractor shall arrange his programme of work so that all trades are complete and away from the area to be painted when the painting begins.

Cards of all paints, etc., shall be prepared and submitted to the Consultant for approval before laying on such material. When approved, samples shall become the standard for work.

Ironmogery shall be removed from joinery before painting is commenced and shall be cleaned and renovated if necessary and re-fixed after completion of painting.

Cover up all floors, etc., with non-resinous sawdust or other approved covering when executing all painting and decorating work.

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

Prices of paint, etc., shall include preparation of surfaces, rubbing down between each coat, and all other work in connection as described and as necessary to obtain a first class and proper finish. Prices must include for the provision of all necessary scaffolding, plant and tools, and also for applying different colours and cutting into line where and as necessary.

Prepare one metre square area sample of Thoroseal finish to show texture and colour sample to be approved by Consultant prior to starting Thoroseal work.

9.23 PREPARATION OF SURFACES

Concrete surface shall be smooth, free from defects and shall be allowed to dry out thoroughly. Surfaces shall be thoroughly brushed down and left free from all efflorescence, dirt and dust.

Surfaces which are to be finished with oil or enamel paint shall be primed with two coats of alkali-resisting primer.

Surfaces which are to be finished with plastic emulsion shall be treated with an approved alkali-resisting primer.

Plastered surfaces shall be perfectly smooth, free from defect. All such surfaces shall be allowed to dry for a minimum of four weeks. Surfaces shall be stopped with approved plaster compound, rubbed down flush, thoroughly brushed down and left free from all efflorescence, dirt and dust.

Surfaces which are to be finished with oil or enamel paint shall be primed with two coats of alkali-resisting primer.

Surfaces which are to be finished with plastic emulsion shall be treated with an approved alkali-resisting primer.

Metalwork (non-primed) shall be thoroughly wire brushed to remove all scale, rust, etc. Where severe rust exists, special anti-rust primer must be used.

Shop-primed surfaces shall have all bare places touched up with an approved metal primer.

Unprimed surfaces shall be given one coat of primer as specified in BS 2523 or 2524.

Galvanized surfaces shall be thoroughly weathered, brushed down with white spirit and given one coat of calcium plumbate primer.

Aluminium surfaces shall be etched with fine emery paper and white spirit, washed down and given one coat of zinc chromate primer.

Bituminous coated surfaces shall be given an isolating coat of shellac knotting followed by an approved metal primer.

Woodwork to be painted shall be cleaned of impurities.

Knots shall be treated with two coats of knotting.

Priming paint shall be applied by brush. Two caots shall be applied to end grain. Priming paint shall be applied on Site after the Consultant has approved the joinery and before it is fixed.

When the priming paint is dry, all cracks, holes, open joints and the like shall be filled with stopping and rubbed down with fine glass paper.

The priming paint and undercoats shall be lightly rubbed down with glass paper to remove blemishes, and all dust before the application of subsequent coats.

9.24 MATERIALS

a) MORDANT SOLUTION

Mordant solution shall be of approved manufacture.

b) RUST INHIBITORS

Rust inhibitors shall be of approved manufacture.

c) KNOTTING

Knotting shall comply with B.S. 1336.

d) STOPPING

Stopping for woodwork to receive clear finish shall be tinted to match surrounding woodwork, to approval.

Stopping for internal woodwork, plywood, hardboard, and fibreboard shall be linseed oil putty to B.S. 544. tinted to match the colour of the undercoat.

Stopping for external woodwork shall be white lead paste well mixed.

e) THINNERS

Thinners shall be approved turpentine or white spirit to B.S. 245.

f) STAIN

Stain for woodwork shall be an approved brand of oil stain complying with B.S. 1215.

g) POLYURETHANE LACQUER

Polyurethane lacquer for woodwork shall be of an approved manufacture.

h) VARNISH

Varnish for interior woodwork shall be an approved brand, oil varnish. Varnish shall form a hard flexible transparent and quick drying film.

i) LINSEED OIL

Linseed oil for woodwork shall be refined linseed oil to comply with B.S. 242.

j) PRIMING PAINTS

Priming paints shall be the primer recommended by the manufacturer of the finishing paint or:

1. For woodwork – lead-based or priming paint to comply with B.S. 2521 and 2523.
2. For steel work – red oxide priming paint to comply with B.S. 2524.
3. For galvanized, zinc or aluminium work grey zinc chromate priming paint.
4. For concrete, blockwork, plaster, plasterboard and the like – alkali-resisting priming paint.

k) UNDERCOATING

Undercoating shall be:

1. Zinc oxide based undercoating paint.
2. White lead based undercoating paint in accordance

with B.S. 2525-7. Colours shall approximately match the finishing paint.

3. Synthetic alkyl based undercoating in accordance with the recommendations of the paint manufacturer.

9.25 FINAL COATS

CONCRETE SURFACES

Flat oil, two coats of flat oil paint over prime coat.

Enamel, enamel undercoat over primer, followed by one coat semi-gloss finish.

Plastic emulsion, two or more coats over primer.

Thoroseal, two coats.

PLASTER SURFACES

Flat oil, two coats of flat oil paint over prime coat.

Enamel, enamel undercoat over primer, followed by one coat semi-gloss finish.

Plastic emulsion, two or more coats over primer.

Thoroseal, two coats.

METAL SURFACES

Over primed surfaces, apply undercoat and one coat of semi-gloss oil enamel. All material shall be for external use.

GALVANIZED SURFACES

One coat of Calcium Plumbate primer, enamel undercoat and one coat semi-gloss enamel.

WOOD SURFACES

Two undercoats and one finishing coat of the approved paint to be applied by brush.

DIVISION 14

CONVEYING SYSTEMS

DIVISION 14: CONVEYING SYSTEMS

14.01 LIFTS INSTALLATION

a) REQUIREMENTS

The lifts shall be supplied and installed by an approved Specialist Subcontractor.

The work shall be carried out concurrently with the work of the building Contract and the Contractor will be required to carry out certain work in connection with the Specialist Subcontract.

b) BUILDERS WORK AND ATTENDANCE

The Contractor is to allow for all builders work as per requirements of the Elevator Subcontractor listed elsewhere in connection with the lift installation.

The Contractor shall also provide normal attendance including all usual facilities for the execution of the Specialist Subcontract.

c) AS-FITTED DRAWINGS AND SERVICE MANUALS

On completion of the lift installation and at least one week prior to the date of inspection, the Contractor shall hand over to the Consultant as-fitted lift installation drawings. Two sets if instruction manuals for general running, maintenance and repair are to be provided.

d) GENERAL

The Contractor shall supply, install, test and commission and hand over the complete lifts installation as specified and in accordance with BS 2655 and BS 5655.

The general requirements of the lifts and particular specifications are given in the schedules at the end of the Specification.

The Contractor shall commence the electrical installation from the isolators provided in the machine room for this purposes. All these shall be coordinated with the other Contractors prior to installation, so that there will be no areas of incompatibility.

The lift system shall be equipped with traction machinery and associated traction equipment, lift cars, solid state control systems and all other equipment and accessories required to provide a complete, modern, durable and efficient vertical transport system.

All the electrical equipment shall be compatible with the available electrical system of the building, as specified under electrical section.

All the components shall be selected to provide satisfactory operation under prevailing environmental conditions at Site.

The Contractor shall be responsible for the complete maintenance of the lifts for a period of 12 months from the date of acceptance by the Consultant of the

complete lifts installation and shall include for cleaning, oiling and inspection of the lifts and all the associated equipment at intervals of one month and to include for all emergency calls throughout the 24 hours of the day for rectifying any failure of the lifts to operate normally.

A monthly inspection sheet shall be submitted to the Consultant immediately after each monthly inspection, cleaning and greasing.

The Contractor shall also give notice that any fault notified will receive immediate attention on the day of the notification.

e) CAPACITY

Each lift shall have a safe carrying load inclusive of weight of complete car cable and ropes, in accordance with the attached lift Particular Specification.

f) SPEED

The rated speed of the lift shall be as specified in the lift Particular Specification.

14.02 LIFTS ELECTRICITY

a) TRACTION MACHINE

The lifts shall be equipped with variable voltage and variable frequency controlled geared motors, having stepless, smooth speed time characteristics.

The traction machines shall be designed to meet the severe service conditions encountered in the elevator operation.

Traction sheave, hoisting motor, electromagnetic holding brakes, etc. shall be mounted on a heavy steel bed plate. The steel bed plate shall be mounted on a suitable vibration damper to isolate the machines from the structure of the building.

All rotating parts shall be statically and dynamically balanced to ensure smooth running. All the rotating electrical machinery shall be fited with microtherms, to provide overload protection.

The winding insulation levels of the motors shall be of Insulation Class ‘F’ and the motors shall meet the requirements of BS 5000.

b) CONTROL SYSTEM

A very effective close loop control system shall be provided for the elevators. This system shall consist of speed pattern generator, pulse generator, digital regulator, speed feedback system, gate controller, PWM controller, thyristor transistor inverter, etc. The speed pattern generator shall provide slow speed command for hand operation during maintenance work. Optical fibre cables may be used to improve the reliability of signal transmission.

c) LIFT OPERATING AND CONTROLLING SYSTEMS

All control systems shall be fully automatic passenger operated type. The

facility to transfer to independent operation, if and when required, shall also be included. An automatic bypass for land and hall calls shall be incorporated in the event of the car being loaded to its maximum capacity. Floor calls shall remain registered and shall be served by the next available car. Each three Car Elevator System shall be provided with three car selective operating system. In this system, all hall and car calls shall be registered. When the car is moving up it shall respond in sequence to both car calls and up hall calls, until it has responded to the highest call.

The direction of travel shall reverse automatically at this point to answer the down calls. The nearest car moving in the appropriate direction shall answer when a hall call is registered. If any hall call is registered behind one car, it shall be answered by the other car. When there are no calls, one car shall return to the main floor to await further calls.

14.03 HOISTWAY EQUIPMENT

a) GUIDE RAILS

For smooth running of the counterweight and the elevator car, guide rails with steel tee sections shall be installed, covering the entire height of the lift shaft. The rails shall rest on the hoistway pit to prevent exerting any physical force on hoistway ceiling or walls of the building.

Proper expansion joints shall be provided to withstand forces created on temperature variations.

b) HOISTING ROPES

Bright steel wire ropes with fibre cores of adequate cross-section, manufactured to BS 4048, or steel wire ropes with adequate cross-section manufactured to BS 329.

c) GOVERNOR ROPES

These shall be manufactured similar to hoisting ropes. The two ends shall be securely linked to the car and attached to the safety car operating level. The governor ropes shall be tensioned by a weight-loaded device located in the pit.

d) COUNTERWEIGHT

Cast iron blocks enclosed in a steel framework shall be provided to balance the weight of the car and the specified capacity.

e) BUFFER

Oil buffers shall be fitted in the hoistway pit beneath both car and the counterweight. These shall be securely mounted on continuous channels and correctly disposed relative to the car and the counterweight.

The plunger shall be of mild steel, accuraly machined and designed to provide very high safety factor. A toughened rubber bumper shall be fitted to the top of the plunger to withstand the impact of the steel buffer plates mounted on the

underside of the car and the counterweight. An oil gauge shall be provided to check the oil level.

14.04 TRAVELLING CABLES

The travelling cables shall be 450v/750v grade multi-core with stranded high conductivity copper conductors, especially designed for lift duty and manufactured to BS 6977. These cables shall be properly supported by retaining straps and individual cable clamps.

14.05 SAFETY EQUIPMENT

The gradual type safety system, comprising a close loop roping system, over-speed centrifugal governor, safely gear equipment, etc. shall be provided.

The operation of the system shall be such that if the car overspeeds in the downward direction, the governor jaws shall strip, operating the safety gear. It shall, in sequence, out of the motor power supply, apply a constant retaining force to bring the car to a gradual and smooth stop within defined limits.

Re-setting of the safety devices shall be possible by moving the car in upward direction.

The complete system shall comply with the relevant sections of BS 2655 and BS 5655.

a) OVER TRAVEL

Over travel limit switches shall be provided at the top and bottom of the terminal landings, to disconnect the power supply and apply brakes to bring the car to a safe stop position in the event of a travel in either direction.

b) EVACUATION DEVICES

Provision shall be made to move the car manually from the machine room to the nearest landing in either direction to facilitate evacuation of passengers during a power failure.

c) FIREMAN EMERGENCY OPERATION

Fireman Emergency Operation Button enclosed in a breaking glass shall be installed near the entrance on the main landing and shall operate any one of the elevators under conditions of emergency, in the event of fire.

When the Fireman Call Button is pressed, it shall immediately disconnect the elevator under normal automatic operation and the car shall return to the main landing. It shall not register any hall calls, so that the passengers will not wait for the lift. The car shall then only operate on the attendant operation and it shall start registering the hall calls.

14.06 ELEVATOR CAR

The size of the Car, Interior Design and Decorations, Ceiling and Lighting and other facilities shall be as called for in the Lift Particular Specification.

The car shall be of rigid steel framework with sound isolation designed and manufactured all in accordance with relevant sections of BS 2655 and BS 5655.

The operating buttons and keys shall be as given in the relevant Sections of the Specification. The following facilities shall be provided for each car, in addition to the items already specified.

a) VENTILATION

Electric Ventialator mounted on the car roof with proper vents.

b) EMERGENCY LIGHTING

Self-containd, non-maintained emergency light, with a trickle charger.

c) EMERGENCY EXIT

An Emergency Exit shall be provided on car roof. This door shall be able to open either inside or outside. A safety electrical switch shall be provided to prevent the car travelling when this emergency exit is open.

d) INTERCOMMUNICATION SYSTEM

Intercommunication system between the car, main landing and the machine room.

e) WORKING PLATFORM

A working platform, complying with BS 2655 on the roof of the car.

f) CAR AND LANDING DOORS

The car and landing doors shall be fully automatic. Two Panel Centre/Side opening, sliding doors. The finish of the doors shall be as specified in the lift Particular Specification.

g) DOOR OPERATOR

The door operator shall be high speed heavy duty, with a Thyristor controlled AC motor. The opening and closing speeds of the doors shall be adjustable. The landing and car doors operate in full synchronism. Advance door opening during car's approach to a landing could be used to speed up passenger transfer.

h) SAFETY FEATURES

1. Emergency unlocking key from landing side for evacuation and maintenance work.
2. Manual opening of the doors from inside the car, within landing zones during power failure.
3. Full door height safety-edge device in the leading edge of the car doors to reverse the doors when there is any obstruction for closing.

4. Electrical interlock to operate in conjunction with the car doors, so that elevator cannot operate unless doors are closed.
5. Overload indicator with Buzzer. If the car is overloaded, it shall prevent from starting. The blinking overload indicator and the sounding buzzer shall signal the overload condition to the passengers.
6. Emergency light with trickle charger.

14.07 TESTING

On completion, a thorough test of the lifts under the working conditions shall be carried out in the presence of and to the approval of the Consultant.

All materials used must be of the highest quality and the best of their respective kinds and must comply with the relevant BS. All weights necessary to carry out the full load and overload tests must be provided by the Contractor and removed after use.

The tests will include the following:

a) No load current and voltage readings both on ‘Up’ and ‘Down’ Circuits.
b) Full load current and voltage readings both on ‘Up’ and ‘Down’ Circuits.
c) One and quarter load current and voltage readings both on ‘Up’ and ‘Down’ Circuits.
d) Overload protection.
e) Gate sequence relays, if provided and installed.
f) All Interlocks.
g) Collective control and priority sequences, if installed.
h) Safety gear mechanism.
i) Speeds on Up and Down travel with loadings and empty.
j) Door Contacts.
k) Final terminal stopping device.
l) Normal terminal stopping device.
m) Insulation and earth continuity.

14.08 OPERATING PANELS AND INDICATORS

a) CAR OPERATING PANEL

The Car Operating Panel of each elevator shall contain the following:

1. Opening Buttons numbered to correspond to the landings served with acknowledge light for each button.

2. Emergency call button.
3. Door Open and Close Buttons.
4. Intercom Station.
5. Overload indicating lamp with buzzer.

b) LANDING POSITION INDICATOR

Car position Indicator shall be provided for each car, in the car and over the main landing entrance of each elevator. As the elevator travels through the hoistway, its position shall be indicated by the illumination of the numeral/letter corresponding to the landing at which the elevator is stopped or passing. Indicators shall be properly designed for better recognition with colour filters to provide good contrast. Travel direction indicators shall also be included in this indicator.

c) PUSH BUTTONS AND INDICATOR FOR LANDINGS

1. Up and Down call buttons with indicator lights to show that the call has been registered.
2. Hall Digital Position Indicator in the Trasom Panel for landing, with the travel continuation arrows as specified in the previous section.
3. Fire Alarm call button in a break-glass fixture at the main landing.

14.09 CAR AND LANDING SILLS

Stills manufactured as specified in the lift Particular Specification shall be fitted at every landing entrance and on the car platform for the entire width of the door opening.

These sills shall be with integral grooves to act as guide for the bottom of the door panels. The car sill shall be securely fitted to the car platform and the landing sills securely fitted to the entrance threshold. These sills shall be flushed with the finished floor level.

