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**REPUBLIC OF MALAWI**

**MINISTRY OF AGRICULTURE**

**SHIRE VALLEY TRANSFORMATION PROGRAMME-1**

**BIDDING DOCUMENT**

 **FOR**

**PROCUREMENT**

**OF**

**CONTRACTOR FOR THE CONSTRUCTION OF LAND REGISTRY AND IRRIGATION OFFICES AND RESIDENCES IN CHIKWAWA**

**VOLUME I – PARTICULAR SPECIFICATIONS**

**PROJECT : SHIRE VALLEY TRANSFORMATION PROGRAMME-1**

**ICB No: MW-MOAIWD-62074 – CW - RFB**

**EMPLOYER: MINISTRY OF AGRICULTURE**

**COUNTRY: MALAWI**

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**SHIRE VALLEY TRANSFORMATION PROGRAMME 1 CHIKWAWA HOUSES- PARTICULAR SPECIFICATION**

**ARCHITECTURAL**

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**ARCHITECTURAL**

**SECTION 1**

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 **SECTION 1**

 **GENERAL REQUIREMENTS**

1.1 Introduction

The requirements of the Particular Specification are to be applied in conjunction with the provisions of the Contract Drawings. Clauses relating to materials or workmanship not specifically required for the project may be ignored unless work is added under a Variation Order that includes such materials or workmanship.

1.2 Materials Generally

The whole of the materials incorporated in the works shall be new and of appropriate quality in perfect condition and shall be to the approval of the Project Manager’s Representative.

In the absence of the use of proprietary brand names as a means of establishing standards and quality, prices shall be deemed to allow for materials of a good standard with suitable and reliable backup. The standard of quality required will be that which is considered normal for buildings. Items such as Ironmongery, Sanitary Fittings, Joinery Fittings, Doors and Windows must be strong and robust and have a proven record for reliability. Generally the Contractor will be expected to submit alternative proposals to the Supervisor’s Representative before placing orders.

Should the Project Manager’s Representative (Lead Architect) discover on the works any materials other than those approved he may order their removal from the site and they shall be replaced by the Contractor with approved materials at his own cost.

All proprietary materials incorporated in the Works shall be fixed or applied strictly in accordance with the manufacturer's instructions. In the event that manufacturers insist that they either fix the materials, or supervise the fixing, then this shall be deemed to be allowed for in the Tender.

Unfixed material will only rank for inclusion in interim payment certificates if they are:

 - On site

 - For the permanent works

 - According to Specification,

 - Properly stored and protected against all damage and loss, including deterioration and theft.

1.3 Applicable Standards

The use of relevant international standards equivalent to British Standards is accepted.

1.4 British Standards

In the General Specification and other documents the letters BS followed by a number refers to a British Standard and the Letters CP followed by a number refers to a British Standard Code of Practice published by the British Standard Institution, 101 Pentonville Road, London N1 9ND.

Reference to British Standards shall not preclude the use of materials from sources where other standards apply, but no materials to be incorporated in the Works shall be in any respects inferior to those that specially comply with the relevant British Standards.

1.5 Samples of Materials

Where in the Particular Specification and other documents the Contractor is required to provide the Project Manager’s Representative with samples consisting of small pieces of materials for approval, the approved samples will be kept by the Project Manager’s Representative for reference. Deliveries of material to site will be compared with the reference sample and if there is any difference between the two, the materials delivered shall not be used in the works without the approval of the Project Manager’s Representative.

1.6 Workmanship

All workmanship shall be the best of its particular kind and shall meet the requirements of the Particular Specification, of other documents and of the Project Manager’s Representative.

1.7 Supervision

The whole of the works shall be supervised at all times by qualified staff fluent in written and spoken English and approved by the Project Manager’s Representative prior to commencement of the Contract.

The Contractor is to submit for approval by the Project Manager’s Representative an organisation chart naming the staff the Contractor proposes to employ, their qualifications, previous appointments and experience, and chart showing the estimated labour force over the duration of the Contract.

1.8 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 Architectural drawings are in accordance with his nominated Sub-Contractor's requirements. Details of holes, fixings etc., which are not shown on the Architect's drawings but are required by himself or by a Sub-Contractor shall be forwarded to the Project Manager’s Representative for his written approval before work proceeds. No holes or fixings shall be made without prior approval of the Project Manager’s Representative.

Where necessary the Contractor shall provide machinery and equipment suitable for erection on the concrete plinths allowed for in the design drawings. Where the equipment proposed by the Contractor calls for plinths larger than those shown on the design drawings then the Contractor shall pay at his own cost for structural engineering design check to ensure that the structure can withstand the additional loading.

1.9 Temporary Works

The Contractor shall be responsible for all necessary clearance of the site for the duration of the Contract.

The Contractor shall furnish the Project Manager’s Representative with full particulars, drawings, etc., of all temporary Works necessary for the erection of the Works and shall allow sufficient time for the Project Manager’s Representative to consider the same. The Project Manager’s Representative reserves the right to comment on the Contractor's proposal if he considers modifications should be made. The Contractor shall be solely responsible for the stability and safety of all temporary Works, unfinished permanent Works, and for the quality of the permanent Works resulting from the arrangements eventually adopted for their execution.

1.10 Construction Drawings

To assist the Contractor in ordering materials and in his preparatory work for constructing the works, the Project Manager’s Representative will issue certain drawings at various stages of their completion. These drawings may be used for planning and programming purposes and will be marked “PRELIMINARY ISSUE”

The Contractor shall ensure however, that only drawings marked "CONSTRUCTION DRAWINGS" shall be used for constructing the Works.

Construction drawings and schedules shall be issued under an Administrative Order or Architects Instruction. The Contractor will be responsible for keeping up-to-date drawings on site and shall have the latest drawing register available for inspection at all times.

1.11 Discrepancies

The Contractor is to bring to the attention of the Project Manager’s Representative any discrepancies within or between Contract drawings and/or the other Contract documents prior to work commencing, and shall not proceed with the works until the Project Manager’s Representative so instructs.

1.12 Programme to be Provided

The Contractor shall submit to the Project Manager’s Representative, within 14 days of signing the Contract, a detailed programme for all trades and external works and services, together with the target dates of receipt of information required to enable the Contractor to comply with the programme.

Every month the Contractor shall submit to the Project Manager’s Representative four copies of his detailed programme of work describing the areas in which he proposes to operate for the following monthly period.

Two weeks prior to commencing any new section of the works, the Contractor shall notify the Project Manager’s Representative in writing, the date on which he proposes to commence the work on that sector and any modifications to the previously submitted agreed working methods. Any such modifications shall have been agreed in writing by the Project Manager’s Representative.

The Contractor shall further submit to the Project Manager’s Representative a detailed schedule of items and information that he requires instruction upon to facilitate early ordering.

1.13 Vehicular Movements

The Contractor is not to construct temporary roads over existing pipelines, etc., or interfere in any way with any other underground or overhead services until approval from the Project Manager’s Representative is given.

Site access and circulation roads are to be to the limits agreed with the Project Manager’s Representative and for the purposes of the terrain to follow the road layout shown on the tender drawings.

1.14 Working Drawings for Services Installation

The Contract Drawings are not Working Drawings and must not be used for construction purposes. The Contract Drawings show typical layouts of plant and equipment and how the various items of plant and equipment are related to each other. For example, they do not necessarily show exact measurements of ducting, conduit, pipework, cables, etc., nor the exact number of bends and fittings required.

The Contractor should note that it is possible, due to the evolution of the designs, that services drawings do not match precisely and in every respect the configuration layouts shown on the architectural drawings. For the sake of clarity it is herein stated that the architectural, civil and Structural designs are definitive for the purpose of constructing the building fabric, external works, etc., the services drawings shall be adapted as necessary, by the Contractor, to meet the building requirements without diverting from the principles indicated thereon.

The Contractor shall be responsible for the production of Working Drawings for services installations that describe the works to be constructed in sufficient details for his site staff to execute the works.

The minimum requirements for Working Drawings are listed below:

 Mechanical Engineering Services

 (a) Ductwork drawings shall indicate clearances between ductwork and the building fabric. All dampers, fresh air inlets, exhaust outlets, connections to equipment and methods of support and any other details necessary for the satisfactory installation of the system must be indicated.

 (b) Piping drawings shall be fully detailed showing all pipes and indicating the precise size of fittings, valves and equipment. Position of expansion bellows, anchors, hangers and supports shall be indicated and a large-scale detail shall be given, showing the type and method of installation of each type of hanger and anchor. Piping drawings shall include external buried distribution services.

 (c) The Contractor shall prepare drawings and schedules showing precise details of holes in concrete, masonry etc., and necessary wood frames required for passage of ducts and pipes and fitting of grilles, louvers, plant, etc.

 Internal and Underground Drainage

 The drawings shall include the following minimum information:

 (a) Identification of materials used in each location by manufacturer and type.

 (b) Identification of fittings, access points and sanitary appliances.

 (c) Diagramatic or isometric details of the system.

 (d) Setting out dimensions of pipelines and invert levels.

 Electrical Engineering Services

 (a) The drawings shall show all details and dimensions of underground cable routes, distribution boards and switch positions, conduit runs (surface and concealed) accessory points, telephone and fire alarm points, draw-in boxes, draw-pits, earth pits, instruments and starters.

 (b) Single line diagrams for schematic systems layouts.

 (c) Drawings showing all other items related to electrical apparatus and equipment which form any part of this Contract.

 Every drawing shall bear the name of the Employer and the Contract title as shown on the cover of this document, each drawing shall be clearly titled and numbered.

 To ensure that all deviations from the Working Drawings are noted and to enable a record of work to be kept, a copy of all Working Drawings shall be maintained on site for the sole purpose of marking such deviations and shall be used for the preparation of the Record Drawings specified later.

1.15 Working Drawings Approval Procedure

 (a) The Contractor shall submit each Working Drawing to the Project Manager’s Representative for approval.

 (b) The Project Manager’s Representative will return one copy of the drawing to the Contractor, via the Main Contractor's Site Agent, within 28 days marked with one of the following:

 (i) Approved.

 (ii) Not Approved.

 (iii) Approved with Comments.

 (c) Drawings not approved will be marked to indicate whether it is for Technical (T) or Procedural (P) reasons. Rejection for procedural reasons could be because information from the Contractor essential to the approval process has not been provided. For example, a builder's work drawing has been received prior to the Working Drawing to which it relates.

 (d) If the Services Contractor is a sub-Contractor he shall send 2 copies of the approved drawings (amended in the case of drawings approved subject to comment) to the Main Contractor who is responsible for:

 (i) Co-ordinating the drawings to ensure there is no conflict with other services or activities.

 (ii) Checking that the Project Manager’s Representative’s comments, if any, have been incorporated into the drawings.

 (iii) Sending sufficient copies of the approved drawing to the Project Manager’s Representative. Each copy of a drawing shall be stamped with "APPROVED DRAWING", dated and signed over with the Main Contractor's company stamp.

 (iv) The number and distribution of the drawings described in (iii) above will be advised at the pre-contract meeting but the services Contractor shall allow for distributing 12 copies of each drawing.

 (e) Where the Services Contractor is not a Sub-Contractor he shall be responsible for all the activities listed above.

The Project Manager’s Representative’s approval of Working Drawings shall not relieve the Contractor of his responsibility for errors, as the Project Manager’s Representative’s approval is only general and not intended to serve as a check. The Contractor shall be fully responsible for ensuring that the works are properly completed and operate in accordance with the Specification and to the Project Manager’s Representative’s satisfaction.

Work must not commence until the Contractor has received the relevant Approved Working Drawing.

1.16 Record Drawings

Concurrently with the progress of the works the Contractor shall prepare all necessary drawings and diagrams of the "as fitted" works for record and for care, maintenance, repair, etc. purposes, and these shall be to the following minimum requirements.

 (a) The drawings shall be done in AUTOCAD 2017 or later version and shall be in accordance with BS EN 61082-1.

 All symbols used on drawings shall be strictly in accordance with the relevant BS’s for "Graphical Symbols".

 (b) The drawings shall show all plant, equipment and cables/conduit/pipe-work/ductwork runs as appropriate. Drawings of plant rooms shall be to a scale not less than 1:50 and shall include plans and sections to show at least two views of all plant and equipment installed. The drawings shall include full details of all plant together with cable/conduit/pipe/duct sizes, wiring diagrams and schematic and interconnection diagram as appropriate.

 (c) The drawings shall also show any other information even if previously shown on Working Drawings, which may be useful in the operation maintenance or subsequent modification or extension to the installation. The drawings shall show reference numbers or letters, for the control of plant items or any parts thereof, corresponding to the lettering, numbering or any other identification fixed to plant or equipment.

 (d) The drawings shall be clearly titled showing the Employer's name, the main title of the works, the contract number if appropriate; the description of the drawing, and room shall be left for the Employer to enter his own drawing reference number. The drawings shall be cross-referenced for ease of interpretation.

The following copies of Record Drawings shall be provided.

(a) 2 sets of white prints on opaque durable material.

(b) 6 sets for inclusion in the Operation and Maintenance Manuals.

(c) Electronic Copy on CD or DVD in both AUTOCAD and PDF Format.

Drawings shall be to the B.S. International A series of A0, A1, A2, A3, and A4.

The above drawings shall be provided within four weeks of handover of the works, or relevant phases of the works.

These record drawings are subject to approval by the Project Manager’s Representative.

1.17 Operation and Maintenance Manuals

Before the commencement of the commissioning of the equipment, 2 complete copies of the necessary draft manuals covering the operation and maintenance of the complete Engineering Services and/or Plant Installations covered by this Specification, shall be provided to enable the Employer to operate, maintain, dismantle, re-assemble and adjust all parts of the Works. The manuals shall be prepared specifically for this contract but where, for convenience of presentation, standard manuals are used they shall be edited to delete all irrelevant information. During the commissioning amendments may be made as necessary to the draft document.

Six copies of the manuals shall be supplied within four weeks of handover. The manuals shall be divided into sections as follows:

(i) An overall general description of the complete equipment installed, together with the method of functioning.

(ii) Full technical description of each and every item of equipment.

(iii) Complete electrical circuit details and/or pipe-work as applicable.

1.18 Ordering

The Contractor shall submit to the Supervisor’s Representative a monthly schedule showing all orders placed. The schedule shall supply the following details: order number, date of order, supplier, delivery date. For major items of equipment, the Supervisor’s Representative will require copy of orders and confirmation notifications from manufacturers.