The sills shall be designed to provide adequate strength to support the loads exerted on them, in addition to the safety and decorative entrance plate appearance.

14.10 ELECTRICAL INSTALLATION OF ELEVATORS

General wiring throughout the installation shall be carried out as specified in the Electrical Specifications. GI trunking shall be used wherever possible instead of multiple conduits GI conduits and flexible conduits shall be used between trunking and apparatus.

Earthing of all the equipment shall be carried out as specified in Electrical Specification and as per Regulations.

Distribution Equipment shall comprise all protection equipment for motors and circuits.

These shall include overload protection. Short-circuit protection, single-phasing protection, etc. ad appropriate.

14.11 BUILDERS WORK REQUIREMENTS

The builders work requirements shall be provided by the Contractor as per the requirement of the Lifts Specialist Subcontractor. Such requirements include but are not limited to the following:

a) Scaffolding material, fixing and removal of same in elevator shaft.

b) Fixing of steel separators in elevator shaft with necessary fixing materials, drilling of holes for the same.

c) Hook or lifting beam in machine room and trap door in the machine room floor.

d) Proper ventilation in machine room to maintain the room temperature below 40 degrees Centigrade and humidity below 85 per cent.

e) Adequate 3 Phase power supply and single phase lighting supply with necessary isolators to be decided at Site.

f) Temporary 3 Phase power supply and single phase supply to be provided in elevator machine room, elevator shaft and pit including lighting of elevator shaft during installation, testing and commissioning work.

g) Laborers and crane facility for unloading lift materials from containers and shifting the same to various floors and machine room.

h) Concrete elevator shaft including concrete sill projections, machine room and all the related civil Works in the elevator shaft, entrances, machine room and pit.

i) Safe lockable store room for keeping the elevator equipments on ground floor, near the elevator shaft.

j) A cat ladder in elevator pit and machine room to be provided for access to elevator pit and raised machine room floor.

k) Screening between adjacent elevators in case more than one elevator is in common shaft.

l) Screening the elevator shaft throughout its height in case there is unoccupied space in elevator shaft.

DIVISION 15

MECHANICAL

DIVISION 15: MECHANICAL

PLUMBING, DRAINAGE AND WATER SUPPLY

15.1 SCOPE OF WORKS

15.1.01 This Specification relates to the manufacture Works testing, supply and delivery to Site, erection, connection, Site testing, adjusting and setting to work of all materials, plant and equipment related to the plumbing drainage and water supply systems including but not limited to the following:

a) Above ground soil and waste drainage systems, including sump pumps.

b) Underground drainage system.

c) Water pressurizing equipment; cisterns, water tanks and connection to main water supply from stopcock on Site boundary.

d) Hot and cold water installations.

e) Motor starter and control panels for plant.

f) Automatic control system to systems and plant.

g) Wet riser systems.

h) Thermal and protective insulation of pipework, plant and equipment.

i) Noise suppression measures for plant and equipment.

j) Protective painting of all materials.

k) Identification of all services.

15.1.02 This Specification shall be read in conjunction with the Conditions of Contract and any supplementary Specifications, schedules and Drawings issued by the Consultant. In the event of a discrepancy between the Specification, its related documents and any drawings, the same shall be raised to the Consultant for clarification.

15.1.03 The installation shall be generally in accordance with the relevant British Standards, Codes of Practices and IEE Regulations and shall conform in all respects with the Plumbing, Drainage, Water and Electricity Regulations in force in Sudan for Mechanical and Electrical Installations in Buildings.

15.1.04 All apparatus and wiring shall be suitable for use with a 3-phase 4-wire 240/415 volt 50Hz earthed neutral system.

15.1.05 The work shall comprise the whole of the labour and all the materials necessary to form a complete installation and such tests, adjustments and commissioning as are described in

subsequent clauses, and as may otherwise be required to give an effective working installation to the satisfaction of the Consultant.

15.1.06 A complete installation shall be deemed to mean not only the major items of plant and equipment covered by this Specification, but all incidental sundry components necessary for the completion execution of the Works and for the proper operation of the installation, with their labour charges, whether or not these sundry components are mentioned in detail in the documents issued for the Contract.

15.1.07 The Contractor shall ensure that all plant to be supplied by him can be installed in available space and that there is adequate access to admit all plant to its position and enable maintenance to be carried out on the plant without difficulty.

15.1.08 Drawings General

Unless otherwise indicated, the Contractor shall provide the following drawings:

a) Eight (8) sets of builder's work drawings, within five weeks of acceptance of his tender (to a scale of 1:50).

b) Four sets of detailed plant room drawings (to a scale of 1:50).

c) Four sets of purpose-made diagrams detailing separately all the composite electrical circuit and wiring layouts.

d) Four sets of drawings of any variations to the design suggested by or agreed with the Consultant.

e) Four sets of 'as installed' drawings, colour printed on linen upon completion of the Work and as a condition precedent to the certification by the Consultant that the Work is completed.

15.1.09 Builder's work drawings shall show, fully dimensioned, all foundations, bases, plinths, sumps, holes required and the overall size and weights of the plant concerned.

15.1.10 With the agreement of the Consultant, smaller holes, built-in fixings, etc., other than in plant rooms, may be marked out on Site instead of on drawings.

15.1.11 Composite circuit and layout diagrams for the electrical services shall detail not only all circuitry within main control panels, but also that within all external equipment such as starters and thermostatic control devices together with all interconnecting wiring or pipework from the main point of supply onwards and all terminal markings. The required sizes and types of all cables shall be indicated on the layout diagrams together with the ratings of such items as fuses and switches.

15.1.12 Circuit diagrams shall, where possible, be arranged so that the main sequence of events is from left to right and from top to bottom of the diagram. Symbols for diagrams shall comply generally with BS. 3939 and the Emirate of Sudan Department of Water and Electricity Regulations. If abbreviations are employed for the designation of components, an integral schedule shall be provided on the drawings to explain the meanings of the abbreviations.

15.1.13 The composite diagrams shall subsequently form part of the set of 'as installed' drawings.

15.1.14 Individual circuit and layout drawings from the various component manufacturers will not be accepted in lieu of composite diagrams.

AS INSTALLED DRAWINGS

15.1.15 During the course of the Works, the Contractor shall maintain a fully detailed record of all changes from the Tender Drawings to facilitate easy and accurate preparation of the 'as installed' drawings and to ensure that these drawings are in all respects a true record of the installation.

15.1.16 The drawings shall show the complete installation, including the sizes and runs of all ducts and pipework. The scales shall be such that details, particularly of plant, can be clearly shown. The drawings shall show the names of the manufacturers, model and type numbers, and all details of duty and rating of all items of plant.

15.1.17 A print of each of the composite 'as installed' circuit and layout diagrams shall be fixed securely to the inside of the hinged front of the main electrical control panels as appropriate, or in such other alternative positions as maybe agreed with the Consultant, and shall be protected by non-flammable transparent material. Where inadequate space exists, the prints shall be suitably reduced in size.

OPERATING AND MAINTENANCE INSTRUCTIONS

15.1.18 The Contractor shall demonstrate and explain the plant and the method of starting, running and stopping to such staff as the Consultant shall nominate.

15.1.19 The Contractor shall provide six sets of Operating and Maintenance Instructions which shall be enclosed in durable covers. The Operating and Maintenance Instructions, three of which are to be in English and three in Arabic shall include:

a) a brief outline of the operation of the plant;

b) Instructions on how to start and stop the plant, noting any safety and/or sequencing arrangements;

c) details of required maintenance with suggested frequency of action;

d) details of all lubricating oils and greases required;

e) details of each item of plant including the name and address of the manufacturer, type and model, serial number, duty and rating.

15.1.20 The Operating and Maintenance Instructions shall be handed to the Consultant not later that at the end of the commissioning period.

15.1.21 GENERAL NOTES

a) Drawings are generally diagrammatic and indicative of work to be installed. Run and arrangement of piping, approximately as indicated, subject to modifications as required to suit field conditions and to avoid interference with work of others. Due to small scale of drawings, all required off-sets, fittings, etc., may not be indicated. Refer to and carefully check Architectural Drawings, Structural Drawings, Electrical and Plumbing Drawings and other sections of Contract Drawings and Specifications, and details and arrange work accordingly, furnishing all off-sets, fittings, etc., required to meet conditions, all at no additional cost.

b) Provide all piping required to make apparatus connected, complete and ready for regular and safe operation. Unless otherwise noted, connect all apparatus and equipment in accordance with manufacturer's standard details, as approved.

c) Consult drawings, specifications and manufacturer's data to determine number and requirements of all items of equipment requiring piping connections. Furnish accessory piping, such as vent, drain, relief, etc. wherever equipment is provided with connections for such piping.

d) All hot and cold piping shall be separated by at least six inches. Ample space shall be provided between piping to allow for the proper thickness of pipe covering and/or isolation sleeves. Where not possible to maintain the six inches of separation, adequate physical separation shall be maintained between all system or construction components to prevent accidental physical contact in the event of vibration or normal movement of the systems.

e) Expansion and contraction in piping systems shall be taken care of where necessary by expansion loops, spring pieces or swing joints. Wrought copper sweat fittings shall be used on copper tubing lines at swing joints.

f) Piping shall conform to applicable standards of current specifications of BS or approved equal standards. Reference to specifications of recongnised authorities, to establish basis of

quality, shall mean current edition at date of bidding.

15.2 PIPEWORK INSTALLATION

GENERAL

15.2.01 Pipe materials shall be as specified elsewhere herein. The Contractor shall install unions or pairs of flanges in the pipework system at the following locations:

a) At intervals not greater than 15m.

b) To enable the disconnection of all items of plant, equipment, pumps and valves for maintenance purposes.

c) To enable sections of pipework to be subsequently dismantled and refixed without disturbing other pipework, plant, equipment and building fabric.

d) Where indicated on the drawings.

15.2.02 Pipework shall be run neatly, parallel to walls or grid lines on plan and shall, where necessary, set around columns and projections. All vertical pipes shall be plumb. Direction changes in pipe groups shall be set out from a common centre point.

15.2.03 All screwed and flanged joints shall be easily accessible.

15.2.04 Where pipes are fitted around columns or piers, the direction change shall be made using short sets and shall be supported from the floor on the centre line of the column.

15.2.05 It shall be the responsibility of the Contractor to ensure that the pipework systems are at least 150mm from any electrical conduit, cable or wiring.

15.2.06 Pipes entering or leaving trenches or ducts, shall be square to them. All pipework shall be fixed in such a manner as to be readily accessible for tools, welding operations or removable without dismantling adjacent pipework.

15.2.07 Where pipework passes through walls, etc., the Contractor shall ensure that these pipes are not subsequently bedded-in by making good by other trades.

15.2.08 Pipework passing through brick or concrete shall be enclosed in a steel pipe sleeve of such diameter that the pipe maybe removed without cutting or deforming the pipework. In particular, where plastic pipes pass through a fire rated wall, fire arresting sleeves shall be used with a packing of intumescent strip between the pipe and sleeve.

15.2.09 Pipework passing through internal or external construction walls

shall pass through formed holes of such size that the pipework may be removed without cutting or deforming the pipe.

15.2.10 All holes through such walls shall be closed after the erection and testing of the pipework by means of removable split closing plates on both sides of the wall. All closing plates shall be manufactured from galvanised sheet steel of not less than 16g thickness in the case of brick or concrete walls. All closing plates shall be painted or finished in accordance with the requirements of this Specification.

GRADIENT OF DRAINAGE PIPELINES

15.2.11 All pipework shall be erected in such a manner that air may be vented and liquids drained from the whole or isolated sections of the system. Except where specified elsewere herein, 32mm diameter key-operated cocks with hose unions shall be fitted at all low points of cold water systems to ensure complete drainage.

15.2.12 Pipelines shall be graded to fall in the direction of flow unless indicated otherwise on the drawings or elsewhere herein. The minimum gradient shall be as follows, unless specifically shown on the drawings:

Water 1 in 720

15.2.13 At low points in water pipework systems, all vessels and on the dead side of each pair of isolating valves in the distribution mains, drain points are to be provided in accessible positions. These shall be fitted with drain cocks of a type specified elsewhere herein.

PIPE SUPPORTS

15.2.14 Pipework shall be supported as indicated on the drawings or as required in the specification and in particular on both sides of all changes in direction. Pipework shall be supported such that no load is imposed upon plant machinery. Pipework shall be supported at intervals not exceeding the following:

15.2.15 Cast Iron, Steel or heavy gauge copper pipework.

(15mm)	-	(1.80m)
(20mm)	-	(2.50m)
(25mm)	-	(2.75m)
(32mm)	-	(2.75m)
(40mm)	-	(3.00m)
(50mm)	-	(3.00m)
(65mm)	-	(3.60m)
(80mm)	-	(3.60m)
(100mm)	-	(4.50m)

(150mm) & above at intervals not exceeding the recommendations of
BS. 3974.

15.2.16 Steel, light gauge copper Plastic Water pipework

(15mm)	-	(1.2m)	(15 to 50)	-	(1.05m)
(20mm)	-	(1.5m)	(65)	-	(1.20m)
(25mm)	-	(1.8m)	(80)	-	(1.35m)
(32mm)	-	(2.2m)	(100)	-	(1.50m)
(40mm)	-	(2.5m)	(150)	-	(2.00m)
(50mm)	-	(2.7m)	(200)	-	(2.40m)
(80mm)	-	(2.7m)			
(100mm) & over		(3.0m)			

All pipe supports shall be manufactured in accordance with BS 3974.

PIPE EXPANSION

15.2.17 Pipework shall be supported in such a manner as to permit free movement due to expansion and contraction. Pipework supports shall be arranged as near as possible to joints and changes in direction and each support shall take its share of the load. The spacing of the supports shall not exceed the centres given elsewhere herein. Where there are two or more pipes the support spacings may be based on the centres required by the smallest bore pipework.

15.2.18 Vertical rising pipework shall be supported at the base or as indicated to carry the total weight of the riser. Branches from risers shall not be used as a means of support for the riser.

15.2.19 Provision for movement due to expansion and contraction shall be made either by loops, special expansion joints or by changes in direction of the pipework. Supports at such points shall be arranged to ensure that all movement is taken up by the loop, jont or change in direction of the pipework.

AIR VENTING

15.2.20 Automatic air eliminators shall be provided at all high points in water pipework system. They shall be installed at the highest points of the sections they are intended to vent.

Insect screen shall be provided on all open vents and overflows.

15.2.21 Air vents on water systems shall be of float type, air eliminator of approved manufacture, having bottom inlet and top outlet with screwed connections. They shall have a stainless steel float valve and valve seat, incorporate a stainless steel check valve and shall be so designed as to allow the internal parts to be removed for

maintenance or inspection without disturbing pipework. Air vents shall be suitable for the system pressures and temperatures. An air release pipe shall be connected to the air outlet and taken to the nearest suitable discharge point.

ANTI WATER HAMMER CUSHIONS

15.2.22 In all open circuit water systems there shall be a series of water hammer cushions or reverse dead-legs in each branch connection and in particular each vertical branch or pipe run.

15.2.23 These cushions shall comprise a branch in the pipe with vertical connection not less than 300mm high above the centre line of the branch. This connection shall be sealed at the top, thus trapping a pocket of air to act as a cushion.

PUDDLE FLANGES

15.2.24 Where pipework passes through the external walls of the buildings or trenches below ground level, the Contractor shall supply, cast or build puddle flanges into the structure.

15.2.25 Puddle flanges are to be manufactured from the same material as the pipework of which they form a part.

15.2.26 Each puddle flange shall comprise a length of pipe, flanged or screwed at each end according to diameter with an undrilled slip-on flange welded on the outside at a point where it will be located mid-way in the thickness of the wall. The puddle flange is to be painted externally with two coats of bituminous paint before being built into the structure.

WELDING OF PIPRWORK

15.2.27 All welds shall be in accordance with the relevant Piping Design Code given elsewhere herein. Methods, other than those covered by the standards, may be used provided that their suitability is demonstrated and that their use is the subject of agreement with the Consultant.

TESTING OF PIPED SERVICES

15.2.28 All pressure tests on the pipework installations shall be carried out in sections as the work proceeds, to suit the general construction programme. All isolation and other temporary Works shall be carried out by the Contractor at no additional cost. The whole of the testing gear required, including all plugs, tees and drain fittings, shall be supplied by the Contractor.

15.2.29 Upon completion of each section of pipework, or as otherwise

directed and by arrangement with the Consultant, the Contractor shall subject the section to a static pressure test to demonstrate that the section is sound.

15.2.30 All water service pipework shall be tested by filling the section with water and raising its pressure to the figure specified later herein.

15.2.31 The section of pipework under test shall then be left without further strokes of the pump and all joints should remain tight for a period of at least twenty four hours. The Consultant's decision as to whether or not the section is sound, as governed by the rate at which the pressure falls, shall be final.

15.2.32 Any faults discovered during such test shall at once be remedied by the Contractor at his own expense and the test re-applied until the section under test is sound.