These items shall be submitted by the Contractor each month.

1.19 Surveying Equipment and Assistance'

If so stated in the Bills of Quantities ((viz Bill No. 6D.1 Preliminaries), the Contractor shall provide for the duration of the Contract all survey instruments and equipment for the exclusive use as the Project Manager’s Representative may deem necessary for the carrying out of his duties in connection with the Contract.

Such instruments shall include laser theodolite and tripod capable of reading to 20 seconds, one level and tripod with horizontal circle, one level and tripod of the quickset type, and suitable levelling staffs graduated in metres, tapes, ranging rods, setting out pegs, etc., as may be required.

The Contractor shall provide a minimum-maximum thermometer located in a shaded ventilated box, to the approval of the Project Manager’s Representative and an elcometer.

The Contractor shall be solely responsible for all such instruments and equipment and shall ensure that they are, at all times, in good repair and adjustment.

1.20 Protective Clothing

At the commencement of the Contract the Contractor shall supply for the sole use of the Project Manager’s Representative and his staff visiting the work site 6 sets of protective clothing which shall include safety helmets and safety boots.

1.21 Testing of Materials

The Contractor shall arrange for testing any materials prescribed by the Project Manager’s Representative, to ensure their compliance with the requirements of the specifications. Any tests that cannot be undertaken on site shall be carried out at a location, and by qualified persons, approved by the Supervisor’s Representative.

1.22 Progress Photographs

The Contractor shall provide the Project Manager’s Representative at the end of each month with digital photographs showing the work in progress on site from different view-points selected by the Project Manager’s Representative.

1.23 Site Hoarding

The Contractor shall provide and maintain and finally dismantle all fences necessary for the demarcation and security of that portion of the site allocated for the Works. The site hoarding shall comprise 2400 x 1200 mm. vertical plywood sheeting fixed to 100 x 50 mm. vertical posts firmly founded and supported, with 100 mm. gaps between sheets, and painted white one side with the Contractor's motif on each sheet.

Alternatively corrugated painted galvanised metal sheeting may be used in lieu of plywood sheeting.

All gates shall be lockable. Hoarding to be in accordance with the requirements of the Local Authority.

1.24 Site Sign Board

The Contractor shall provide and maintain a sign board consisting of a steel framed sheet metal panel size about 5 x 3.50 m. painted with two coats of white oil paint back and front and supported 2.00 m. above the ground with concrete steel framing and struts painted matt black and let into the ground and fixed in concrete foundations. The sign board to be fixed on main highway at location to be agreed with the Project Manager’s Representative.

The Board shall be lettered in English to include:

1. The Project Client's Name.
2. The Donor’s Name.

b) The Consultant's Name.

c) The Contractor's Name.

d) Project Details

A large scale layout is to be submitted for approval by the Project Manager’s Representative before manufacture. No advertising material other than the above will be permitted.

1.25 Cleanliness of the Site and Roads

The access road and the site are to be kept clean and free from obstructions, rubbish and general spoil as the work proceeds and are to be maintained to the satisfaction of the Project Manager’s Representative. The public roads from which access to the site is gained must be kept clear and free from spoil, rubbish and disturbance. The Contractor must also ensure that the surfaces where damage occurs are to be maintained or repaired to the satisfaction of the Project Manager’s Representative.

1.26 Fuel and Water

The Contractor shall make his own arrangements for the supply of fuel and water required to undertake the works and for the support of his own operations.

1.27 Latrines

The Contractor shall provide sufficient and proper latrines for workmen and staff of both themselves and their Sub-Contractors in places near to where work is in progress. Latrines shall be kept in a clean and sanitary condition and the contents disposed of to the satisfaction of the Project Manager’s Representative. All latrines shall be constructed and maintained strictly in compliance with the requirements of the Health and Sanitary Authorities of the Government of The Project Country and to the satisfaction of the Project Manager’s Representative.

1.28 Dimensions and Levels

All dimensions and levels shown on drawings shall be verified by the Contractor on the site and he will be held responsible for the accuracy and maintenance of all dimensions and levels. All levels and dimensions shown on the drawings are expressed in metric units.

The Contractor shall check and verify all site measurements and levels, and shall produce a grid of existing ground levels at 0,25 metre intervals in both directions across the entire site which must be agreed by the Project Manager’s Representative prior to commencing excavations.

1.29 Site Clearance

The Contractor shall be responsible for the clearance of the site of all shrub, debris, rubbish, etc., such shrub, debris, rubbish, etc., to be removed off site to a location to be provided by the Contractor. However, no trees shall be removed without the prior permission of the Project Manager’s Representative.

The Contractor shall on completion of the works or when directed by the Project Manager’s Representative, remove all plant, tools, materials and rubbish which may have been used or may have accumulated during the progress of the works other than those permanently taken into the works. All rubbish or surplus materials or plant which the Project Manager’s Representative may require the Contractor to move at any time, shall be removed within seven days of receipt of written notice from the Project Manager’s Representative requiring him to remove same. In default of compliance with such notice, the Employer may forthwith remove such rubbish, surplus materials or plant and deduct the cost of doing so from the monies due to the Contractor.

1.30 Site CHIKWAWA HOUSES

The Contractor shall supply, erect and satisfactorily maintain in good repair, clean (at least once daily) and light, temporary, burglar-proof buildings for the exclusive use at all times as CHIKWAWA HOUSES by the Project Manager’s Representative and his agent.

The Contractor shall provide adequate vehicular access to the CHIKWAWA HOUSES and shaded car port adjacent thereto, for parking of the Project Manager’s Representative’s site staff vehicle.

The Contractor shall be responsible during the continuance of the Contract for the security of the CHIKWAWA HOUSES and for all plans, documents and papers and other articles contained therein.

The buildings shall be constructed to approved tropical standards, be well ventilated and air-conditioned and provided with windows capable of being screened from the direct rays of the sun and adequately weather and insect-proofed. The siting of the buildings shall be in accordance with the instructions of the Project Manager’s Representative.

The details of the buildings and the furniture and facilities that shall be provided for them are listed below. All the above shall be subject to the approval of the Project Manager’s Representative.

The Contractor shall at the completion of the Contract be responsible for the removal of the buildings, foundations and ancillary structures, and for the general levelling of the areas. At the completion of the Contract furniture and fittings shall be removed by the Contractor.

 Office floor area minimum 50 m²

 Loose furniture and fittings:

 2 No. desks 2 x 1 m. with lockable drawers

 2No. Office chairs.

 1 No. large table (3 x 2 m.) for drawing examination.

 1 No. conference table for 10 to 12 people (Approximately 3.75 x 1.2m).

 12 No. Chairs

 1 No. lockable filing cabinet (metal, 4 drawer).

 1 No. lockable plan chest (metal).

 2 No. waste bins.

 1 No. Telephone Set on land line or other approved.

 1 No. air conditioning unit 18,000 BTU.

 2 No. 3.6 x 1.2m pinboards

 Curtains or blinds to all windows.

 Project Manager’s Representative Office (area 20 m²)

 Loose furniture and fittings:

 1 No. table size 1.8 x 1.0 + 1 No. Office chair.

 1 No. 3.6 x 1.2 pin board.

 Kitchenette (area 10 m²)

 1 No. kitchen sink with two basins (stainless steel) mounted

 in cupboard unit for storing cut less cups, sugar bowls, tea, coffee, filters etc.