15.2.33 On completion of the test, the water is to be released and drained completely away as rapidly as possible and the section then thoroughly sluiced through to ensure the removal of as much dirt and dross as possible.

15.2.34 The Contractor shall take all necessary precautions against damage during testing.

15.2.35 Any damage resulting from failure on the part of the Contractor to take the necessary precautions shall be made good at no additional expense.

15.2.36 Al cold water services shall be tested hydrostatically to a pressure equal to twice the working pressure maintained for a period of twenty four hours.

BRANCHES

15.2.37 All branches from mains shall be taken in such a manner as to facilitate the venting of air and the drainage of liquid from the pipework.

15.2.38 Branches shall be welded to the pipes in accordance with the specified Piping Design Code.

15.2.39 Each installation shall be fully commissioned. Commissioning shall include the balancing and regulation of the water distribution system and the final adjustment of control system in accordance with the Commissioning Code (Series W) "Water Distribution Systems" as published by the British Chartered Institution of Building Services or an equally approved code.

CLEANING AND PROTECTION

15.2.40 The condition of pipes shall meet the requirements of the specified Piping Design Code.

15.2.41 The Contractor shall ensure that all pipework and fittings delivered to the Site for inclusion in the Works are stored in an approved manner to avoid deterioration due to accidental damage and atmospheric conditions.

15.2.42 Any part of the pipework installation which, in the opinion of the Consultant, is sub-standard, unduly distorted, marked by tools or in a deteriorated condition shall be removed and replaced at the expense of the Contractor.

15.2.43 Before final erection, all pipework, shall be free of scale, rust, oil or other forms of corrosion. Such defects shall be removed and the pipework made good in a manner approved by the Consultant. Any stoppage or restriction occurring after the pipework systems have been put into operation which is attributable to neglect by the Contractor shall be rectified by the Contractor at his own expense.

15.2.44 Prior to fabrication, all areas likely to become inaccessible shall be given one coat of high build phosphate primer paint.

15.2.45 The open ends of all ferrous pipes (excluding stainless steel) prepared for welding, shall be protected by plastic plugs. Plugs of paper, cardboard, cotton waste, hessian or similar material will not be permitted.

15.2.46 Open ends of all ferrous pipes intended for threading shall be provided with either a protective cap or screwed socket to protect the threaded ends of pipe in addition to the plastic plug.

VALVES

15.2.47 Valves shall be provided to isolate each item of plant and each main branch.

15.2.48 The Contractor shall make all reasonable attempts to ensure the manufacture of valves is consistent throughout the whole of the installation in order to minimize stock holding of spares.

15.2.49 Valves and cocks of any tank or vessel not within a secure building shall be lockable.

15.2.50 Any valves and cocks exposed to public view, shall be of the easy, clean pattern and have a polished finish.

15.2.51 Valves in plant room, tank rooms etc., shall be of the handwheel

pattern.

15.2.52 Control valves shall be located so as to provide easy access for manual operation and servicing. Control valves shall normally be installed in horizontal lines with stems vertical.

15.2.53 Each such regulating valve shall be fitted with a regulation indicator calibrated in tenths of one revolution of the handwheel.

15.2.54 Ball, Globe and oblique valves shall be used on service pipelines where regulation is required, and shall be supplied and fitted in positions indicated on the Contract Drawings. Valves shall be of the same nominal bore as the pipeline in which they are indicated.

15.2.55 Globe and oblique valves used for circuit regulation shall have characterized plug discs.

15.2.56 Handwheels shall be designed for operation at a temperature suitable for safe handling. They shall be of the open wheel type manufactured from malleable iron or die cast aluminium alloy. Handles shall have 'open/shut' direction indication.

15.2.57 Stopcocks shall be fitted to each sanitary fitting or groups of fittings as shown on the drawings.

WORK TESTS

15.2.58 All valves shall be subjected to a pressure test prior to leaving the manufacturer's Works. Valves shall be tested from both sides.

STRAINERS

15.2.59 The Contractor shall install strainers in the pipeline before the following items of equipment:

a) Pressure reducing valves.
b) Solenoid valves.
c) Automatically controlled valves.
d) Pumps.

15.2.60 Strainers shall be suitable for withstanding the maximum operating temperature and pressure of the pipeline in which they are installed.

CAST IRON Y-TYPE STRAINERS

15.2.61 The strainers shall be of the cast iron straight Y-Type.

15.2.62 The strainers shall be complete with cast iron body and cap steel screen rods and standard perforated stainless steel screens unless otherwise indicated on the drawings or elsewhere herein.

Connections shall be as described elsewhere herein.

CAST IRON BASKET FILTERS

15.2.63 The strainer shall be complete with cast iron body and quick release cover to BS. 1452-14, perforated stainless steel basket to BS. 970 EN58J with mesh.

15.3 SOIL, WASTE, VENT AND STORM WATER SYSTEM

15.3.01 PIPE WORK GENERALLY

a) Vent pipes shall extend through roof and terminate 1500mm above it. Vent pipes passage through the roof shall be made watertight by proper flashing.

b) All changers of direction shall be gradual and not abrupt, 45 degree fittings shall be used wherever possible, and 90 degree fittings shall be of the longsweep type. All unnecessary turns and off sets shall be carefully avoided, and run as directly as possible from the sanitary fixtures to the vertical stacks.

c) Concealed pipes shall be installed in such a manner as to permit easy accessibility for maintenance. This applies particularly to valve locations.

d) All pipes shall be fixed in neatly arranged lines, and adequately pitched horizontal lines to allow the system to be properly vented and drained. Air pockets, traps and sags shall be carefully avoided.

e) Supports, clamps and hangers shall be made of galvanized steel, fixed with drilled plugs. Cutting and pinning of fixings will not be permitted.

15.3.02 CLEANOUTS ON SOIL, WASTE, VENT AND STROM WATER INSTALLATION

a) Cleanouts shall be installed at each change of direction of drainage pipes, greater that 45 degrees, inside the building, and where indicated on the drawings. Cleanouts shall be not more than 10m apart in horizontal lines. A cleanout shall be provided at or near the foot of each vertical waste or soil stack.

b) Cleanouts on concealed piping shall be extended through and terminate flush with finished wall or floor. Pits or chases may be left in the wall or floor, provided they are of sufficient size to permit removal of the cleanout plug and proper cleaning of the system.

c) Where it is necessary to conceal a cleanout plug, a chrome plated, brass covering plate shall be provided, which will permit ready access to the plug.

d) Cleanout plugs shall be of heavy cast brass, of the screwed

type.

e) Cleanouts shall be of the same nominal size as the pipes up to 100mm pipe diameter and not less than 100mm for larger piping.

f) Cleanouts shall be so installed that there is a clearance of not less than 45cm for the purpose of rodding and cleaning.

15.3.03 MATERIAL

a) Soil, waste, vent and rain water pipes inside the building shall be UPVC pipes as manufactured by National Plastics or approved equal.

b) Soil, waste and rain water pipes buried under ground up to manhole shall be UPVC Class E.

c) Sewage pipes between manholes shall be of vitrified clay pipes, covered with concrete.

d) All pipes subject to traffic specially under roads shall be covered with reinforced concrete.

15.3.04 INSTALLATION

a) Storm Drainage: Provide a complete system of storm drainage piping for all roofs, set-back areas and canopies.

b) Sanitary Drainage: Provide a complete system of sanitary drainage piping for plumbing fixtures, kitchen wastes, air conditioning wastes, etc., the like from ground level which can be connected to the city drainage scheme.

c) Vent piping: Provide ventilating pipes from the various sanitary plumbing fixtures and other equipment to which drainage connections are made.

d) The storm, sanitary and vent piping shall be as shown on the drawings, as specified herein and in accordance with the local authorities.

e) Take special care in setting roof drains to ensure that they are set at an elevation which will preclude formation of puddles.

f) Install connections to roof drains in conjunction with the roofing specified under another section of the Specifications and at such times as designated by another section of the Specifications, so that the building is adequately protected during construction from damage by storm water.

g) Do not use short radius bends, use short “Tee-Wye” fittings in vertical piping only.

h) Provide cleanouts at foot of all stacks, changes of directions, at the ends of branch runs, in straight runs as required and where indicated. Terminate as specified under “Cleanouts”.

i) Run building drains at a minimum grade of 2% (1:50) pitch unless otherwise noted, downward in the direction of flow. Pitch branch connections to stacks from fixtures at 2% (1:50) where possible.

j) Provide all the required appurtenances to make the drainage system complete in compliance with Code requirements including traps, pipe fittings, hangers, and the like.

k) Wherever possible, vent stack offsets shall be made with 45 degree fittings.

l) Extend the tops of ventilating stacks independently through the roof or collect together and run through the roof in series of larger pipes, as shown on the drawings.

m) Any piping passing through roofs shall be so arranged as to be a minimum of 300mm (1ft.) from walls or other obstructions so as to permit proper flashings which are provided by another trade.

15.3.05 FLOOR DRAINS

a) Floor drains shall have HDPE traps of a minimum water seal of 7cm, and shall be provided with adjustable and removable strainers. The open area of strainer shall be at least two thirds of the cross-sectional area of the drain line to which it connects.

b) Floor drains shall have brass, chrome plated floor plates connected to the HDPE trap, with a removable strainer and cover plate. Floor drains shall have a built-in rodding eye.

15.3.06 ROOF DRAIN

Roof drain and open to sky drains shall be HDPE of Dome type connected to the rain water pipe without any trap. Size of drain shall be as per drawings.

15.3.07 GREASE INTERCEPTORS

Each grease interceptor shall be suitable for a flow rate of 50 GPM with a grease capacity of 100 lbs. The interceptor shall be complete with hydrofilter and baffle assembly, deep seal trap, actimatic mixing chamber with dial thermometer and combined cover securing handle and actimatic mixture inlet valve, 2lb container of actimatic powder with labeled operating instructions and with non skid polished aluminium rectangular frame and cover.

15.3.08 CHANNEL GRATING

Channel grating shall be of heavy duty cast iron construction to the sizes shown

on drawings. The channel grating shall be set on angle frame of the same construction all to the relevant British Standard.

EXTERNAL DRAINAGE PIPES

15.3.09 GENERAL REQUIREMENTS

a) Pipe connections to manholes, septic tanks and percolating pits shall be made in a completely watertight and approved manner.

b) Pipes shall be kept clean until final acceptance of the work. Exposed ends of all incomplete lines shall be closed with wooden plugs and adequately secured at all times when pipe laying is not actually in progress.

c) Pipes shall be installed on a good foundation and adequate means taken to prevent settlement. Pipes laid in trenches shall be provided with a solid uniform bearing throughout their entire length.

d) Pipes shall not be buried at less than 60cm below finished grade for protection against mechanical damage. Pipes shall not be run closer than 1m to building bearing walls and footings for protection against building settlement.

e) All pipes shall be laid to a uniform slope of 1% minimum. Slopes shall be limited to 3% maximum. The free vertical drop of a sewer pipe into a manhole shall be limited to 45cm between the invert level of the pipe opening and the bottom of the manhole. Where conditions necessitate that the drop would exceed 45cm at the maximum slope of 3% a drop manhole shall be used.

f) Trenches shall be kept free of water by pumping, use of well points, underdrains or other approved means during pipe laying operations so that all pipe joints are made in the dry.

g) Precautions shall be taken to protect incomplete work from floating due to storms or from any other cause. All pipe lines or structures not stable against uplift during construction shall be well braced or otherwise protected.

h) All completed underground lines shall be subject to the inspection and approval of the Consultant. All pipes shall be true to line and grade. The full circle of the pipe shall be visible at the manholes. All pipes shall be tested and inspected as described under TESTING, BALANCING AND ADJUSTING.

15.3.10 DRAIN PIPING

a) All drain pipes and fittings shall be vitrified clay pipes and fittings with push-fit flexible joints to British Standards 65 and 540 extra strength quality of the sizes and to gradients shown on the drawings, with all necessary bends, junctions etc.

b) Set out all drains, in accordance with the issued drawings, and provide all profiles etc., as may be necessary for the proper

execution for the Works.

c) The drains shall be laid truly straight in line and to an even gradient.

d) Excavations shall be made true and even to falls, the bottoms being trimmed to correct level and well rammed. Remove mud, rock projections, boulders and hard spots and replace with approved fill material well consolidated.

e) Minimum width of trench shall be 300mm greater than external diameter of pipe.

f) Any trenches excavated in error to a greater depth than required shall be in-filled back to the required level with concrete mix, at the Contractor's expense.

g) Before laying, all pipes and components shall be checked for defects and joint spaces cleared of dirt.

h) Bed the vitrified clay drain pipes of the sizes and to the gradients shown on the issued drawings, with all necessary bends, junctions, etc. Socketted pipes to be laid with sockets uphill.

i) Flexible joints shall be made in strict accordance with manufacturer's instructions.

j) Where lubrication of the joint is required, the pipe manufacturer's recommended lubricant shall only be used.

k) Spigot and socket cement joints where required shall be made with ring of tarred gasket well caulked in socket and remaining socket space filled with 1:3 cement mortar, finished in 45 deg. Fillet.

l) Lay and compact bed of granular material to provide 100mm thickness over the full width of the trench. Scoop out locally at pipe sockets where socketted pipes are used. Adjust pipes to line and level and ensure that pipe barrels rest uniformly on the bedding.

m) Add granular side fill uniformly up each side of pipes compacting by hand.

n) Any trench sheeting should be lifted before the fill is compacted.

o) The granular material shall be compacted in 100mm layers by hand up to 100mm minimum distance above top of pipes.

p) Granular material shall be locally available crushed rock graded in relation to pipe size as follows:

10mm	nominal size aggregate	-	100mm dia. pipes
10 or 14mm	ditto	-	150mm dia. pipes
10,14 or 20mm	ditto	-	200mm dia. pipes & above.

q) During bad weather, or in wet fine grained soils such as clays, silts or sands, it is important to prevent the trench bottom being churned up by men working in the trench. In such cases a blanket of granular

material 75mm thick laid over the trench bottom immediately after excavation, or alternatively a sealing layer of weak concrete 50mm thick, is required.

r) Provide concrete bed Grade A (CP 301 Table 1 Specified Works Cube Strength at 21N/mm^2 at 28 days) to drain pipes and concrete infill (Concrete Mix 1:15) where drain track is below level of bottom of foundation base and within 900mm horizontal distance from foundation base. The concrete infill is to be carried upon to level of the bottom of the foundation base.

s) Drain tracks beyond 900mm of adjacent foundations and where the bottom of the trench is lower than a depth beneath the foundation equal to the horizontal distance between the nearside of the trench and the foundation less 150mm, shall be infilled with concrete upto that depth.

t) Concrete bed and surround shall incorporate movement joints at each drain pipe joint.

u) Each joint shall form a plane surface in the concrete above and below the drain and vertical to the drain and centre line, and shall separate the lengths of concrete with 13mm thick resilient fibre board or expanded polystyrene pre-cut to pipe diameter and concrete cross-section height and width and left insitu.

v) Drains below roadways, car parks, and any area subject to vehicular traffic where less than 900mm of cover, shall be bedded and surrounded with concrete Grade 'A' (CP 301 Table 1 Specified Works Cube Strength at 21N/mm at 28 days) 150mm minimum thickness all round with provision for movement joints.

w) Granular fill shall be laid in 100mm layers and hand compacted to a level 300mm minimum above top of pipe followed by main backfill material placed and compacted in 300mm layers, any trench sheeting being withdrawn as the work proceeds. Heavy mechanical compactors shall not be used until there is at least 300mm cover over the pipes.

x) Construction vehicles shall not be allowed to cross drain trenches until the final surface is placed except where timber sleepers or steel plates are positioned to bridge the trench.

15.3.11 MANHOLES

a) Internal manholes will be constructed insitu as part of the concrete ground floor slab. Channels and ¾ section branch bends shall comply with BS. 65 and 540. Concrete benching between the branch channel, shall be trowelled smooth and sloped towards the main channel at a slope of not less than 1:12. Step irons shall be built into the walls of all manholes of more than 1 metre depth. Step irons shall be staggered 300mm apart on plan and 300mm vertically.

b) External manholes shall be constructed as shown on drawings or

described elsewhere from reinforced concrete to the given thickness or from rendered concrete blocks, built to give a wall thickness of no less than 225mm. The base slab shall be 150mm thick concrete, and cover slab 250mm thick and reinforced. The manhole shall be of rendered watertight construction. Channels, benching and step irons shall be as previously described for internal manholes.

c) Sewage interceptor chamber (if any) shall be constructed of 1800mm diameter precast concrete sections depth as indicated on drawings but to be not less than 1m below invert of lowest pipe entering chamber.

d) Internal manhole covers shall be bolt-down, airtight, double seal, double covers.

e) Covers are to be insitu concrete filled, with surface finish to match surrounding floor. All covers are to be medium duty, locking and sealed, with a clear opening of 600 x 600mm.

f) External manholes subject to vehicular traffic shall be single seal, solid top heavy duty, with a clear opening of 600 x 600mm. Covers to be complete with lifting key-holes, and generally constructed in accordance with BS. 497:67.

g) External manholes subject to pedestrain traffic only shall be as previously described but ‘light duty’.

15.3.12 TESTING OF DRAINAGE AND VENT PIPE SYSTEMS

a) Before the sanitary fixtures are installed, drainage and vent pipe systems shall be subjected to a water pressure test to ensure and prove their tightness and to a flow test to ensure their freedom from obstructions.

b) The water pressure test shall be applied to the system in its entirety or in sections. All openings in the piping shall be tightly closed with special cast iron pipe plugs or other suitable means and the system filled with water to the point of overflow from the highest opening. The plugs shall be temporarily opened to make sure that all air has been vented and that water has reached all parts of the system.

c) No section shall be tested to less than a 3 metre head of water. In testing successive sections at least the upper 3 metres of the next preceding section shall be tested so that no joint or pipe, except the uppermost 3 metres of the whole system, shall have been subjected to a test of less than a 3 metre head of water.

d) The water shall be kept in the system or in the portion under test for at least 24 hours before inspection starts. While the system is under pressure, a careful inspection shall be made of all pipes and joints and if any leaks in joints or evidence of defective pipe or fitting is disclosed the defective work shall be corrected immediately by replacing defective parts with new joints and materials. No makeshift

repairs or application of any repair compound will be permitted.

e) Underground drainage pipes shall be tested by plugging the end of the pipe and filling with water to a minimum head of 3 metres. The test pressure shall be maintained for 24 hours. Pipes and joints shall be inspected and approved before backfilling the trench.

f) All drainage systems shall be tested for proper flow to ensure their freedom from any obstruction. The Contractor shall disassemble, clear, repair and re-assemble obstructed piping at his own expense. After re-assembly the piping shall again be subjected to the pressure test.

15.4 GENERAL DESCRIPTION OF PLUMBING SCHEMES

15.4.01 DOMESTIC COLD WATER SYSTEM

The system shall comprise the following:

a) Underground concrete water tank of adequate capacity as shown on the plans sufficient for domestic and fire fighting purposes. Internal part shall be constructed to ensure proper circulation and that water shall not be stagnant for a long time.

b) One packaged booster pump set having two pumps (one duty and one stand-by) and each capable of delivering 100% of the required water supply quantity. The pumpset shall be complete with control panel and all accessories. Cold water supply from the overhead tank to the various floors shall be gravity fed through a filtration system. The upper floor however shall have pressurized water supply through booster pumps.

c) Cold water network of UPVC Class E pipes to BS 3505 with fittings to BS 4346. Piping shall be complete in all respects with valves, fittings and related works.

15.4.02 DOMESTIC HOT WATER SYSTEM

The system shall comprise the following:

a) Individual water heaters of the horizontal ceiling suspended type as shown on the drawings.

b) Hot water piping network of copper pipes to BS.2781 Part 1, Table X. All piping shall be insulated.

15.4.03 FIRE FIGHTING SYSTEM

The system shall comprise the following:

a) Fire fighting water storage tank (combined with domestic water storage tank).

b) Wet riser pump package comprising:

1. Main electric fire pump.
2. Main diesel driven fire pump.

3. Jockey pump, electric driven.
4. Fire fighting pump control panel.

c) Wet riser piping network of seamless galvanised steel pipes type schedule 40 to ASTM A120 complete with all the fittings, valves and expansion joints.

d) Fire stations in different locations of the building including the following:

1. Fire engine inlet siamese connection connected to the main network via gate valve and check valve.
2. Landing valves.
3. CO_2 fire extinguishers.
4. Dry Powder fire extinguishers.

e) Fire detection and alarm system specified under Electrical Part of this Specification.

15.5 COLD AND HOT WATER SYSTEMS

PARTICULAR REQUIREMENTS

15.5.01 MATERIAL

a) Cold water distribution pipes shall be UPVC to BS 3505 Class E with solvent welded joints to fittings complying complying with BS 4346.

b) The UPVC pipework components should, at all times, be stored in a location offering protection from direct sunlight, i.e. from ultra violet light and the associated heating effect, it being remembered that materials close to the ground will be heated by reflection in sandy locations.

1. The storage Site should be flat, level and free from sharp stones, flints, etc.
2. Pipes should not be stacked to heights exceeding the following:

Pipe Size (Inch/m)		Max. Stacking Height
Up to 3 in	or 90mm	10 x pipe size
4 – 6 in	or 110-160mm	6 x pipe size
8 in	or 200mm or greater	4 x pipe size

3. UPVC pipes should be protected from direct sunlight and heat of the sun by providing shaded areas.

c) UPVC pipe jointing sequence shall be carried out as per the written recommendations of the manufacturer and it must be stated that any omission or variation from the jointing procedure will result in a

marked reduction in the efficiency of the joint. It is essential in the jointing process that only cleaner and solvent cement recommended by the manufacturer is used to make joints.

d) When making a joint in high ambient temperature conditions the following should be observed:

1. Store the cement in a cool shady place.
2. When possible protect the pipe which is about to be installed from direct sunlight.

e) Boosted cold water pipework from booster pumps to overhead storage tank shall be UPVC class E pipes.

f) Hot water distribution pipes shall be copper to BS 2871 Part I, Table X with soldered connections.

15.5.02 PIPE WORKMANSHIP

a) UPVC Pipes shall be protected from direct sunlight. Where pipes are exposed to sunlight, it should be painted by a Titanium Dioxide based industrial quality white paint and **NOT** of the cellulose type. Pipes shall be lightly abraded, cleaned, wiped with white spirit and painted with white under coat and followed by white gloss paint.

b) Where exposed to sunlight, UPVC pipes shall be insulated with moulded sections mineral wool or fibre glass, 40mm thick and covered with 2 heavy canvas layers embedded in sealing agent while wet.

c) After drying it shall be painted with approved paint of oil base.

d) Hot water pipes shall be copper tube to BS.2871 Part I Table X, Specifications Code (p 401& 402) or equivalent approved standards. Copper pipe work shall be jointed by capillary or soldered connections. Joints to sanitary fittings, valves etc., shall be made with brass compression unions. Soldering shall be copper phosphorus 40% silver solder. Dielectric joint with neoprene or similar insulator shall be fitted at junctions between copper and galvanised steel. Direct joints between copper and steel will not be permitted.

e) The water supply system shall be complete with all pipe fittings, valves, metres, cisterns, water treatments, booster pumping equipment, mains, risers, heaters, pressure and temperature controls, protective painting, insulation tests, and the like, all as shown on the drawings, as specified herein and in accordance with the authorities having jurisdiction.

f) The system shall include the required metres and metre

accessories. Make all arrangements with the Local Water Authorities and include all costs, if required, at no additional cost.

g) Hot Water: Make required provisions in hot water system for pipe expansion, air elimination, protection against excess pressure and system noise.

h) Pipe the discharge of all air relief valves to funnels, floor drain or as indicated on the drawings.

i) Install approved type vacuum breakers on all equipment and fixture connections required by Code, indicated on the drawings, as specified, or as required for the proper functioning of the equipment. Provide all hose threaded faucets inside of the building with a check valve.

j) Provide all supply lines to bidets with check valves.

k) Provide cold water supply to water heaters with check valves.

l) Where hot and cold water supply pipes connect to a combination supply fitting with a shut-off valve on its discharge, or the combination supply fitting is equipped with manual or thermostatic mixing valve, equip each hot and cold water supply pipe with a composition disc, swing check valve ahead of the supply fitting.

m) Provide at all water points, such as lavatory basins, WC, hose taps, etc., with stop cocks which shall be adjusted so that the taps, ball valves, etc., operate quietly and efficiently before final acceptance by the Consultant.

15.5.03 INSULATIN TO HOT WATER SERVICE PIPES

Insulation to hot water service pipes shall be done by the following types:

a) Performed sections of rigid mineral wool fixed to pipe work with galvanised wire bands at 300mm spacing and covered with heavy duty canvas strips spirally wound. The canvas shall be thoroughly soaked in sealer before application and applied whilst still wet.

When dry the canvas shall be painted one coat of oil paint and exposed ends of insulation shall be trimmed with bands of 40mm wide aluminium. Valves and the like shall not be insulated.

b) In case of exposed pipes as in (a) in addition, one coat of vapour barrier, one coat of bituminous paint and a protective covering of aluminium sheet which shall be wound around the insulation and jointed with pop rivets.

c) Thickness of insulation for Domestic Hot Water Pipes:

Declared thermal conductivity (W/mK)

Up to 0.040	.041 to 0.055	0.056 to 0.070

Size of tube (mm)	Minimum Thickness of Insulation		
15 to 32	25	25	25
32 to 80	32	32	32
100 to 150	50	50	50

15.5.04 MAIN COLD WATER SUPPLY PIPE

The Contractor shall furnish and install the main water supply pipe from the water metre box close to the boundary line as shown on the Drawings. The main shall be buried with a minimum cover of 1000mm.

15.5.05 G.R.P. STORAGE TANKS

This Section covers the supply, delivery, installation, testing, commissioning and leaving in complete working order water storage tanks and cisterns, as indicated on the Contract Drawings and described below:

a) Cisterns and tanks shall be of glass reinforced plastic construction.

b) Each cistern shall be provided with a heavy duty cover formed from standard panels and complete with manholes and vent.

c) The termination of vent pipes into cisterns and tanks shall permit easy removal of the covers.

d) Tanks shall be of the type and capacity shown on the drawings.

e) Jointing materials shall be suitable for the liquid to be stored. In the case of drinking water, jointing materials shall be of a non-toxic nature.

f) All facilities for pipe connection shall be made at the manufacturer's Works. Pipe connections for up to 50mm nominal bore pipework shall be BSP screwed sockets. Pipe connections for pipework 65mm nominal bore and above shall be studded pads suitable to receive counter flanges to BS.10.

g) Where shown tanks shall be divided into equal compartments using standard panels and components. Divisions shall be stayed to enable one compartment of the tank to be emptied whilst the other compartment is in service.

h) All tank covers shall be provided with purpose made manholes of a minimum diameter of 458mm with hinged or bolted lids. Where tanks are provided with internal ladders separate manholes shall be provided to the ladder and to the ball float valve or float switch. Tanks with no internal ladder shall be provided with one manhole positioned to allow access both to the tank interior and to the ball float valve.

i) Tank cover(s) shall also be provided with cowls to adequately ventilate the interior.

j) Tanks 2000mm deep and over shall be provided with internal S.S. and external mild steel access ladders suitably protected against corrosion and bolted to the tank walls. In elevated positions external tank ladders shall be fitted with safety hoops.

k) Each cistern or tank shall be fitted with a ball float valve. Ball float valves shall be of the sizes indicated and suited to the pressure available.

l) Overflow pipes shall be twice the bore of the ball valve fitted or 32mm size, whichever is the greater. Overflow pipes shall be run to discharge outside the building via floor gully to the nearest manhole.

m) Vent cowls and overflows shall be fitted with a suitable gauze screen to prevent insects and vermin from entering the tank.

n) The tanks shall be sectional pattern, glass reinforced plastic manufactured by the hot press moulded process, constructed with plain diaphragmed panels 1m square.

o) Tanks to have heavy duty covers with hinged ventilated cover. Jointing of panels to be with flexible sealing strip and stainless steel bolts. External support of tanks in excess of 1.84m deep shall be formed from rolled I-section to BS.4, hot dipped galvanised to BS.729. The design of the corsetry is to comply with BS.449.

p) All tanks shall be assembled on the supporting bases in accordance with the manufacturer's instructions, using torque wrenches to prevent damage to the sections due to over-tightening of nuts and bolts.

q) Detailed construction drawings of all tanks shall be submitted to the Consultant for approval prior to manufacture.

r) The Contractor shall provide and install a layer of bituminised felt for insertion between the tank and its supports.

15.5.06 COMMISSIONING AND TESTING OF CISTERNS AND TANKS

a) All tanks operating at atmospheric pressure shall be tested under "Tank Full" conditions for tightness and structural soundness.

b) All cold water tanks shall be subject to a standing leak test for twenty four hours, during which time all joints shall be carefully examined. Any defects shall be rectified immediately and the test repeated.

15.5.07 G.R.P. TANKS (PARTICULAR SPECIFICATIONS)

The Contractor shall supply and assemble at Site sectional water tank of hot pressed moulded GRP insulated panels (Glass Reinforced Plastic) of ivory or gray colour provided with lockable

manhole cover air vent with overflow and all piping connections. The panels shall have convex shape to assist a complete draining of water of the following characteristics:

a) Specific gravity of 1.8

b) Tensile strength of not less than 850 kg/cm^2.

c) Flexural strength of 1600 kg/cm^2.

d) Impact strength of 50 kg-cm/cm^2.

e) Thermal expansion of 2.1 x 10^{-5} per deg. C.

f) Thermal conductivity of 0.02 kcal/m.hr deg. C. (insulated panel with polythene foam between the G.R.P. single panel & G.R.P. cover for the sides and bottom of the tank).

g) Water absorption less than 0.2%

h) Glass content more than 30%

i) No light transmission

j) Gasket of synthetic rubber

k) Bolts and nuts of stainless steel

l) Frame angles and frame plates of hot dipped galvanised steel.

m) External ladder of hot dipped galvanised steel.

n) Internal ladder of rigid UPVC or S.S. according to Manufacturer's standards.

o) Tie rods of stainless steel.

p) G.R.P panel thickness not less than 8mm.

q) Insulation of 25mm.

r) Resin cover of 2mm.

15.5.08 PARTICULAR TANK ACCESSORIES

a) Mechanical water level indicator:

An approved type of glass tube level indicator shall be provided for all storage tanks and cisterns.

b) Electrical Water Level Controller:

Shall be provided for storage tanks when required. It shall actuate a solenoid valve or a motor starter as the case may be. Control relay and probe housing shall be enclosed in approved anti-corrosive enclosures.

c) Vortex Inhibitor (at Fire Pump Intake):

An approved pattern vortex inhibitor shall be fitted within the storage tank at the start of the suction pipe. The inhibitor shall prevent a vortex within the tank and be used to overcome a large

'deadwater' area at the bottom of the tank.

15.5.09 VALVES

a) Globe valves upto 65mm dia shall have threaded ends with bronze body and trim screwed (Renewable seat and disc), screwed bonnet suitable for re-packing under pressure. Globe valves 80mm and larger shall be bronze body, bronze Trime Flanged, Outside screw and yoke, renewable seat and disc.

b) Gate valves upto 65mm dia. Shall be bronze pattern with threaded ends screw gun metal wedge disc for rising stem type and hollow disc for non rising stem. Gate valves above 65mm dia. shall be flanged bronze, bronze trime wedge disc type complete with hand wheels, bolted bonnet and stuffing box. Valve stem shall be manganese bronze and seats shall have shouldered seal rings of bronze screwed into the valve body.

c) Check valves upto 65mm dia. shall be threaded bronze pattern swing type with renewable leather disc and screw-in cap. Above 65mm dia. shall be flanged bronze swing type with renewable seat and disc components.

d) Pressure reducing valves shall be of brass construction with spring chamber and regulating handles fitted with integral strainer. A pressure gauge shall be fitted when specified.

e) Valves shall always be installed in accessible locations to permit easy operation and maintenance.

f) Special care must be exercised in the installation of screwed valves to avoid straining their bodies, and preventing the gate or seat from closing tight. The wrench shall always be applied to the side being attached to the valve. When attaching pipe to a valve already in place, a second wrench shall be used to hold the valve while the pipe is being tightened. A pipe shall not be screwed so far into a valve as to damage the seat.

g) Valves shall be suitable for the following working pressures:

Boosted cold water services (300 psi)	-	20	bar
Hot and cold water services preceding the PRV (260 psi)	-	16	bar
Hot and cold water services after the PRV (125 psi)	-	8	bar

15.6 FIRE FIGHTING EQUIPMENT

The Contract Works shall include fire protection pripework and equipment as specified herein and as shown on the drawings.

15.6.01 WET RISING MAIN (FIRE)

a) INTRODUCTION:

The vertical wet rising main is fitted with landing valves on each storey including the roof and is intended to be used only by the Fire Brigade.

b) CONSTRUCTION:

The piping system should be as straight as possible. Necessary changes of direction should be made with standard bends, springs or long turn fittings; elbows should not be used.

The piping system should be of galvanised wrought steel piping to ASTM A120 sch 40 screwed and socketed. The fittings should be of malleable iron or wrought iron galvanised and of steam quality.

THESE MAINS SHOULD BE ELECTRICALLY EARTHED TO AN EARTH ROD INDEPENDENT OF THE MAIN ELECTRICITY EARTHING SYSTEM.

15.6.02 LANDING VALVES

Hydrant outlets should be of a type acceptable to the Public Fire Brigade and should comprise a valve 65mm bore constructed in gun metal, screwed or flanged for attachment to the riser and fitted with a 65mm instantaneous female coupling to conform to BS 336 and a blank cap secured by a suitable length of chain. The valve gate should lift clear of the waterway and the valve cover should be securely fitted to the valve body so that it does not unscrew when operated. The valve spindle should not be less than 22mm diameter and fitted with a gun metal handwheel about 150mm in diameter which should be marked with OPEN and SHUT directions; opening should be anti-clockwise. The whole fitting should be of sound construction and shall be suitable for a working pressure of 20 bar.