 1 No. Refrigerator.

 1 No. hot water kettle.

 1 No. coffee maker.

 - supply ofcups, cutlery, bowls, etc.

 - 5 litre chilled bottle water dispenser.

 Toilet (area 6 m²)

 1 No. W.C. in cubicle.

 1 No. lavatory basin.

 1 No. roller towel fitting.

 1 No. toilet roll holder

 1 No. mirror

 - supply of toilet paper, and adequate towels.

 It is preferred that the foregoing accommodation should be provided in one building, but individual adjacent units may be accepted if approved by the Project Manager’s Representative.

# SHIRE VALLEY TRANSFORMATION PROGRAMME 1 CHIKWAWA HOUSES- PARTICULAR SPECIFICATION

 **ARCHITECTURAL**

 **SECTION 2**

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**SECTION 2**

 **ROOFING, WATER PROOFING AND INSULATION**

2.1 Metal Roof Decking

Roofing (and/or vertical cladding) shall be approved, concealed-fix standing seam profile sheeting consisting of a galvanized sheet 0.60mm thick, 500mm wide with an embossed. powder coat finish to exposed side, fixed strictly in accordance with manufacturer’s instructions.

The roof decking material must be supplied complete with all accessories and fixings such as ridge caps, hip caps, valley gutters, flashing edge trims and copings as appropriate for the particular application.

2.2 Storage and Fixing of Roof Sheeting

The roof sheeting materials shall be stored and fixed in strict accordance with the Manufacturer's instructions and technical details guide.

Sheets shall be fixed to metal or timber purlins with approved clip fixing system strictly in accordance with manufacturer’s instructions.

2.3 Protection

All roof covering shall be covered up and protected during the course of the works and left thoroughly clean on completion to the satisfaction of the Project Manager’s Representative.

2.4 Roofs to be Weatherproof

All roofs are to be left perfectly weatherproof on completion to the satisfaction of the Project Manager’s Representative.

Waterproofing shall be guaranteed for a period of 10 years.

2.5 Roof Insulation

Where applicable, shall consist of reinforced aluminium foil sheet insulation as Super Sisalation 420 complying with SABS 381 - PART IV-1985.

2.6 Pipes through Roof deck

All ventilation stacks, ducts and pipes penetrating the roof deck to be waterproofed in accordance with the Architects details, consisting of steel powder coated galvanised steel sheething turned through 90 deg. above the upstands.

2.7 Waterproofing of Underground Structures

Where directed by the Project Manager’s Representative, to be asphaltic paint, to be laid over concrete surfaces in contact with the ground and on walls of underground structures.

2.8 Waterproofing of Wet Areas

The concrete floor slab shall be treated with two coats of bitumen based paint approved by the Project Manager’s Representative, in areas below bathroom tiles. Waterproofing to be turned 150 mm up walls on all sides of areas concerned.

2.9 Waterproofing of Flat Slab Roofs and RC Gutters

Waterproofing to reinforced concrete flat roofs and gutters is to consist of 4mm torch-on layer of Atactic Polypropylene modified Bituminous membrane applied strictly in accordance with manufacturers instructions and technical manuals.

Roof surfaces, grading material and slopes shall be prepared in conformity with British Standard Codes of Practice. Unless otherwise shown on the drawings slopes shall not be less than 1:100.

Roof decks shall be dry, even, smooth and clean. After screeding in the normal manner, the surfaces shall be lightly steel trowelled to give a smooth surface, free of voids and loose and raised particles. Corners and edges shall be coved or arrises rounded and finished as above.

2.10 Terms of Guarantee

On completion of the roofing in all respects, a guarantee that the roofs remain waterproof for a period of ten (10) years is required. This guarantee shall be in the name of the Employer and the Subcontractor or supplier who’s waterproofing system is used.

In the unlikely event of waterproofing failure in roofs at any time during the guarantee period, such treatment as may be necessary to keep roofs waterproof without extra cost to the Employer, subject to the conditions laid down in the guarantee, will be required.

# SHIRE VALLEY TRANSFORMATION PROGRAMME 1 CHIKWAWA HOUSES- PARTICULAR SPECIFICATION

**ARCHITECTURAL**

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**SECTION 3**

**CARPENTRY AND JOINERY**

3.1 Timber

All hardwood for carpentry and joinery work shall be well seasoned, sound, bright, free from shakes, large, loose or dead knots, waned edges, warp, incipient decay, stained sapwood or other defects and shall be equal to samples submitted for the approval of the Supervisor’s Representative.

Timber for Carpentry work shall hold the full dimensions shown on the drawings. All sizes shown on the drawings are finished sizes unless otherwise stated.

Timber for joinery work shall be cut to size and shape and finished wrought to the sizes shown on the drawings with pencil rounded exposed arises. No joinery shall be built in until inspected and approved by the Project Manager’s Representative.

The whole of the hardwood joinery shall be rubbed down to a smooth surface and left clean and ready to receive its final finish.

3.2 Moisture Content of Timber

Timber shall be properly and carefully air seasoned and if necessary kiln dried. The moisture content shall be suitable for the situation of the finished timber but shall be limited to 10% for internal work and 10% for external work. When fixed in position the timber shall remain stable and free from any expansion of contraction or other movement which will detract from the satisfactory performance or required appearance of the element. The timber shall be free from all drying defects whatsoever and there shall be no indication of shrinkage.

Timber shall be properly stacked and protected from excessive sun, rain or ground moisture.

3.3 Preservation of Timber

All timber shall be treated by vac-vac process to achieve an average loading of 40 litres preservative per cubic metre of timber.

Treatment shall be carried out after all cutting and shaping is completed and care shall be taken to avoid damage to surfaces of treated timber in subsequent handling. If treated timber is unavoidably cut or damaged a liberal application of preservative shall be made to the cut or damaged surfaces.

All treated timber shall be dry before incorporation into the works.

3.4 Plywood and Blockboard

Plywood and blockboard shall be of approved local or imported manufacture in accordance with BS 6566, BS EN 636 and BS 3444 respectively. Veneers shall be Grade 1 unless otherwise described.

3.5 Plastic Laminate

Plastic laminate shall be 1.5 mm standard grade decorative laminate or equal approved and shall be fully bonded with approved adhesive and backing materials.

A suitable balance shall be applied to the reverse face of materials that are described as being faced on one side with plastic laminate.

Plastic laminate shall be of the colour shown on the drawings or schedules and in accordance with BS 5252 and BS 4901 and the manufacturer's range.

3.6 Adhesives

Adhesives for timber shall be based on synthetic resins of phenolic and amino-plastic type complying with BS EN 301.

3.7 Fixings and Jointing

Nails shall comply with BS1202-1:2002 and screws shall comply with B.S.1210.

3.8 Plugging

Timber fixed to walls etc. Shall be plugged at 450 mm. centres with hardwood plugs. Plugs shall be cast or built in as the work proceeds, thus obviating as much as possible any later cutting away and making good.

Fibre, plastic or other proprietary plugs may be used only with the written permission of the Supervisor’s Representative.

3.9 Shot Firing

Shot firing will only be permitted at the discretion of the Supervisor’s Representative.

Shot fired fixings shall be approved by the Supervisor’s Representative and shall be fixed in accordance with the manufacturer's instructions.