Landing valves should be installed at a height above floor level between 750mm and 1100mm. The hydrant outlet should be installed to give the following clearances: not less than 150mm on both sides and below the valve and not less than 200mm clearance above the handwheel.

If the hydrant outlet is installed in a recess the depth of the opening should not be greater than is necessary and in no case should the front edge of the female coupling be more than 75mm behind the front face of the wall. The opening should be fitted with a hinged door the lock of which should be spring loaded so that in an emergency, if the key is not available, the door can be opened from the inside after the glass has been broken. The glazed door should be conspicuously indicated by the words “FIRE BRIGADE WET MAIN” in black letters on the inner face of the glass.

The hydrant outlet valves used shall be of the type incorporating a device to limit

the outlet pressure to a maximum of 5.2 bar and shall be installed in a recessed cabinet. The instantaneous coupling shall be of the single-lug twist release instrantaneous pattern with vulcanised rubber blank cap all complying with BS 336.

15.6.03 INLET BREECHING PIECE

The wet riser shall be fitted with a twin inlet breeching piece for Fire Brigade use in addition to the fire pumping station, as required by the Local Fire Authority. The inlet shall be protected by a non-return (check) valve.

The breeching piece shall comprise 2 inlets consisting of a 65mm instantaneous male coupling and a non-return valve and shall be protected by a cap secured by a suitable length of chain. The coupling shall comply with BS 336.

A 25mm drain valve should be fitted to the riser in the inlet box. The valve should be kept strapped and padlock closed.

The inlet shall be as Angus Fig.251 or approved equal.

15.6.04 INLET BOX

The breeching piece and drain valve shall be housed in an inlet box with a glass fronted door.

The door should be as follows:

a) Glazed with wired glass and conspicuously indicated by the words: “FIRE BRIGADE – WET MAIN INLET” or ‘WET RISER INLET” in block letters on the inner face of the glass, both in English and Arabic.

b) Fastened only by means of a spring lock which can also be operated from inside without the aid of a key after the glass has been broken.

c) Made large enough for hose to be connected to inlets even if the door cannot be opened and the only means of access is by breaking the glass.

The box should be constructed in accordance with BS 3980 with minimum dimensions of 610x400x305 mm.

The box should be built into the structure with a fall of 1 in 12 from the rear of the base to the front of the base. The inlet box shall be as Angus Fig.249 or approved equal.

15.6.05 LANDING VALVE CABINET

The landing valve, hose, pin rack and branch pipe shall be in a landing box or cabinet, with a glass fronted door. The door should be as described for the inlet

box, giving full access to valve and equipment after breaking glass. Door to be marked conspicuously “FIRE BRIGADE LANDING VALVE”.

The hose to be provided, complete, with nozzle, shall be of the 65mm canvas 30.0m long.

The size of the box or cupboard shall be sufficient to provide ready access to equipment for immediate use when required, hose running freely from pivoting pin rack and valve turned on or off easily.

Strapping and padlocking of valves may be omitted where the access door is normally kept locked (lock to be as for inlet box).

15.6.06 FIRE EXTINGUISHERS

a) Water type fire extinguisher 2 gallons capacity.

b) Dry powder type: An approved make of 6 kg. Capacity and suitable size to be installed in a purpose made fire box as detailed elsewhere.

c) Halon 1211: As above, capacity to be 6 kg.

d) Pre-mixed foam fire extinguisher 2 gallons capacity.

e) Ceiling hung type Halon Extinguisher, self contained type capacity 6kg.

f) Asbestos (blanket) 1800mm x 1200mm stored in a metal container painted red and fitted with quick release and wall mounting fitments.

15.6.07 FLEXIBLE FIRE HOSE

Hoses shall be 2 ½” nominal diameter suitable for the design working pressure specified by Civil Defence Authorities. Hoses shall consist of seamless rubber lining, a flexible reinforcement and an elastromeric cover, red colour. Hose length shall be 20m and terminate in a nozzle – from one side – giving three settings namely:

- Jet, Fog and Stop –

15.6.08 ELECTRIC DRIVEN FIRE PUMP:

a) **Type:** The pump shall be of the centrifugal base mounted type, especially designed and constructed for quiet operation.

b) Pump: Shall be of the horizontally split case, double suction design, making possible complete servicing without breaking piping or motor connections. Motor pump connection shall be of the flexible coupler type. The pump shall use a mechanical rotating type carbon seal and shall face against a Remite insert. The pump shall be equipped with oil lubricated bronze sleeve bearings for smooth and quiet operation.

c) **Motor:** Shall be drip proof, 2900 RPM and shall be especially selected for quiet operation and shall be so stamped. The horse

power of the motor shall be of such a size as to insure non-overloading of the motor through the capacity range of the pump.

d) **Base:** Shall be of a size suitable for the pump, motor and shaft, and shall be constructed of cast iron or welded steel.

e) **Installation:** A concrete base 8 inches higher than the surrounding floor shall be provided. Construct base and install as shown by the detail on the drawings. Provide a minimum of four ½" anchor bolts from concrete to pump base.

f) **Controls:** The pump shall be controlled by a combined manual and automatic across-the-line type fire pump control panel. The control panel shall have an externally operated circuit breaker, a pilot light to indicate when power is on, switches or push buttons for manual or automatic operation, a pressure switch control for automatic operation and a remote alarm signal when pump is operating. The entire control panel shall be factory assembled in a steel cabinet.

15.6.09 JOCKEY PUMP

a) Type: The jockey pump shall be of the centrifugal base mounted type, especially designed and constructed for quiet operation.

b) Pump: The jockey pump shall be bronze fitted, directly coupled to its motor. The pump shall use a mechanical rotating type carbon seal and shall face against a Remite insert. The pump shall be equipped with oil lubricated bronze sleeve bearings for smooth and quiet operation.

c) Motor: Shall be similar to Electric Driven Pump motor in 15.6.08 (c).

d) Base: Shall be similar to Electric Driven Pump base in 15.6.08 (d).

e) Installation: shall be similar to Electric Driven Pump installation 15.6.08(e).

f) Controls: The jockey pump shall have a relief valve set for the proper pressure and a pressure switch for automatic operation. There shall be a magnetic across-the-line starter with "Hand-Off-Automatic" selector switch in cover provided to start and stop the pump.

15.6.10 DIESEL DRIVEN FIRE PUMP

a) Fire pump shall constitute a diesel engine and fire pump of the double suction, horizontally split case type. Centrifugal pump specification shall be as mentioned above under item 15.6.06 (b), except for pump speed which shall be 1500 RPM. according to the choice of the diesel engine speed.

b) Rating of diesel engine shall be chosen at the prevailing conditions at Sudan, i.e. ambient temperature of 50 deg C. and a humidity ratio of more than 90%.

c) Automatically controlled Diesel Engine

The diesel engin for driving the fire pump shall be specifically designed for fire pump service. It shall develop sufficient horse power to drive the pump and shall have bare engine brake horse power not less than 20 percent greater than the maximum horsepower required to drive the pump at its rated RPM.

The engine shall be an open type, self-contained power unit including the following accessories:

1. Stub shaft.
2. Fuel pumps and filters.
3. Air cleaner.
4. Adjustable governor capable of regulating engine speed within a range of 10 percent between shut-off and maximum load conditions. The governor shall be set to maintain rated pump speed at maximum pump load.
5. Lube oil pump.
6. Lube oil filter.
7. Overspeed shut down device arranged to shut down engine at a speed approximately 20 percent above rated engine speed and with manual reset. The overspeed shut down device shall be so designed that the automatic engine controller will continue to show an overspeed trouble signal until the device is manually reset to normal operating position.
8. Electric starter, generator or alternator and voltage regulator.
9. Dual storage battery units. Each unit shall have capacity to maintain cranking speed through a 6 minute cycle (15 seconds cranking and 15 seconds rest, in 12 consecutive cycles). Provide certification that the battery unit complies with this requirement. Batteries shall be furnished in a dry charge condition, with electrolyte liquid in a separate container. Electrolyte shall be added at the time the engine is put in service, and the battery si given a conditioning charge.
10. Dual battery chargers, automatically controlled.

    Chargers shall be specifically designed for fire pump service.

    The rectifier shalll be a semiconductor type.

    The charger for a lead acid battery shall be a type which automatically reduces the charging rate to less than 500 milliamperes when the battery reaches a full charge condition.

    The control equipment incorporated in an “off-on” type of charger for a load acid battery shall start the rectifier hourly. It shall shut off automatically when the battery has been fully charged.

The battery charger at its rated voltage shall be capable of so delivering energy into a fully discharged battery in such a manner that it will not damage the battery. It shall restore to the battery 100 percent of the battery's ampere hour rating within 24 hours.

An ammeter with an accuracy of five percent of the normal charging rate shall be furnished to indicate the operation of the charger.

The charger shall be designed so that it will not be damaged or blow fuses during the cranking cycle of the engine when operated by an automatic or manual controller.

A manual charge switch with indicator light shall be provided or, in lieu thereof, the charger shall automatically charge at the maximum rate whenever required by the state of charge of the battery.

When not connected through a control panel it shall be arranged to indicate loss of current output on the load side of the d-c over-current protective device.

Storage batteries shall be substantially supported, secured against displacement, and located where they shall be readily accessible for servicing.

11. Engine mounted radiator cooling system:

    Cooling water shall be from the discharge of the pump, taken off prior to the pump discharge valve. Threaded rigid pipe shall be used for this connection. The pipe shall include a manual shut-off valve, flushing type strainer, pressure regulating valve, automatic electric solenoid valve and a second manual shut-off valve shall be installed around the manual shut-off valves, strainer, pressure regulator and solenoid valve.

12. Engine jacket temperature regulating device.

13. Engine jacket water pump.

14. Instrument panel with water temperature gauge, oil pressure gauge, ammeter, tachometer of the totalizing type or an hour metre.

15. Exhaust mufflers and flexible connectors, stainless steel non-sparking.

16. The engine shall be arranged for automatic operation with all wiring terminating in a junction box suitable for filed hook-up.

17. Exhaust piping from flexible connection at engine to muffler and from muffler to point of discharge to atmosphere shall be schedule 40 black steel pipe and fittings, welded.

d) Pump and Diesel Engine

Shall be mounted on a common base plate, directly connected through a flexible coupling, and equipped with a coupling guard. Coupling shall be a spacer type to permit pump shaft and impellers to be removed without

moving diesel engine or pump bottom casing.

e) Automatic Diesel Engine Control Panel

The automatic diesel engine control panel shall be specifically designed for fire pump service. The panel shall be enclosed in a floor mounted duct and moisture resistant housing. The controller shall be the combined manual and automatic type including a “Manual-Off-Automatic” selector switch.

1. A pressure switch and single phase power failure relay with local visual indication and auxiliary contact for remote indication of 240 volt AC power failure shall be provided which will, upon drop in system pressure or loss of single phase AC power, cause the controller to open or close all circuits necessary to automatically start the engine by performing the following functions:

   - Turn on fuel supply.
   - Open the cooling water solenoid valve.
   - Crank the engine in a series of crank-rest cycles automatically alternating between the dual batteries on each cycle.
   - Disconnect cranking motor upon engine start.
   - Once the engine is started, it shall remain in operation until shut down manually. A signal in the Synoptic Panel shall indicate that the Diesel Engine is operating.
   - If the engine should fail to start after several cranking attempts, the controller shall disconnect all starting circuits and energize an audible and visual alarm to indicate “overcrank” in the Synoptic Panel as well as in the engine control panel.

2. Alarm and Signal Devices on Controller:

   - A pilot lamp(s) shall be provided to indicate that the controller is in the “automatic” position. The lamp shall be accessible for replacement.
   - Separate pilot lamps and a common bell shall be provided to indicate trouble caused by:

     Low oil pressure in the lubrication system.
   - The controller shall provide means for testing the position of the pressure switch contacts without causing trouble alarms.

     Failure of engine to start automatically.

     Shutdown from overspeed.

     Battery failure: Each battery shall be provided with separate

lamps which shall be lit or extinguished on battery failure on attempt to start.

High engine jacket water temperature.

3. Water pressure control: A pressure actuated switch having high and low calibrated adjustments and responsive to water pressure in the fire system shall be provided in the controller circuit. Suitable provision shall be made for relieving pressure to the pressure switch to test the operation of the controller and the pump.

4. Enclosure: The structure or panel shall be securely mounted in an enclosure(s) which will protect the equipment against mechanical injury and falling drops of water striking the enclosure. All switches required to keep the controller in the "automatic" position shall be within the locked cabinets having to break glass panels.

5. A wiring diagram shall be provided and permanently attached to the inside of the enclosure showing exact wiring for the controller, including a legend identifying numbers of individual components. All wiring terminals shall be plainly marked to correspond with the wiring diagram furnished.

6. Wiring Elements: Wiring elements of the controller shall be designed on a continuous-duty basis.

7. Field Wiring: All wiring leading from the panel to the engine and to the batteries shall have adequate carrying capacity. Such wiring shall be protected against mechanical injury. Controller manufacturer's specifications for distance and wire size shall be followed.

8. Marking: Each operating component of the controller shall be marked to plainly indicate an identifying number referenced to the wiring diagram. The markings shall be located so as to be visible after installation.

9. Instructions: Complete instructions covering the operation of the controller shall be provided and conspicuously mounted on the controller.

f) Fuel Storage Tank

1. The fuel storage tank shall be an integral part of the unit and shall be mounted within the support base of the unit. The tank shall have a capacity of 150 gallons. Provide all piping, fittings and valves required.

2. The unit support base shall be designed to allow space for oil pan clearance.

g) Tests

1. Prior to shipment, the pump and engine

shall be thoroughly shop-tested as a unit by the pump manufacturer. A characteristic curve showing the pump performance based upon the results of the shop test shall be submitted to the Consultant prior to shipment, and shall include the performance of pump and engine at the set-governor's speed. Absence of these test reports, indicating that the complete unit has been tested in the factory, will be ample grounds for the equipment rejection.

2. Each control panel shall be fully assembled and factory-tested by the control manufacturer prior to their shipment, and evidence of this test shall be furnished with the controller.

3. Field Acceptance Tests:

- The field acceptance test results shall be as good as the manufacturer's certified shop test characteristic curve for the pump being tested within the accuracy limits of the test equipment.
- Overheating: The pump shall operate at peak load conditions without objectionable heating of the bearings or of the prime mover. The operating pump speed shall be the speed at which the pumping unit would be expected to operate during a fire.
- The engine shall not show signs of overload or stress and its governor shall properly regulate the speed.
- Controllers:

  The automatic controller shall be put through not less than ten automatic and ten manual operations.

  A running interval of at least five minutes at full speed shall be allowed before repeating the starting cycle.

  Automatic operation of the controller shall start the pump from all the provided starting features, such as pressure switches, valves, etc.

  Duration of Test: The pump shall be in operation not less than one hour (total time) during the foregoing tests.

h) Unit Purchase:

The pump, driver, and all controls and necessary attachments, specified herein, shall be purchased under a unit contract. The pump manufacturer shall assume unit responsibility and shall provide the services of a qualified engineer to supervise the installation and alignment of equipment. Field

tests shall be conducted in the field to satisfy Local Authorities of satisfactory operation of pump, driver and controller. The pump manufacturer's engineer shall be at the job Site, supervising the test. The control manufacturer shall have their representative at the job Site to train operators in the use of the controls. The pump manufacturer shall see to it that a qualified engine representative is present to train operation and maintenance personnel in the use of the diesel engine.

i) Spare parts and tools

Spare parts and tools necessary for two years operation, as recommended by the manufacturer, shall be provided as a part of the Contract for the engine. A list of these spares shall be included in the offer.

15.6.11 FIRE STATIONS

Fire hose reels, fire hydrants, fire extinguishers and other fire fighting accessories shall be located in different places in the building as indicated on the drawings.

15.6.12 PIPE MATERIAL FOR FIRE FIGHTING NETWORK

Fire mains shall be seamless GALVANISED STEEL SCHEDULE 40 TO ASTM A120.

15.6.13 IDENTIFICATION SIGNS

Drain valves, test valves, control valves, shall be fitted with approved enameled signs indicating their use.

15.6.14 TESTING

General: All testing shall be performed under the work of this Section. All services required for testing shall be a responsibility of the work of this Section. The Contractor shall notify the Consultant of all tests, 48 hours prior to testing.

A) The fire protection pipeing systems shall be tested hydrostatically for not less than 24 hours at 1½ times the system pressure without leaks and as directed by the LOCAL FIRE DEPARTMENT.

b) If the systems are tested in sections, the connection to the previously tested section shall be included.

c) All tests that may be required by the Local Fire Department shall be performed under the work of this Section in the presence of their representative if so required.

d) All leaks shall be corrected and the system re-tested until no leaks are found, at no additional cost.

e) Functional tests of all water flow alarms are a responsibility of the Works of this Section.

f) When the various systems are completed, operation tests shall be

run on all equipment to demonstrate proper operating conditions. These tests shall be run under the observation of the Inspector and the Consultant. The operating personnel shall be instructed during this period. Operation tests shall be performed under the work of this Section.

g) Should any piece of equipment or apparatus of any material or work fail in any of these tests, it shall be immediately removed and replaced by a perfect material, and the portion of the work replaced shall again be tested under the work of this Section.

h) Cost to repair any damages to the building construction occasioned by pipe leaks or defective materials shall be borne under the Works of this Section, at no additional cost. All corrective work shall commence immediately after damage has occurred.

15.6.15 APPROVAL

Upon completion of the systems, the Contractor shall furnish the Consultant with a certificate of approval from legally constituted authorities.

15.6.16 OPERATION INSTRUCTION

Upon completion and approval of the systems, the Contractor shall provide an experienced engineer to instruct the operating personnel in all details of operating and maintaining the system. The Contractor shall provide three (3) sets of type written operation instructions, parts lists and service manuals of all equipment, wiring diagrams, control diagrams and test reports, suitably bound.

DIVISION 16

ELECTRICAL

DIVISION – 16: ELECTRICAL

16.1 GENERAL CONDITIONS FOR ELECTRICAL WORKS

16.1.01 SCOPE

This Specification covers supply, installation, connecting up, testing and commissioning of all materials and equipment required in connection with the Electrical Installation Works as detailed in the Specification and as shown on the drawings. All these should be within the completion period.

16.1.02 RELATED DRAWINGS AND DOCUMENTS

This Specification shall be read in conjunction with the Contract Documents and Tender Drawings all forming part of this Specification. In the event of any discrepancy between the Tender Drawings and the Specifications, the drawings shall be deemed correct for tendering purposes. However, the Tenderer shall be required to draw attention to such discrepancies at the time of tendering. Failure to do so shall make the Tenderer responsible for all the Works mentioned in any of the Tender Documents and as interpreted by the Consultant.

16.1.03 GENERAL

Before submitting his Tender, the Contractor shall be deemed to have visited the Site and appraised himself of any conditions which might in anyway affect the carrying out of his work as no claims shall be entertained for lack of knowledge in this respect.

The Contractor shall execute all the Works in strict accordance with the drawings, schedule of points, the Specifications and any further instructions which may be issued by the Consultant from time to time irrespective of their appearance or not in drawings and Specifications. All Works shall be carried out to the approval of the Consultant.

The Contractor shall refer to all relevant drawings to ascertain the location and routes of all other services including water, gas, telephones, etc., in order to maintain sufficient and safe clearance between these and the Electrical services.

16.1.04 COMPLIANCE WITH STANDARDS

The Contractor shall supply and use all equipment and materials that shall comply with the latest relevant British Standards Specification. Materials and equipment to standards other than the BSS may be offered on condition that these standards meet the requirements of the BSS as a minimum.

All materials and equipment used shall be new and of the best quality and free from all flaws and defects. Any materials and equipment not accepted by the Consultant shall be removed and replaced by the Contractor at his own expense.

16.1.05 STANDARDS OF WORKMANSHIP AND COMPLIANCE WITH REGULATIONS

All works under the Contract shall be executed to conform to the best principles of modern practice and shall generally be in accordance with the current edition of the Regulations for the Electrical Equipment of Buildings issued by the Institution of Electrical Engineers, U.K. but shall in no way conflict with the current rules, regulations and requirements of the Local Electricity Company i.e. SEWA's regulations and approvals.

The Contractor shall be required to satisfy the Consultant that all works shall be carried out by fully competent tradesmen of appropriate grades.

16.1.06 ELECTRICITY SUPPLY

Allow low voltage electrical works, equipment and materials shall be suitable for operation at 220/380V, 3-phase, 4-wire, 50Hz supply.

The Contractor shall liaise with a local supply company and obtain all relevant information and data pertaining to his part of the Works, well ahead of said installation Works.

The Contractor shall be responsible for making all necessary arrangements to obtain the main electricity supply to the premises without delay and to be within commissioning completion period.

16.1.07 CLIMATIC CONDITIONS

All equipment and materials used shall be suitable for the following climatic conditions in Sudan.

Altitude	:	Seal Level
Maximum Ambient Temperature	:	50º C
Maximum Humidity	:	100%

16.1.08 STATUTORY APPROVAL

Wherever applicable, the Contractor shall be responsible for obtaining, in good time, all necessary approvals for the installation of various items from all the relevant statutory authorities.

16.1.09 POSITIONS OF FITTINGS

The approximate positions of fittings, equipment, apparatus, etc., indicated on the drawings shall be assumed to be correct for the purpose of tendering only and are intended to indicate generally the arrangement of the Works. Their positions, however, may be varied in accordance with the architectural drawings or by the Consultant's instructions on Site, without extra cost, unless such alterations are made after the fittings, equipment, etc., are already installed with the knowledge and approval of the Consultant.

16.1.10 CO-ORDINATION WITH OTHER TRADES

The Electrical Contractor shall be required to co-ordinate with and to carry out his part of the Works relating to the requirements of the specialist Sub-contractors for the following installation works:

a) Civil.

b) Plumbing and Drainage.

c) Air Conditioning

d) Local Electrical Co. (NEC).

e) Carpentry/Furniture/Interior Decoration.

In addition to the above, the Electrical Sub-contractor shall co-ordinate with the Sudatel and Civil Defence and in compliance with their rules, regulations and requirements, shall carry out his part of the Works relating to all telephone installation works.

16.1.11 TENDER DRAWINGS

One copy of the Tender Drawings for all electrical works shall be provided by the main Contractor. Any necessary design modification shall be in the form of design notes and/or sketches as directed by the Consultant.

16.1.12 BUILDER'S WORKING DRAWINGS

The Contractor shall submit, within thirty days of Consultant's order for commencement of works, two copies of drawings indicating dimensioned details of holes, chases etc., required in the structure, together with dimensioned details of supports, bases, etc., to be provided by others to enable him to fulfil his part of the Works. The drawings shall be prepared to 1:50 scale.

16.1.13 AS FITTED DRAWINGS

During the course of the Works the Contractor shall maintain a fully detailed record of all changes to the Tender Drawings so as to ensure easy and accurate preparation of all the drawings as a true record of the actual installations.

16.1.14 The Drawings shall show the complete installation of all the Works within the building, including the sizes and runs of all cables, the precise location of all cables which may be buried within the structure and those sections of any external cables which are installed in trenches. The location and depth of all underground cables at the entry to the building shall also be clearly indicated.

16.1.15 RECORD DRAWINGS AND OPERATING MANUALS

Before acceptance of the Works by the Consultant, the Contractor shall be required to demonstrate and explain, to the Consultant, the operation of all the electrical installations, and also the method of starting, running, and stopping of all mechanical electrical plant, etc.

Within one month of the completion of the installations, the Contractor shall provide complete sets of record drawings and operating manuals, recommended spare parts, parts list ordering information, etc. as applicable.

a) General arrangement of all services as fitted to a scale of not less than 1:100 metric.

b) Details of all items of plant and equipment including name and address of the respective manufacturer, type and model, serial number, duty, rating and any other pertinent information.

c) Single line schematic drawings indicating all distribution boards, switches, etc., together with relevant notes describing their purposes.

The Contractor shall submit to the Consultant one complete set of all record drawings and manuals for his study and approval. After obtaining approval in writing, the Contractor shall provide on negative and three black and white prints of each drawing together with three (3) bound sets of all manuals and operating instructions to the Consultant.

16.1.16 MAINTENANCE AND SERVICING

The Contractor shall be required to provide maintenance, servicing and replacement of all defective parts during the maintenance guarantee period of 1 year (successful commissioning and acceptance).

16.1.17 SAMPLES

The Contractor shall submit samples of all materials to the Consultant and obtain his approval, in writing before commencing any part of the Works.

Samples should be kept on Site till all material has arrived on Site.

This can be adjusted against the total quantity.

16.1.18 SPARE PARTS

The Contractor shall provide, as part of this Contract, all special tools required for equipment and maintenance together with sufficient spare parts for each item of equipment to provide maintenance for a period of five years, all in accordance with the respective manufacturer's recommendations.

16.1.19 INSPECTION AND TESTING

The Contractor shall provide all necessary facilities to the Consultant to inspect all materials and equipment, Works, etc., on Site during the progress of the Works.

The Contractor shall provide, free of charge, all necessary labour, materials, testing equipment and instruments which may be required to carry out the various tests on the installation as directed by the relevant statutory authorities and as called for by the Consultant.

The Contractor shall give fourteen days notice before the installation is ready for testing. Subject to the Consultant agreement, the Contractor may proceed with the test and forward three certified copies of the results obtained to the Consultant. If the results are found satisfactory in every respect, the installation shall be accepted, but such acceptance shall be without any prejudice to any claims in respect of defects which may develop during the guarantee period for maintenance.

In order to facilitate progress of works it may be necessary to test sections of the Works separately, Tests shall be repeated, within a reasonable time and without extra charges, on any sections of the installations which have failed the tests.

In case where sections of the works are to be above false ceilings or within builder's ducts, voids, etc., the Contractor shall notify the Consultant that the works are ready for inspection before enclosure takes place, and shall be responsible for keeping the Works accessible until inspection and testing have been completed.

16.1.20 ELECTRICAL TESTS

On completion of the installation, and prior to its being made "alive" for service, the Contractor shall carry out the electrical tests on all sections of the Works in the presence of the Consultant and the representative of the local supply authority. All tests shall be carried out in strict compliance with the requirements of the regulations mentioned previously in clause 16.1.05 of this Specification.

The tests shall include but be not limited to the following:

a) Insulation resistance test between Phases, Phase and Neutral and Neutral and earth.

b) Earth continuity tests.

c) Earth electrode resistance measurement.

d) Verification of polarity.

e) Ring circuit continuity tests.

f) Operational/functional tests on all equipment, relays, etc.

g) Test on ELCB.

h) Earth loop impedance test.

The Contractor shall submit the results of all tests, in duplicate, on completion tests certificate forms as prescribed by the current edition of the aforementioned I.E.E. Regulations to the Consultant for approval.

16.1.21 NOTICE

In each switch room the following notices relating to important instructions and information shall be provided and hung in a conspicuous place:

a) The instructions for the treatment of electric shock, in Arabic and in English, enameled on steel frame and screwed to the switch room wall.

b) A schematic diagram of the plant located in the room together with a complete outline single line schematic drawing of the complete electrical distribution system, framed and mounted on the wall.

16.1.22 DAMAGE TO SEWA'S PROPERTY

The following Decree has been issued by the Government of Sudan, which makes it a punishable offence to damage or misuse NEC property. The Contractor must be aware of the provisions of the Decree and the punishments that accompany contravention of these provisions.

"Act No. (1)/1995 concerning Protection of safety of the General Network of Electricity and Water Services"

16.1.23 CONDITIONS FOR THE APPROVAL OF SUB-CONTRACTOR

The Sub-contractor shall confirm in writing on the letter head the conditions as given in 'Appendix – 1".

16.2 SYSTEM REQUIREMENTS

16.2.01 INTERNAL AND AUXILIARY WIRING

Internal and auxiliary wiring of minimum size 1.5 mm^2, 600/1000 V grade of fire proof insulation shall be used throughout and shall be protected against mechanical damage.

16.2.02 LABELLING

On each board every incoming and outgoing feeder shall be labelled, both in Arabic and English, by means of approved name plates, screw fixed to the panel doors.

16.2.03 BUS BARS

The horizontal and vertical Busbars shall be fabricated from high conductivity electro-tinned copper. Horizontal busbars rated as per I/C rating at 50º C.

The horizontal and vertical bus bars shall be braced to withstand a prospective fault current of 40KA for one second. ASTA certificates shall be provided as verification.

The vertical bus bars shall be totally incapsulated in rigid, glass-filled, polyester moulding over their entire length and shall have exposed area only at power take-off points

16.2.04 FINAL L.V. MINIATURE CIRCUIT BREAKER (M.C.B) DISTRIBUTION BOARDS

The Contractor shall supply, install, test and connect split type MCB distribution boards in the approximate locations indicated in the drawings.

16.2.05 GENERAL REQUIREMENTS

All indoor M.C.B. boards shall be equipped with suitably rated integral load break switches and adequately rated copper bus-bars. These boards shall be constructed of sheet steel of minimum thickness 1.6 mm and shall be enameled to light gray colour, and shall be manufactured to comply with the requirements of the latest version of BS 5486.

All boards shall be factory fabricated and shall be totally enclosed, dust, vermin, damp and corrosion proof. Unless otherwise indicated, these boards shall generally be of the flush mounted type and shall be provided with cover, lock and key. The boards shall be labeled as previously described and a neatly typed schedule, inside the board, shall describe all the outgoing final sub-circuits, their ratings and the

areas and points served.

16.2.06 M.C.Bs

All M.C.Bs shall be manufactured and tested to comply with the requirements of BS 2871: Part 1, including, latest amendments. These shall be of the plug-in/bolted type and shall have guaranteed breaking capacity of not less than 6 KA and a minimum life time of 20.000 operations.

16.2.07 POWER FACTOR CORRECTION

Bulk power factor correction shall be provided at the main intake position by means of automatic power factor correction capacitors manufactured in accordance with BS 1650/IEE 831. Each capacitor bank shall be housed in a sheet metal enclosure containing the fuses, suitably rated contractor, hand/off/auto selector switch and capacitor, auto detection and switching relays, energized indication lamps for each switching stage. The operation of switching of the capacitor banks must be in cycle order i.e. the same capacitor banks shall not be in service for the whole operating time.

The capacitor bank shall be assembled into floor mounted free standing cubicle or wall mounted assembly, complete with suitable rated interconnecting busbars between banks and an incoming cable chamber and control cabinet. This cabinet shall be of sheet metal construction containing a staged power factor control module/relays, power factor meter, control circuits; fuses and incoming cable connections. Capacitor elements shall be wound from aluminium foil, high reliability tissue and polypropylene film assembled into standard packs complete with individual element fusing. Discharge resistors shall be fitted. Further, provision shall be made for alarm and indication in the event of temperature rise in capacitor bank chamber above the present value.

Type	: Dry capacitor without impregnation made of metalized polypropylene film.
Temperature	: maximum temperature 50ºC .
Class	: Average temperature over 24 hrs. 45ºC .
	Average temperature over 1 year. 40ºC .
Voltage and Over	: Insulation level 0.6KV.

Load Specification	: For 1 minute, withstand 3KV at 50Hz.
	: Impulse voltage lost 13KV.
	: Long period over voltage 10%
	: Temporary over load capacity for 15 minutes 20%
	: Overcurrents due to harmonics 30%
Capacitor Loss Factor	: Power output loss shall not be more than 0.4 W/KVAR including discharge resistor.
Life	: must be suitable for a minimum of 30,000hrs. operation.

16.2.08 UNDER VOLTAGE RELAY

Under voltage relays, timers and circuitry shall comply with NEC. Regulators are to be provided under this Contract for all air-conditioning installations. In principle, the provision of such could be achieved by:

a) Providing under voltage relays and timers for each equipment. This could be provided as part of the control circuitry of each equipment or on the main power circuit of each equipment, this scope of work being carried out at the respective equipment.

b) Provision of under voltage relays and timer at dedicated Sub-distribution Boards/MCC for air-conditioning (window/split unit) units to activate the main incomer to the SMDB/MCC.

c) Provision of under voltage relay and timer at the Distribution board or at each consumer unit/sub feeder.

Each relay with timer must have the setting that it cuts off the supply to the circuit at 75% of the supply voltage within 0.1 second and auto reset between 5 to 10 minutes.

Type	: 4 wire supply monitor with timer.	
Voltage Range	: 380v + 35% A.C. supply.	
Frequency Range	: 48-63 Hz.	
Power Consumption	: Max. 4 VA per phase.	
Time Relay	: From fault detection	100 millisecond
	From fault rectified	5 to 10 minutes.
Temperature Class	: 20ºC to 55ºC.	

16.2.09 EARTH LEAKAGE PROTECTION

a) Earth leakage protection is effected by installing the earth leakage circuit breakers on final subcircuits feeding from distribution board, manufactured in accordance with BS 4293.

b) Earth leakage circuit breakers shall be provided at the distribution board and it must ensure that it opens a circuit automatically in case of an earth leakage fault between phase and earth and / or neutral and earth.

c) Earth leakage circuit breakers connected on final subcircuits supplying socket outlet, the disconnection must occur within 0.2 seconds of an earth fault, whereas the final circuits supplying fixed equipment, the disconnection must occur within 5 seconds, except for electrical equipment in a bathroom where 0.2 seconds applies.

d) All socket outlets or equipment supplied by means of socket outlet must be protected by the residential current device having a rated residual operating current/tripping current not exceeding 30mA.

e) All lighting circuits and air-conditioning circuits must be protected by the residual current device, have rated residual operating current/tripping current not less than 100 mA.

f) The installation and arrangement of residual current device on the final subcircuits feeding from distribution board shall be in accordance with IEE/SEWA standards.