3.10 Carpentry Generally

Carpentry work shall be put together with steel nails except where described as framed when it shall be properly jointed and held together with glue and brass screws. Fixings shall be stout steel nails and screws.

3.11 Structural Timber

Structural timber shall be SP 2 grade 50 in accordance with CP 112.

Structural timbers are to extend in one piece between their supports of fixings or to be jointed in an approved manner.

Where structural timbers are notched over supports the depth of the notch is not to be more than two fifths of the depth of the timber.

Where structural timber is to be cut for passage of pipes and the like, cuts are to be made as near the neutral axis as possible and are not to exceed one third of the depth of the timber, alternatively they are to be made in the top of the timber as far from the centre of the span as possible.

3.12 Joinery Generally

Joinery work shall be carefully put together and properly jointed in accordance with BS 1186 Part 2; all joints shall be glued and screwed or dowelled. Any screws appearing on face work shall have the heads let in and be pellated unless otherwise described hard-wood joinery shall be put together and fixed with brass screws.

Joinery shall be worked strictly in accordance with the contract drawings and finished to a smooth, wrought face (not machine planed only) with all arises pencil rounded. Where joints are not specifically indicated they shall be the same as joints shown on the drawings for similar positions. Joinery work shall not commence until the Supervisor’s Representative has approved the Contractor's full size setting out drawings but shall be prepared, framed up and put together, as soon as possible after the Contract is signed, and placed in a drying room for as long as possible before being wedged up. None of the joinery shall be delivered until it is required for fixing in the building.

The Contractor shall take overall measurements for joinery from the site and not from the Contract drawings.

All joinery that is to be oiled or painted shall be finished smooth and clean by rubbing down by hand with fine glass paper. All joinery shall be adequately protected from damage during the course of the works and on completion shall be to the Supervisor’s Representative’s entire satisfaction.

All glazing beads shall be pinned and glued in position.

3.13 Flush Doors

Flush doors generally shall comply with relevant British Standards.

Standard timber doors shall be semi-solid or solid core flush doors with veneers as specified Hardwood lipped all round.

The Contractor shall store flush doors in a weatherproof shed and they shall be stacked in a flat position so that their true shape is preserved until required for use.

3.14 Framed and Panelled Doors

Framed and panelled doors shall be of sizes and sections as indicated on the drawings and shall comply with relevant British Standards.

The doors shall be made in such a way as to avoid sag, bowing and generally in rigid construction.

3.15 Matchboard Doors

Matchboard doors shall be constructed and framed up to sizes shown on the drawings and shall comply generally with BS 459 Part 4.

3.16 Frames and Linings

All frames and linings shall be secured as detailed to the walls at jambs and to approval of the Project Manager’s Representative.

3.17 Architraves, Door Stops, etc.

Architraves, door-stops, etc., shall be properly mitred at intersections.

3.18 Defective Work

Should any shrinkage, warping or any other defect occur in the work either during the course of the works or during the period of maintenance the Contractor shall replace and make good any such work to the Project Manager’s Representative’s approval at his own expense.

3.19 Ironmongery

The ironmongery as detailed on the schedule shall be obtained from an approved manufacturer. The Contractor shall store and fix all ironmongery including cutting all necessary mortices, rebates and the like.

All ironmongery shall by carefully wrapped and protected until the completion of the works and items that are damaged or defaced shall be replaced before handing over.

All ironmongery shall be checked before hand-over.

All locks will be supplied with three keys properly labelled.

All locks shall be under a master key and sub-master key system unless otherwise specified. Design of the master key system shall be by the ironmongery supplier/manufacturer.

All card frames or door nameplates shall be engraved with room numbers.

3.20 Door matts

Door matts shall be close tread of the size to fit the matwells encased in pavement.

The matt well shall be formed by a 20 x 20 x 2 mm. stainless steel L shaped frame recessed in slab, with top edge levelled with finished floor.

Size of matts shall at a minimum cover width of entrances and thickness shall be 20mm.

3.21 Draught Excluders, Weather-proof Stripping and Threshold Seals

These shall be of proprietary manufacture approved by the Project Manager’s Representative.

Seals shall be formed from high tensile heat treated aluminium alloy with elastomeric inserts. The finish shall be anodized natural aluminium. Screws shall be bright zinc-plated double passivated to ZN3.

3.22 Architectural Ironmongery/Finish Hardware

Scope of Work

This specification provides the minimum requirements for the supply and installation of architectural ironmongery as applied to civil and building works.

General

Architectural ironmongery/finish hardware shall facilitate building use and maintenance, prevent unauthorised access and (if required) egress, allow escape from, protect against and inhibit spread of fire, create desired aesthetic effect. Advise the Project Manager’s Representative if any item detracts from these requirements.

Unless stated, hardware to aluminium units shall be by the aluminium fabricator in accordance with this specification but with finishes to match his sections. Floor spring units, boxes and cover plates and master keyed cylinders shall be by the general hardware supplier.

Hardware shall provide convenience of use and maintenance of the building security against unauthorised access (and in some cases exit), escape from, protection against and prevention of fire, smoke spread of toxic atmospheres of other hazards and protection to doors and other surfaces. The Contractor shall ensure that hardware supplied meets with the Project Manager’s Representative’s requirements, and if any item proposed or specified detracts therefrom the Project Manager’s Representative shall be informed.

The Contractor shall state in his tender his proposed source of supply of hardware, if different to that specified and that source shall not be changed without the approval of the Project Manager’s Representative.

The Contractor shall provide approved weather-proof storage facilities for all hardware delivered to the Worksite.

The Contractor shall check the hardware on installation for correct operation, maintain each item in accordance with the manufacturer`s instructions, protect it against damage by other trades and adjust, clean and lubricate it on completion of the Works.

The Contractor shall not fix hardware until background finishes are complete. Hardware previously fixed shall be removed before any finishing process. Ironmongery shall be supplied complete with all matching fixings.

British or other approved standards set minimum requirements, if this specification requires higher standards, the more stringent requirement will apply. Use of manufacturer references will not limit the Contractor`s duty to comply with the specification or the current editions of:

BS 476-10:2009 Fire tests on building materials and structures.

BS 729 Hot dip galvanised coatings.

BS 1210 Wood screws.

BS EN 12540:2000 Electroplated coatings of nickel and chromium.

BS EN 1935:2002 Hinges.

BS EN 10131:2006 Steel plate, sheet and strip.

BS EN 485, BS EN 515 Wrought aluminium.

BS EN 12329/12330 Electroplated coatings of cadmium and zinc.

BS EN 1172/1652/1653 Copper and copper alloys.

BS EN 13724:2002 Letter plates.

BS 3621:2007+A1:2009 Thief resistant locks.

BS 6100-1.3.6:1991 Glossary of terms.

BS EN1906:2002 Builder`s hardware. Lock and larch furniture (doors).

BS 5499:2002 Fire safety signs, notices and symbols.

BS EN 1125:1997 Emergency exit devices.

BS 5839-1:2002+A2:2008 Fire detection and alarm system for building.

BS EN 12209:2003 Locks and latches for door in building.

BS EN 1154:1997 Mechanical performance of door closers.

BS 6496:1984 Powder organic coatings for application and stoving to aluminium alloy.

BS 8220-1:2000 Guide for security of building against crime.

CP3 CH 4 Precautions against fire.