Nominal Voltage	2 Pole	:	220/240 V - 50 Hz.
	4 pole	:	380/415 V - 50 Hz.
Temperature Class		:	5 to 40ºC.
Electrical life		:	4000 operations.
Mechanical life		:	40.000 operations.

16.2.10 ELECTRICAL MATERIAL

a) All concealed conduits shall be PVC Decoduct or approved equivalent and under ground sleeves “Cosmoplast”.

b) All exposed (surface) conducting shall be G.I. ‘Barton” U.K. make. All metallic flexible conduits should be ‘Kopex’.

c) All switches and sockets shall be M.K., U.K. make white plastic logic range.

d) All cables and wires shall be DUCAB.

e) Capacitor bank rating shown on the drawings and indicated in schedule is approximate based on assumptions. The actual rating of capacitor bank has to be established by the Contractor, prior to the final installations. The Contractor is deemed to have made necessary allowances in his Contract.

f) All MDB, SMDB, and DBs – Klockner Moulller, or approved equivalent.

g) Door bell: Legrand Cat. No.: 41705 with built in transformer or approved equivalent.

h) Exhaust fan for kitchen and toilet, K.D.K. 8" dia for toilet and 12" dia for kitchen. All exhaust fans should be gravity operated.

i) TV antenna: Specified MATV make – ASTRO – Germany.

j) Isolator – A.B.B. weather proof, metallic and lockable type.

16.2.11 TELEPHONES

Main telephone ducting including conduiting and wiring within the plot, shall be carried out by the specialized Contractor according to SUDATEL specifications and requirements.

16.2.12 EXTERNAL WORKS

Ducts and sleeves below pavement and roads shall be provided by the Contractor for all service authorities with clear indication for their location and to the authorities specifications and requirements.

16.2.13 FIRE FIGHTING

Fire fighting system shall be carried out by M/S Unitor or equivalent and the equipments shall be to Civil Defence approval and satisfaction of the Consultant.

1. G.I. pipes shall be to grade B or medium duty as manufactured by M/S Zenith or TATA steel, India. G.I. pipe fittings to be Crane and shall be painted with red oxide and two coats of oil paint to Consultant approval.

2. Fire extinguishers to be from Moyne-Roberts as follows:

a) Dry powder multi purpose model MP-6 capacity 6 kg.

b) Carbon Dioxide model 5050 capacity 5 kg.

3. Fire pumps Diesel & Electric – KSB, WILO

4. Fire Valves shall be Unitor as follows:

a) Two inlet breaching (horizontal) NO.112 to be fitted in box No. 114.

b) Air valve 25mm No. 100.

c) Globe (landing valve) No. 122.

5. Fire hose reel to be from Moyne-Roberts, model 4B manual recessed swinging 25mm size and 30 M length.

16.2.14 FIRE ALARM SYSTEM

Fire alarm shall be carried out by M/S Unitor or equivalent and the

equipment shall be to Civil Defence approval and satisfaction of the Consultant.

1. Panel Zeta S0/16 with 5 Amps battery charger and 2x12v, 15 AH lead acid sealed batteries.

2. Smoke detector ZTA 601.

3. H.D. ZTA 602.

4. B>G. ZT-MCP flush fitting film protected glass with test key.

5. Bells ZTB 8 (WP)

6. Wiring with FP 200.

16.3 MAIN, SUB-MAIN AND FINAL L.V. DISTRIBUTION SWITCH BOARDS

16.3.01 MAIN L.V. DISTRIBUTION SWITCH BOARDS

The Contractor shall supply, install, test, and commission, in the locations indicated on the drawings, low voltage switch boards, designed MDB/DB/ Capacitor Banks comprising components, all in accordance with the requirements of this Specification and as detailed in the distribution schematic drawings.

16.3.02 GENERAL

The general arrangement of the switch board shall be indicated in the appropriate drawings. However, it shall be the responsibility of the Contractor to provide, with his working drawings, the proposed arrangement and physical layout of the switch boards together with the manufacturer's specification and full technical details of the switch gear and all ancillary equipment he proposes to use, for study and approval of the Consultant. The Contractor shall ensure that his offer shall include all items, whether or not explicity specified, but which are considered necessary for a complete, safe, and satisfactory installation. The Contractor shall also ensure that the switch boards offered shall be of suitable layout and dimensions for the locations specified. A complete set of plans indicating details and fixing dimensions together with the necessary number of foundation bolts for each board shall be submitted.

The switch board, if necessary, shall be arranged for delivery to Site in sections which can be easily placed into position and then bolted together. Lifting lugs shall be provided for each section.

Stage inspection during panel manufacturing shall be arranged for all panels.

The board shall be installed complete in all respects and shall be tested and commissioned to the satisfaction and approval of the Consultant.

16.3.03 MOULDED CASE CIRCUIT BREAKERS (M.C.C.B)

All M.C.C.Bs protecting feeders shall be of instantaneous type and shall be designed and constructed to have short circuit breaking capacity of not less than 50KA/42KA for main panel and 30KA/25KA for sub-main panel, and shall conform to the requirements including latest amendments, of BS. 4752 Part 1, IEE 157-1, and shall be fault tested to category P2 of these standers.

All M.C.C.Bs shall be of thermal magnetic, manually and automatically operated type, and shall be designed to provide positive trip-free operation on abnormal overloads with quick break contacts for both manual and automatic operation. Adequate protection for the stationary and movable contacts shall be provided with effective and rapid interrupting devices. An inverse time delay thermal overcurrent trip element and a magnetic instantaneous overcurrent trip element shall be provided on each pole of the breaker for common tripping of all poles.

16.4 LOW VOLTAGE CABLES, WIRES AND ACCESSORIES

16.4.01 GENERAL

The Contractor shall supply, install, test and connect all the cables and wires, commencing at the L.V. Panel, MDBS and then to the SMDB, MCB distribution boards, equipments and points, all in accordance with Clause 16.3.03 and 16.2.07 and the requirements of this Specification, and as detailed and indicated in the plan and distribution schematic drawings.

Unless otherwise specified, all cables and wires shall have copper conductors and shall be of 600/1000 V insulation grade. All cables shall be adequately protected in finishes.

No joints shall be permitted in cable runs between any two points unless the lengths involved are longer than standard manufactured lengths. The joints, if any, and their positions shall be approved by the Consultant.

Cable lugs, terminals or sweating sockets, all made in strict accordance with the relevant BS, shall be of the correct bores appropriate to the sizes of the cables to be connected. The bore shall be of adequate size to accommodate all strands of the cable core, as filling-in of surplus space with solder shall not be permitted. All soft solder used in the cable installation shall comply with BS 219 grade E

or F for tinning and grade H for wiped joints.

16.4.01 INSTALLATION OF CABLES

Generally cable routes shall be assumed from the drawings for tendering purpose, but the final routing shall be agreed with the Consultant before any installation is undertaken.

All external cables shall be either buried directly in the ground or installed in ducts. Directly buried cables shall be provided with protective tiles, continued type and route marks where as cables installed in ducts should be provided with caution type and route marker only.

All work associated with the installation of the cables shall include for jointing materials, cable supports, steel racking, etc.

Purpose made fire barriers shall be installed wherever cables pass through walls or floors.

In all horizontal and vertical surface runs of cables along walls, beams, columns, service ducts, etc. shall be supported by “claw” type cleats at spacing as laid down in Table B2M of the 16th edition of the I.E.E. wiring regulations.

Bends in cables shall be properly supported and shall be of the maximum possible radius in the space available. The internal radius of every bend shall not be less than the recommended value as laid down in Table B1M of the aforementioned Regulations.

16.4.02 CROSS LINKED POLY-ETHYLEN XLPE INSULATED CABLES

Armoured copper cables: All XLPE cables specified shall be manufactured in strict accordance with BS 5467. These cables shall be XLPE insulated, single wire armoured, PVC sheathed, multicore copper cables of 600V – 1000V insulation grade.

16.4.03 ARMOURED P.V.C INSULATED CABLES

These shall be P.V.C insulated, single wire armoured PVC sheathed cables manufactured in strict accordance with BS 6346.

The conductors shall be stranded and of plain annealed high conductivity electrical copper complying with BS 6360.

The conductors shall be insulated by PVC compound and the core insulation shall be coloured Red, Yellow, Blue and Black for identification. The bedding shall consist of PVC compound over which a single layer of galvanised steel wire shall be provided as armour. The final serving over the armour shall be extruded PVC sheath of

black colour. The PVC compound used for core insulation, bedding and sheath shall comply with BS 6746.

Cables shall terminate in glands approved by the cable manufacturer. An earth tag must be provided so that an earth bond to the frame of the equipment can be fitted. A PVC shroud shall be fitted over each gland.

All terminations shall be carried out using a system of compression jointing as recommended by the cable manufacturer. Special protective bushes shall be used at points where cables pass through metal surfaces such as distribution boards or trunking.

16.4.04 PVC INSULATED CABLES

These shall be single core standard copper cables with PVC insulation; multi, non-armoured stranded copper cables with PVC insulation and overall PVC, sheath, manufactured in strict accordance with BS 6004. The PVC compound used for insulation and sheath shall comply with BS 6746.

16.4.05 MINERAL INSULATED METAL SHEATHED CABLES

Mineral Insulated cables complying with BS 6207: Part 1 shall be of the copper conductor and copper sheath type having an overall high grade PVC sheath of approved colour.

The cables shall be rated at 600 V grade for cross sections upto and including 4mm and 1000V grade for all cables above this size.

Immediately after cutting the cable, each end shall be effectively sealed by a permanent seal or by dipping in hot bituminous compound. No through or other joints shall be permitted without the written permission of the Consultant.

An impact resistance platic shroud shall be fitted over each termination to protect the gland and the section of the cable from which the PVC sheath has been removed. At all termiations coloured sleeves shall be fitted around the insulation to identify the cores in accordance with the I.E.E. regulations.

Cables shall be supported with PVC sheathed copper saddles and shall be fixed with brass fixings. Multiple runs of three or more cables shall be run on adequately supported galvanised steel trays of approved manufacture.

Cables shall not be embedded in the building structure without the prior writen approval of the Consultant. Cables passing through floors and walls shall be installed in suitable sleeves for easy withdrawal.

All terminals shall be easily accessible. All glands shall be of ring type with locknut and steel serrated lock washers, all supplied by the cable manufacturer.

The seal shall comprise a metal pot fitted with a sealing compound of high insulating properties and retain a plastic state between the temperatures of 20ºC and 105ºC. High temperature PVC insulating sleeves and insulating discs shall be provided.

For connection to equipment, conductors above 2.5mm^2 shall have cone grip compression type lugs. Under no circumstance shall a compression type lug be crimped with a tool using dies other than those designed for the type and size of lug in use.

All works related to mineral insulated cables shall be carried out in strict compliance with the manufacturer's recommendations. The Contractor shall ensure that all installation works shall be carried out by specialists who shall have received an approved course of instruction in the termination and installations of mineral insulated cables.

16.5 LIGHTING AND SMALL POWER INSTALLATIONS, LUMINARIES, WIRING AND WIRING ACCEESSORIES

16.5.01 GENERAL

The Contractor shall supply, install, test, and connect the complete lighting and small power installations inclusive of all luminaries, lamps, socket outlets, switches, contractor switches, conduits, trunking, wiring, wiring accessories, etc., for either flush or surface mounting, as described briefly here and as shown on the drawings.

All wiring shall be carried out in strict accordance with the cable sizes and circuit details provided in the load schedules and the drawings. All wiring of multi-point sub-circuits shall be carried out as a "loop-in" system and no joints at any point in the cable runs shall be allowed.

Wiring for lighting and power circuits shall be run in separate conduits backed to their distribution boards. No single conduit shall contain more than one phase to any lighting points, socket outlet etc. where these are arranged for single phase supplies. Care must be taken to ensure that both the live and the neutral conductors shall in all cases be contained in the same conduits, and that every single pole switch and MCB in a 2 wire circuit shall be connected to the phase conductor of the supply. Circuits shall be arranged such that no more than three conductors are bunched at any one terminal.

Each circuit of cables contained in trunking shall be taped and bound at intervals throughout the runs and suitably labeled at each junction

and terminal point for identification purposes. Single phase circuits taken from T.P. and N distribution boards shall have their own neutral connections.

Before any cables are drawn in the conduits/trunking installations, the conduit and trunking system including outlet boxes, isolators, MCB distribution boards shall be completed and inspected. Any conduits/trunking rejected shall be replaced without extra charges.

The Contractor shall pay special attention to the segregation of L.V. and the wiring system for fire detection, Telephone system, etc., which may be either installed by him or other specialist sub-contractors to ensure that no interaction may occur between the various systems. Segregation of the wiring system shall strictly comply with the requirements of the latest edition of the I.E.E. regulations.

The colouring code and identification of cable cores shall be in accordance with Table B4, the I.E.E. regulations.

The Consultant reserves the right to request for samples of each type of material, equipment, fixtures, etc., to be submitted for final approval before placing the order.

16.5.02 LIGHTING INSTALLATION

The lighting installation in the sub-station, lift machine room, electrical and mechanical rooms, etc. shall be surface mounted fluorescent types as indicated on the drawings. For all areas the conduit system shall be concealed in the building structure.

Each light point should be served through 6A, plug in type ceiling rose.

All lighting luminaries shall be of the type, size rating and manufacture as specified in the Schedule of Materials.

Wherever necessary, connections between PVC cables and flexible cables for lighting fittings shall be effected by means of porcelain shield connectors with twin brass screws. Due care shall be taken to ensure that vibrations do not loosen the screws.

16.5.03 SMALL POWER INSTALLATIONS AND SOCKET OUTLETS

Generally socket outlets shall be of 13Amp. Shuttered 3-pin switched type complying with the requirements of BS 1363. These shall generally be connected on ring main circuits. Connections to the phase and neutral conductors shall be carefully made in accordance with the manufacturer’s markings and the earth pin shall be effectively earthed. Generally all socket outlets shall be mounted

200mm above F.F.L. Wherever indicated on the drawings 15Amp shuttered 3-pin switched and unswitched socket outlets complying with the requirements of BS 546 shall be installed. 15 Amp socket outlets serving points for water heaters or other like equipment shall be of the unswitched type controlled by 20 Amp D.P. switches with neon indicators.

All switch sockets in the plant room and the sub-station room shall be of the industrial pattern protected type.

16.5.04 FLUORESCENT FIXTURES

All fluorescent lighting luminaries shall be provided with capacitors to give p.f. in excess of 0.9 lagging. Capacitors shall comply with BS 4017 and shall be suitable for operation at temperature upto 85ºC.

All the ballasts shall conform to BS 2818 and shall be suitable for rapid start operation. Capacitors incorporated for the purpose of Radio interference suppression, requirements for the above luminaries, shall conform to the appropriate requirements of Codes for “Radio Interference Suppression Devices”.

Fluorescent luminaries shall have spring-loaded bi-pin lamp holders and shall be equipped with instant start-control gear to give trouble-free operation at an ambient temperature of 45ºC. The control gear shall be of polyester resin filled type and shall be noiseless in operation.

The internal wiring shall be silicon rubber flexible cables of appropriate sizes neatly clipped in position. All luminaries shall contain all associated control gear within the body of the luminary. The main body of the luminary shall be stove enameled of the rust, damp and dust proof type.

All starting switches shall conform to BS 3772.

All tubular lamp shall conform to the requirements of BS 1853 and shall be suitable for quick start operation. The tubes shall have a life of approximately 7500 hours. Unless otherwise indicated, all fluorescent lamp shall have colour rendering features and lumen/watt output of type “white Deluxe” lamps.

16.5.05 INCANDESCENT LIGHTING LUMINARIES

Lighting luminaries for use with tungsten filament lamp shall comply with BS 4533 and BS 5225; Part 1. All tungsten lamps shall be internally frosted type and shall comply with BS 161. All ceiling lamps should be pin type and shall comply I.E.E. 16th Edition including amendments. All lamp holders shall be of Edison Screw type for

lamps upto and including 150 watt and shall comply with relevant British Standard.

16.5.06 SWITCHES

All lighting switches shall comply with BS 3676. These shall be rated at 20A (grid) and shall be suitable for making and breaking inductive loads. These shall generally be mounted at a height of approximately 1.35m above F.F.L. and shall be complete with galvanised steel boxes of specified manufacture. Each light fixture shall be provided with separate switch.

Single pole switches supplied from different phase or different distribution boards shall not be mounted in the same box. Single pole switches shall only be connected to the live side of the circuit.

16.6 CONDUITS, TRUNKING, TRAYS AND DUCTS

16.6.01 GENERAL INSTRUCTIONS

The Contractor shall supply and install a complete network of conduits, trunking, trays and duct works for the cabling and wiring system of the complex to the satisfaction and approval of the Consultant.

All conduits, trunking, trays, etc., shall be arranged in a neat, inconspicuous manner, and each system shall be completely assembled, inspected and tested before drawing-in of cables commences.

All Works shall be carried out in accordance with the latest I.E.E. wiring regulations and the recommendations of the manufacturers.

Before commencing any part of the works, the Contractor shall submit to the Consultant, for his study and approval, two sets of prints indicating conduit, trunking, trays and duct sizes together with the proposed layout of the systems.

16.6.02 CONDUIT INSTALLATIONS

GENERAL

Unless otherwise specified no conduits of diameter less than 20mm shall be used.

All conduits throughout shall be of sufficiently large sections and so arranged with sufficient number of draw-in boxes to allow easy drawing in or out of any or all the cables. Care shall be exercised to ensure that the number of wires in a conduit shall not exceed the number set out in the I.E.E. wiring regulations Tables B5M and B6M

for galvanised steel and PVC conduits respectively.

However, should these differ in any way from the regulations of the Supply Electricity Co. the requirements of the later shall be adhered to.

All conduits shall be run so as to facilitate self draining to outlet boxes, each length of the conduit shall be cleaned and dried with the help of a swab drawn through its length, and all boxes shall be cleaned to remove moisture before installing the cables.

Conduit bends shall be made with the bore of the tube remaining full and free throughout and all conduits shall be perfectly smooth inside and outside, and free from any burrs and sharp corners. Bends shall be made without heating the conduits and by using approved type of bending machine or bending block to give results consistent with the best practice.

No more than two right angle bends shall be permitted between draw-in boxes. No diagonal runs of conduits shall be allowed on the walls of the structure. Conduits concealed in the ceiling slab shall run parallel to walls and beams and those concealed in walls shall be run vertical and/or horizontal.

All conduits cast in concrete or laid in floor screeds shall be effectively secured, positioned and protected against mechanical damage and ingress of concrete etc. Allowance shall be made for thermal expansion and contraction of straight runs.

Where conduits run parallel to one another, the distance between adjacent conduits shall not be less than 15mm. At junction of multi-run of conduits, rectangular adapter boxes having internal dimensions not less than 150x100x50mm, shall be used. Maximum of 3 nos. 20mm diameter and maximum for 2 nos. 20mm diameter conduits shall enter the longer and shorter sides of the boxes respectively. Fore more or large sized conduits, larger boxes of appropriate sizes shall be used.

All conduits embedded in the walls shall be fully recessed to permit a minimum thickness of 15mm plaster or other finish to be obtained. Ceiling boxes for lighting fittings etc. shall be brought flush pattern switches, socket outlets etc. shall be recessed squaring into the wall structure until the from edge is level with the finished surface of the plaster or other finish.

Conduits shall be terminated in accessories, distribution boards etc. either screwed into the tapped spouts or holes where such are provided, or by locking into clearance holes by means of couplers and smooth bore hexagonal male bushes. Connections between the

conduits and box with clearance holes shall, in addition, be filled with a brass compression washer between the box and the coupling with no exposed thread.

Under no circumstance shall holes be drilled on any structural steel or prestressed concrete without the prior written approval of the Consultant.

PVC CONDUITS

PVC conduits shall be high impact, rigid, heavy gauge, tube complying with BS 5607, Part 1 and 2. All fittings and accessories shall be of the same manufacture as the tubes. Recommended suppliers are Egatube, Marshal,, Tuflex or as per particular condition.

All Conduits shall be unthreaded, slip-fit, push-on type. Plain couplers shall be used unless otherwise specified. All joints shall be made by weather proof adhesive as recommended by the manufacturer.

Terminations in metal equipment and accessories with tapped entry shall employ flanged couplings locked to the metal case and smooth bore brass or PVC bushes. At all expansion joints in the structure, expansion couplers shall be installed.

Draw-in boxes shall be of PVC

Wherever necessary, flexible conduits and approved type of adaptors shall be used.

Spacing of conduit runs from other services shall be to the following minimum values:

1. Cold water : 50mm
2. Hot Water : 250mm
3. Air ducts : 20mm

16.6.03 TRUNKING INSTALLATIONS

Heavy guage galvanised sheet steel trunking of approved manufacture and of minimum thickness 1.6mm shall be used in lieu of multiple conduit runs. The trunking shall be rigidly supported along its entire length at intervals not exceeding 1m. on horizontal runs. The lid or cover plates shall always face upwards.

Rigid heavy gauge PVC trunking of approved manufacture shall be used in lieu of multiple conduit runs, and shall be rigidly supported along its entire length. All fixings shall be with cadmium plated steel screws.

STEEL TRUNKING

Metal trunking and lids shall be constructed from sheet steel complying with BS 1449, Part 1B and shall be stove enamel finished inside and outside.

Galvanised trunking shall comply with BS 2989, Group 2, Class F, and shall be designed to be weather proof and shall be provided with external fixing lugs.

The thickness of the sheet steel for the different sizes shall be as follows:

Sizes upto but not including 50x50mm : Minimum 30 S.W.G.

Sizes from 50x50mm to 75x75mm : Minimum 18 S.W.G.

Sizes from 75x75mm to 225x150mm : Minimum 16 S.W.G.

Lengths of trunking shall be efficiently bonded to each other using strip copper links not less than 12x2mm and fixed with brass nuts and bolts and desrrated wahsers. All trunking shall be supplied with cable retaining straps at intervals of 925mm.

Trunking run horizontally shall be provided with cable separators with insulated pins at 925mm intervals. Trunking run vertically shall be provided with a cable support unit with insulated pins at 3m intervals.

Where trunking passes through floors and walls, fibreglass or an approved ceramic fibre packing shall be fixed into the trunking to form effective fire barrier.

Under no circumstance shall the cutting and bending of trunking to form flanges and attachments be permitted.

PVC TRUNKING

The installation of PVC trunking shall be generally similar to the installation of steel trunking but shall in no way conflict with the recommendations of the manufacturer.

Allowances shall be made for expansion of the trunking by using washers at all fixing points.

The earthing of the system shall comply with the I.E.E. wiring regulations and shall use separate earth continuity conductor throughout.

All jointing shall be carried out using a Vinyl cement glue in accordance with the manufacturer's recommendations.

16.6.04 CABLE TRAYS

Cable trays shall be perforated and manufactured from solid steel complying with BS 1449: Part 1 B, classification CR4/GP.

Cable trays shall be supplied in nominal 2.4m lengths and shall be of the return flange type.

Trays upto but not including 150mm wide shall be of 20 S.W.G. thickness; trays of width 150mm to 375mm shall be of 16 S.W.G. thickness and trays of width 400mm to 600mm shall be of 14 S.W.G thickness.

Wiring trays and accessories shall be hot-dip galvanised. Sections of trays shall be jointed together with 6mm diameter mushroom headed safety bolts and nuts to comply with BS 1494.

Holes cut in trays for the passage of cables shall be drilled and suitably bushed with lead.

Adequate copper earthing strips shall be fitted at every joint.

16.7 EARTHING

16.7.01 GENERAL

The Contractor shall supply install, test and connect a complete earthing system in compliance with the requirements of IEE regulations, and the recommendations as laid out in the BS Code of Practice C.P. 1013. Should these regulations and recommendations differ in any way with those of the Supply Electric Co. then the regulation sand recommendation of the latter shall be adhered to.

The Main L.V. earthing system shall comprise earth electrodes installed at appropriate locations near the electric room. Appropriate sized copper earthing conductor shall connect the earthing electrodes to main copper earth bars which shall be installed in the sub-stations. Frames of all items of L.V. switchgear, earth conductor etc. shall in turn be connected to the main earth bar.

16.7.02 EARTHING ELECTRODES

Tests for soil resistively shall be carried out in areas where earth electrodes are to be installed.

The number of earthing electrodes, their types, diameter, length, setting depth and the method of installation shall be in complete

conformity with the I.E.E. regulations and the requirements of NEC. The earth electrodes resistance shall under no circumstances exceed 0.5 ohm.

Generally earth electrodes shall be driven to a minimum depth of 3m or 0.3 below permanent water level. The earth electrodes shall comprise minimum 16mm diameter hard drawn copper rods complete with hardened steel tip, driving cap and phosphor bronze coupling suitable for the required size of copper earth conductor.

In areas of high soil resistivity it may be necessary to install more than one electrode. In such a case the electrodes shall be at least 6m apart with the necessary couplers between them.

The earth electrodes shall be connected to the main earth bar via a test clamp to be located 0.6m above F.F.L.

16.7.03 MAIN EARTH BAR

The main earth bar shall comprise a 65x10mm high conductivity electrical bars. 25x4.75mm copper strips shall connect all items of L.V. switchgear and all other L.V. equipment in the sub-station to the main earth bar.

16.7.04 EARTH ELECTRODE CABLE

The earth electrode cable shall be PVC insulated and sheathed standarded copper conductor of appropriate cross sectional area. The cable shall connect the earth electrode/s to the main earth bar. The ends of the cable shall be sweated into a lug and connected to the main earth bar with 16mm (minimum) brass bolts with 3 brass washers and two brass locknuts.

16.7.05 EARTH ELECTRODE INSPECTION HOUSING

A concrete inspection housing with a heavy duty hinged cast iron cover and frame made in a pit measuring 300x300x300mm shall be provided for each earth electrode connection. A permanent label marked with the words ‘SAFETY ELECTRICAL EARTH – DO NOT REMOVE” shall be provided at each connection.

16.7.06 ITEMS TO BE EARTHED

All metal parts of electrical equipment shall be connected to the earth system. Items of electrical equipment to be earthed are switchgear and distribution gear frames, cable shealths, metal conduits, trunking and accessories, outlet boxes, motor and pump casing, metal sinks, plant accessories, lighting fittings, switch plates, socket outlest etc. which are wholly or partly encased in metal.

All items in the system shall be effectively earthed and shall be continuously electrically conductive so that the electrical resistance at any point in the system to the main earth electrode shall not exceed 0.5 ohm.

Test specified in Appendix 6 of the 16th Edition of the I.E.E. wiring Regulations shall be satisfied.

The neutral conductor shall not be earthed anywhere within the complex.

The earthing of water mains and other services shall be carried out in strict accordance with the I.E.E. Regulations.

16.7.07 EARTHING CONTINUITY CONDUCTORS

Size of earth continuity conductors shall be in accordance with the latest I.E.E. regulations.

16.7.08 CONNECTIONS

All joints in copper shall be tinned, riveted and soldered.

Bolted connections shall be of the multiple bolt type. Bolts, washers and stop nuts shall be of copper alloy, everdur, durium, duronze or silicon bronze. Ferrous hardware shall under no circumstance be permitted. Where bare copper is jointed by bolting, contact surfaces shall be silver plated.

16.8 LIGHTNING PROTECTION

16.8.01 GNERAL

The Contractor shall supply, install, test and connect a complete and satisfactory system using approved protector heads to provide adequate protection of the complex against a strike by lightning.

The system shall comprise PVC covered copper tapes on the roof connected to buried earth electrodes by means of down conductors suitably spaced at intervals around the perimeter of the roof.

The installation of the system, including roof conductors, down conductors, testing clamps. Earth electrodes, fixing brackets, saddles, cleats, supports, jointing materials and all accessories, shall be carried out to generally comply with the recommendations laid down in the BS Code of Practice CP.326 and BS 6651 entitled “Protection of Structures Against Lightning”.

All joints and bends shall be kept to an absolute minimum. Clamps and bolted joints shall only be permitted at electrodes, protector

heads and test points. All other joints shall be tinned, soldered and secured with suitable number of rivets.

All exposed metal works like frame of water tanks, pipe work etc. shall be connected to the network.

No drawings are being provided for the lightning protection but the Contractor shall supply with his offer, his proposal for the complete installation works.

16.8.02 PROTECTOR HEADS

The installation of the radio-active protector heads shall be carried out to comply with the recommendations of the manufacturer. The protector heads shall be mounted on galvanised mild steel masts.

16.8.03 ROOF AND DOWN CONDUCTORS

Roof conductors shall be of high conductivity electrical, soft-annealed, copper tapes of minimum cross-section 20x3mm.

Down conductors shall be PVC sheathed, high conductivity, electrical, soft-annealed, copper tapes of minimum cross section 20x3mm. The down tapes shall terminate at the earth electrode/s.

Testing clamps fixed to the building structure above finished ground level shall be fitted to all down tapes to allow isolation of earth terminations for testing purposes.

Under no circumstance shall joints in down tapes be permitted.

16.8.04 EARTH ELECTRODES

The earth electrodes shall be 1.5m long 12mm diameter steel cored, hard drawn, copper rodes fitted with clamps for the earth tape connections.

In the event of multiple electrode earthing being necessary due to high soil resistivity, the electrodes shall be spaced a distance at least equal to their lengths.

16.8.05 TESTS

Tests shall be carried out to ensure that one or more earth electrodes shall be installed to give a resistance to earth not exceeding 10 ohms.

Tests shall also be carried out to prove the electrical continuity and mechanical strength of all conductors, bends and joints.

Test records shall be submitted to the Consultant for his study and

acceptance.

16.8.06 CONCRETE INSPECTION CHAMBERS

All electrodes shall be contained within a purpose-made concrete inspection chamber provided with a lift-off cover to facilitate easy inspection and access for testing.

16.9 FIRE DETECTION AND ALARM SYSTEM

16.9.01 GENERAL REQUIREMENTS

The Contractor shall supply, install, test, connect and commission fire alarm system which shall be designed to comply with the requirements of BS 5839.

The fire alarm system shall comprise a multi-zone control and indicator panel, manual break glass points, alarm bells, batteries and chargers, all as indicated in the drawings and shall be complete with all necessary connections, accessories and wiring to give a complete, reliable and satisfactory system designed to operate on 24 Volt DC.

The alarm system shall be designed to cover all zones as detailed in the drawings. In any zone of the building, the manual breaking of a break glass contact shall give visual and audible alarm signal at the indicator panel, and shall simultaneously ring local alarm bells in the particular zone.

All equipment and components of the alarm system shall be ordered from one approved manufacturer. The supply, installation, and commissioning of all fire alarm system shall be to the approval of the Civil Defence Authority.

The Contractor shall provide the Consultant with schedules of equipment and comprehensive wiring diagrams of the alarm system proposed and shall obtain his written approval before placing orders.

16.9.02 CONTROL AND INDICATOR PANEL

The control and indicator panel shall be designed and constructed to the requirements of BS 3116. The panel shall be located in suitable and approved position in the Entrance Hall.

The panel shall be of the illuminated lamp type designed for surface mounting and shall be equipped with all necessary supervisory alarm, buzzers, indicators, pilotlamps, switches, relays, push buttons, etc. The panel shall be arranged to indicate where the alarm initiated.

The panel shall be suitably protected against unauthorized operation:

On receipt of manual or automatic fire signal in any zone the following shall occur:

a. Visual and audible signals shall be given on the panel.
b. The appropriate zone indicators shall operate.
c. An “evacuate” signal shall sound in the particular zone.
d. An “alert” signal shall sound for 30 seconds in all other zones.

Facilities shall be provided on the panel for the following:

a. To silence the panel and zone alarm bells.
b. To enable the “Evacuate” signal to be sounded in any threatened zone.
c. To initiate alarm for individual zones or a general alarm for all zones.
d. To indicate an alarm condition to the Fire Brigade via telephone link.

The following functions shall be monitored against fault:

a. Alarm sounder circuit fault.
b. Mains supply failure.
c. Battery supply failure.
d. Earth leakage.

16.9.03 MANUAL CALL POINTS

All manual call points shall be designed and constructed to comply with the requirements of BS 5364. These shall be of the break glass surface mounted type, housed in a shatter proof and corrosion resistant case with front glass plate of approved type.

All call points shall be finished stove enameled Red and shall be complete with attached hammer and an instruction plate lettered “FIRE SMASH GLASS”.

All call points shall be arranged so that testing the alarm can be carried out without breaking the glass.

All call points shall be surface mounted at a height of 1.4m above F.F.L at the approximate location indicated on the drawings.

16.9.04 ALARM BELLS

All Alarm bells shall be of 150mm dia. These shall be tangent under done pattern, finished stove enameled Red, with the movement totally enclosed beneath gong. Minimum sound level for each bell shall be 65 dB(A).

All bells shall be surface mounted at a height of 2.3m above F.F.L. at the approximate locations indicated in the drawings.

16.9.05 BATTERIES AND CHARGER

Batteries shall be Nickel Cadmium type complete with trickle charger of sufficient capacity to operate the system for a minimum period of 24 hours during monitored conditions and, in addition, provide a full alarm for 30 minutes.

The batteries, chargers, metres, switches, including lamps, etc., shall be housed in a floor mounted sheet steel cubicle of approved construction and finish. The unit shall be connected to a switched fused spur unit supplied and protected from a final sub-circuit off the MCB distribution board DBG.

16.9.06 WIRING

The whole of the wiring shall be carried out in MICC PVC served cables of minimum cros-sectional area 1.5mm^2. The limit of voltage drop under full alarm load shall not exceed one volt.

All fire alarm wiring shall be completely segregated from all other wiring in the building.

16.9.07 RADIO AND ELECTRICAL INTERFERENCE

The alarm system shall be designed to avoid radio interference in excess of the limits specified in BS. 800. Interference from lighting and power supply transients shall be kept to a minimum.