Designs Materials and Finishes

Regardless of other provisions, materials shall meet fire safety requirements and not be subject to bimetallic corrosion with background materials or other ironmongery.

Each item’s design and finish shall reflect the nature and quality of the project. Every finished surface of one material, whether extruded, rolled, cast or stamped, shall match exactly in colour and texture, and all items on any one visible door face ,shall be finished to an identical appearance.

Unless otherwise stated, minimum standards shall be:

Aluminium:HE9-TF alloy, hand polished and anodised 15 microns.

Stainless Steel: Grade 316 (18/10/3) molybdenum bearing grade) satin finished or hand polished to platinum like reflectance as required. Other grades or thin stainless steel cladding on other metal bases are unacceptable.

Coloured finishes: Electrostatically applied, oven cured powder coat BS 6496 on Grade HEO-TF aluminium alloy, anodized before coating, applied in a BS ISO 9000-2:1997 quality assured accredited factory and tested to BS 6496 and for light fastness, detergent resistance, impact and abrasion resistance (conical mandril to ASTM D 522 and falling ball to BS EN ISO 6272:1994, adhesion (1 mm crosscut to BS 3900 and scratch resistance (2000 g load to BS 3900).

Brass: CZ 121/2874 alloy, hand finished satin or mirror polished as required and protected by a transparent electrostatically applied, oven cured powder coating as specified for coloured finishes.

Bronze: CZ 121/2874 alloy, hand finished, bronze plated, acid relieved and protected by a transparent electrostatically applied, oven cured powder coating as specified for coloured finishes.

Fixing Devices

Provide suitable, matching, metric, rust-proofed fixing devices to suit the location and background, of allen key or equivalent positive locating drive types.

Pull handle fixings shall be passivated steel bolt through type, with cups, unless otherwise specifically required.

Fire Resisting and Emergency Exit Doors

The UK Guild of Architectural Ironmongers` Code of Practice sets minimum requirements but if a higher standard is required by this specification, by statute or by the Fire Service Department, the higher standard shall apply.

Ironmongery to fire rated door assemblies shall be of types and materials that will not compromise the specified rating. Fire and smoke controls doors, escape route doors and final exits shall have closers as described hereafter.

Emergency exit devices shall be mortice types of BS EN 1125:1997, with stainless steel crossbars, unless otherwise required. Visible latches or vertical bolts are aesthetically unacceptable.

"FIRE EXIT" and "PUSH BAR TO OPEN" signs to BS 5499-1:2002 and other signs required by the Fire Services Department will be provided by the signage supplier, unless otherwise specified.

Where latches or night latches are used, with a lever(s), on escape route doors, provide specially moulded polycarbonate, non-toxic, non-radiactive, visually unobtrusive, luminous rose surrounds and/or insert escutcheons, able to store natural or artificial light and, when lights are doused or fail, of emitting a bright luminosity for up to eight hours, to indicate the position of the lever. Such indicators shall be to DIN 67510 with a measured value FL.2.1-280 green and 2.10 mcd/m² minimum luminous density at one hour after excitation.

Hinges

Hinges shall be suitable types matching other items on the door, independently tested and certified as suitable for the door weight, size and usage intended. Hinges to fire rated doors and doors with closers shall be cage ball race type, to minimize closing friction and prevent wear, independently tested and certified as not compromising the specified rating and shall not contain low melting point materials, like aluminium or plastics.

If aluminium or brass hinges are required they shall have double stainless steel washers, lugged to minimise wear.

Stainless steel butts shall be ball race type. Stainless steel plain washers or rising butts are unacceptable, due to high friction wear.

Locks and Latches

Lock suites for use on fire rated door assemblies shall be independently tested and certified as not compromising the fire rating and shall not contain plastics, zinc or other low melting point components.

Mortice locks and latches shall be heavy-duty type to performance requirements of BS EN 12209:2003 Category B and, in addition, shall have:

a) 25 mm. deadbolts incorporating anti-sawing hardened steel rollers, 19 mm. stainless steel three part, low friction guided latch bolters.

1. If for lever handles, special springing against progressive lever droop (levers with sprung roses are unacceptable due to potential for damage and corrosion).

c) If for knobs, soft springing with two-way action and 70 mm minimum backset.

d) Facility for full reversal of hand, without opening the case.

e) Suitable forends, strike plates and rebate components if for rebated meeting styles, of non-corroding materials to match handles (including coloured finishes).

f) Six pin cylinders with practically infinite differentiations, incorporating safety pins and side locking bars finished to match handles and trim (includes coloured finishes), easily removable with the door open, without dismantling trim but not removable if closed. Five keys per lock.

Unless otherwise stated, locks shall be master keyed to a system of grand master, master and sub-master suites, without compromise to security standards.

Locks and latches shall also be construction keyed, with ten keys for the Contractors use, on completion, turning a master key in a lock shall negate all construction keys. Master and differ keys shall be supplied direct to the Supervisor’s Representative or Employer in a sealed container.

Supply a proprietory, lockable key filing/security cabinet with space for one key for each lock, including locks for fittings, fixtures, etc. plus 20% spare capacity and five plastic key tags with card insets and five "key-out tags for each space.

Lever Handles, Roses and Backplates

Lever handles should be of rounded section stainless steel or aluminium unless otherwise stated.

The levers shall be supplied complete with a corrosion proof hardened steel spindle suitable for door thicknesses between 35 mm and 54 mm.

Roses and backplates shall be of a 3 mm material with polished and anodised edges and the former should be capable of being fixed rigidly to the associated lock case by the use of metal thread screws provided, or fixed to the door with screws.

Lever handles should have a return section at free end to within 5 mm of door face.

Pull Handles

Pull handles should be of an approved stainless steel or aluminium section and shall be located directly opposite each other where handles are required each side of a door.

They shall be provided with bolt through fixings employing countersunk corrosion-proofed bolts with cup washers and locking patches.

Where appropriate, levers and pulls shall be of a type that allows forearm operations in addition to being suitable for hand operation. Pull handles, with a free end should have a return at the free end to within 5 mm of the door face.

Protection Plate

The protection plates shall be manufactured from 3 mm material except stainless steel plates which shall be from not less than 2 mm material.

They shall be fixed with flush countersunk screws located 5 mm from the plate edge/corner.

The plates should have square edges which have been polished and anodised, or with round formed edges.

The minimum sized of plates, unless otherwise specified, shall be:

 - Push plates : 185x185 mm.

 - Kick plates : 200 mm high.

 - Midrail plates : 200 mm high.

 - Trolley plates : 800 mm high.

Kick plates, trolley plates and mid-rail plates shall extend the full door leaf width less 10 mm.

The Contractor shall check dimensions on site against doors before ordering.

Door Closing Devices

Door closers generally shall be fully adjustable, hydraulic check types, incorporating the following features:

a) Closing speed fully adjustable between two and thirty seconds (if delayed closing is specified the door, when opened to 90 degree or beyond, shall stand motionless for a period adjustable up to 60 seconds, before starting to close).

b) Snap action closing to overcome latch resistance with a switch to negate such action for doors without latches.

c) Opening and closing from any angle up to 180 degrees, with check adjustable to operate from any angle between 135 degrees and closed.

d) Hydraulic reverse check or back-heck action, fully adjustable for angle of operation unless otherwise specifically stated.

e) Ten year guarantee for use in local ambient conditions, including positions of extreme exposure and, for backcheck closers, even if stops are not specified.

f) No visible manufacturer`s markings, except those of BS EN 1154:1997.

g) Produced in factories with a BS quality assurance.

Overhead closers shall be to BS EN 1154:1997. Standard units shall have power adjustable between sizes 2 and 4 of BS EN 1154:1997 (supply other sizes when necessary). They shall have plain, rectilinear, solid extruded bodies (not loose covers) finished identically to other items on the door, suitable rustproofed arms, fully concealed fixings and adjustment controls and only one fixing position, established by template, to minimise potential for incorrect fitting.

Closers to fire/smoke control doors, escape route doors, external doors and doors opening through more than 90 degrees shall be to BS BS EN 1154:1997 Class C and shall be certified by the US Underwriter`s Laboratory or other approved independent body as not compromising the fire rating of the door assembly.

Floor mounted closers shall be of one type suitable single or double action, wood or metal doors by use of compatible fittings, with concealed fixing cover plates matching other ironmongery on the door and specially reinforced galvanized main boxes allowing mechanical adjustment vertically, longitudinally and traversally after installation.

Rising butts are acceptable only on WC/shower cubicle doors. Spring hinges are unacceptable unless specifically required.

If both leaves of a pair of doors have closers and one must close first, due to rebated styles, etc. provide suitable selectors, which will not obstruct other ironmongery.

Bolts

At top and bottom of non active leaves of pairs of doors, flush bolts shall be provided having a 25 mm throw. The flush bolts shall have a 225 mm long body with a dove tail return to resist damage to the door.

Bolts located inside plant rooms, cupboards, etc. shall be of a lever action pattern and bolts on doors within escape corridors shall have slide knob operation.

Suitable bolt sockets or keeps shall be provided and shall be the easy clean "boat" type generally, but of a spring loaded dirt excluding type, at external or dirty locations.

Door Stops

Door stops are unnecessary if doors have stand-open or backcheck closers, unless opening against a wall. Elsewhere, provide suitable stops of types with robust holders matching other ironmongery on the door and with replaceable rubber inserts.

Where practical, use wall bumpers with round roses and buffered coat hooks within bathrooms and toilets. Elsewhere, use floor stops 38 mm (minimum) high 47 mm diameter, with expansion shield fixings, unless these will cause safety hazards to occupants, or if doors are undercut. Use overhead limit stays where necessary, Use roller bumpers if doors open onto each other.

Cabinet Hardware

Provide suitable ironmongery to fittings, fixtures, etc. to suit the location, type and function and to match door ironmongery.

Signs and Nameplates

The Contractor shall purchase signs and nameplates from a source approved by the Project Manager’s Representative.

Signs and nameplates shall comply with the appropriate British Standard as listed in Clause 0616, paragraph 3.

Signs and nameplates shall be in French and/or English script (except for graphic only signs).

Signs and nameplates shall be mechanically fixed to the background material by such means as approved by the Project Manager’s Representative. The use of adhesive shall not be permitted without the written approval of the Project Manager’s Representative.

Technical Support

The supplier shall offer full technical support and he or his agent must have suitable qualified resident staff, able to prepare/amend proper ironmongery schedules and advise on technical matters, including master key systems and problems of specification, installation and operation.

Manufacturer`s Guarantees

Before supply commences, provide a guarantee, specific to ironmongery for the project and unlimited by disclaimers of responsibility for ironmongery schedules, undertaking to repair or replace, free of charge, items which are or become defective due to faulty material or workmanship, or unsuitability for intended building use or prevailing external or internal environmental conditions, subject only to fixing according to approved ironmongery schedules and installation instructions supplied, for periods after installation of:

a. Hinges: five years (including guarantee against wear).

b. Locks and panic exit devices: five years.

c. Floor mounted or overhead surface mounted closers: Ten years including, for backcheck closers, if no stops are fitted.

d. Non-mechanical items (plates, handles, etc.) ten years subject to normal wear characteristics of the materials and finishes supplied according to these specifications.

Submittals

Make submittals in three stages. At stage 1 provide:

1. Details of the supplier and the qualifications and experience of local representative staff.

2. General catalogues, suitably marked to indicate each item of ironmongery proposed.

3. 150 x 150 mm samples illustrating each finish proposed to be supplied for locks, handles, closers, etc.

4. Independent test certificates providing compliance with relevant British Standards, including:

 a) Locks to BS EN 12209:2003.

 b) Panic exit devices to BS EN 1125:1997.

 c) Closers to BS EN 1154:1997.

 d) Stainless steel to BS/EN Grade 316.

5. The Draft guarantee in Appendix A, signed to indicate full acceptance of the conditions thereof.

6. Technical literature detailing lock range(s) proposed, marked to indicate equivalent types proposed and showing exact comparisons with functions of the locks specified.

7. Comparisons of ironmongery proposed with this specification detailing each deviation from the requirements hereof.

8. A representative sample board, showing items for typical doors, including a hinge, an operation lock with handles and trim fitted, a pull handle and overhead door closer.

Upon Stage 1 approval, make stage 2 submission, comprising:

1. A full ironmongery schedule, using the door-by-door set types principle, with each set fully detailed and listing every door for which the set type is proposed.

2. Any further information required by the Project Manager’s Representative.

On Stage 2 approval, make Stage 3 submission, comprising:

1. Samples of items not submitted at Stage 1 or 2.

2. The final signed manufacturer’s guarantee.

Approved samples will be kept and compared with items installed.

The granting of any stage approval will not guarantee approval at subsequent stages, nor will approval limit the Contractor’s responsibility to ensure that ironmongery complies with the specification and is suitable for the required use. If any item supplied is found not to comply with this specification and if such deviation was not included in the list of deviations in Stage 1 above, the supplier may be required to replace such items with items complying with the specification, at his own expense.

Operation, Maintenance, etc.

Delivery to the Project Manager’s Representative, on practical completion:

1. Any spares and parts required by the Contract documents.

2. Two full sets of fixing and operating tools.

3. Bound operation manuals with, in clearly labelled sections:

 a) Copies of manufacturer`s guarantee required above.

 b) General maintenance and fixing instruction sheets.

 c) Full performance/construction specifications, operations, adjustment and maintenance instructions for all locks, cylinders, handles, spindles, door closing devices, panic exit devices, hinges, etc.

 d) Final as-installed ironmongery and keying schedules.

 e) Such other information as may be reasonably required.

Work incidental to Ironmongery

The Contractor shall execute such incidental work as:

1. Co-ordination with other trades.

2. Factory mortising and reinforcing wood or metal doors.

3. Protecting from damage and deterioration during construction.

4. Removing fixed items before finished processes and re-fixing.

5. Checking, maintaining, adjusting, cleaning and lubricating.

6. Forming holes, mortises, chases and the like, reinforcing hollow constructions, making good finishes and protective and decorative painting where required.

7. Providing wiring, accessories, etc for access control doors.

**SHIRE VALLEY TRANSFORMATION PROGRAMME 1 CHIKWAWA HOUSES- PARTICULAR SPECIFICATION**

 **ARCHITECTURAL**

 **SECTION 4**

 **WALLING**

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**SECTION 4**

 **WALLING**

4.1 Brickwork

4.1.1. To be read in conjunction with the provisions of Section 7 of the Particular Specification for Civil and Structural Works.

1. Cement shall be as specified in Concrete Work.

4.1.2. Sand For Mortar

1. Sand shall be clean, uncoated grains of naturally occurring pit or fresh water sand; free from injurious amounts of dust, lumps, soft or flaking particles, shale, alkali, organic matter, loan or other deleterious substances, washed if necessary and shall pass a 5mm (3/16) BS sieve and not more than 15% by weight shall pass a No. 100 BS Sieve.

4.1.3. Sand For Concrete Bricks

1. Sand for Concrete blocks or bricks shall be fine aggregate complying with BS 882 or equivalent SABS.

4.1.4. Lime

1. Lime shall be non-hydraulic or semi-hydraulic well quickline from an approved source or hydrated lime to comply with BS 890 Class ‘A’ or ‘B’ or equivalent SABS.
2. Quicklime shall be thoroughly dry slaked (but not to saturation) for a period of from two to five days for lump lime and from one to three days for ground lime before mixing into wet mortar. Hydrate lime can be mixed into wet mortar without further slaking.

4.1.5. Water

1. Water shall be as specified in Concrete work.

4.1.6. Mortar

1. Cement mortar for brickwork below ground floor level for external pointing shall be composed of one part cement and four parts sand by volume.
2. Gauged mortar for brickwork above ground floor level shall be composed of one part cement, one part lime and six parts sand by volume.
3. Gauged mortar for all blockwork shall be composed of one part Cement, one part lime and eight parts sand by volume.
4. The proportions shall be measured in approved gauge boxes. The mortar shall be mixed in an approved mixer or by hand on a clean close jointed timber or metal mixing platform. If the mortar is mixed by hand, the materials shall be turned three times dry until the mixture is of an even colour throughout and turned three times dry until the mixture is of an even colour throughout and turned three times wet.
5. All mortar shall be prepared in sufficient quantity for immediate use only. No mortar shall be retempered for re-used after it has taken initial set.

4.1.7. Standard (Common Clay, Ceramic Clay, Sand-Concrete)

1. Bricks shall be a normal size of 225mm (9”) long (+6mm) x 112mm (4½) wide (+6mm) or (¼) x 70mm (2½”) high (+3mm) (or 2/8”); sound, hard well and evenly burnt, uniform in colour, regular in size and shape with true square metres arrises: free from all defects, stones and lumps especially of lime and shall have a minimum average crushing strength, for any 12 bricks, of 5.6N/mm² (800psi) for any individual brick.
2. Bricks used for fair face shall be handpicked for evenness of texture and shape.

4.1.8. Testing of Bricks and Blocks

Testing of bricks and blocks shall be in accordance with BS EN 771-3 and BS EN 772-2 and the Contractor shall submit the results of testing to the Project Manager’s Representative at regular, but not exceeding fortnightly, intervals. Testing of bricks shall be at the Contractor's expense.

Prior to manufacture the Contractor shall prepare ten samples of each brick or block for the Project Manager’s Representative's approval and the approved samples shall be clearly marked and retained until completion of the Contract.

4.1.9. Concrete Bricks

1. The length and height of Concrete Bricks shall be standard brick sizes or multiples thereof.
2. Concrete Bricks shall be true and square, with sharp arrises free from cracks and other imperfections.
3. Concrete Bricks shall be solid and shall have a minimum average crushing strength, (at 28 days after manufacture) for any 12 bricks of 5.6 N/mm² (800 p.s.a) for any individual brick.
4. Concrete Bricks shall be composed of cement and sand mixed in such proportions as to give a brick complying with the crushing strength stated above. In no case, however, shall the mix be richer than one part cement to six parts of sand or weaker than one part of cement to ten parts of sand.
5. The cement and sand shall be measured in approved gauge boxes and mixed in an approved mixer, or by hand as described for mortar, with only sufficient water to give the driest possible working mixture. The mix shall not stand longer than 20 minutes before moulding.
6. Moulding shall be carried out in metal moulds. The mix may be hand tamped, machine pressed or vibrated in the mould.
7. After removal from the mould, the bricks shall be stacked on a hard level platform, covered up and protected from the weather and kept constantly moist for a period of at least 8 days. Thereafter, the bricks shall be covered and protected from the weather for a further period of at least 21 days to allow them to dry out completely before being used. During the rainy season the Contractor will be required to erect a water-tight roof over the area upon which the bricks are made and stored.

4.1.10. Wall Ties

1. Wall ties shall be galvanised mild steel butterfly type or vertical twist type to comply with BS 1243.

4.1.11 Workmanship - Brickwork

1. All mortar shall be used fresh and made only in quantities sufficient to meet the immediate demand. No mortar which has partially set shall be revived or re-used.
2. Gauge boxes must be kept constantly on the site for the mixing of all mortar so that proportions shall be accurate.
3. All bricks shall be carefully stacked on delivery. No broken bricks shall be used in the structure. Four courses of brickwork shall not rise more than 40mm (1⅝) higher than four courses of bricks laid dry. Proper gauge rods shall be used. All vertical and horizontal joints shall be flushed up solid in mortar as the work proceeds. Bricks with “frogs” shall be laid “for up” and flushed solid with mortar.
4. All bricks shall be wetted on the scaffold before being laid and where work is left off, the tops of the walls shall be wetted before further work is begun.
5. All the bricks shall be well bedded and the joints flushed up thoroughly and pointed as the work proceeds. Damaged pointing shall be raked out and re-pointed.
6. All brickwork in walls shall be carried up in a uniform manner, no one portion being raised more than 1000mm (3’0’) above any other at one time. All perpends, quoins, etc, shall be kept strictly true and square and the whole properly bound together and levelled around at each floor.
7. The cavity of hollow walls shall be kept clean and free from mortar droppings by use of cavity laths laid across the ties and drawn up as the work proceeds. Sufficient bricks shall be bedded in sand at the bottom of the cavity to be cleaned out and shall be properly bedded in mortar completion.
8. Prices for holes shall include for cutting out in the required position after building, on the rake if necessary.
9. The prices for grooves, chases mortices, holes, etc are to include for cutting or leaving, which ever may be expedient.
10. The Contractor is to allow in his prices for construction a sample panel of facing brickwork, including pointing one side. The accepted standard for this panel will regarded as a yardstick throughout the job.
11. All brickwork in the course of construction shall be protected from inclement weather by suitable coverings.

4.1.12 Workmanship Blockwork

 a) All blocks shall be carefully stacked on delivery. No broken blocks shall be used in the structure. All blockwork shall be built true and perpendicular. Blocks shall not be wetted before laying and the tops of walls shall be protected from rain at all time during construction.

 b) Blockwork below ground shall be constructed in solid blocks with all vertical and horizontal joints flushed up solid as the work proceeds.

 c) Blockwork above ground shall be constructed in solid or hollow blocks with all vertical and horizontal joints shell bedded in mortar as the work proceeds (‘shell bedding’ consist of laying the mortar in strips not less than 40mm (1⅝) wide along the two outer edges of the block only so that a gap is left between the strips to prevent the passage of moisture).

 d) Blocks shall be properly bonded. Cut blocks shall not be allowed in fair face work.

4.1.13 Reinforcement

1. Where brickwork is to be reinforced with ‘Brickforce’ reinforcement or other approved such reinforcement shall comply strictly with the requirements of BS 4483 and shall

be free from rust laid in joints of brickwork and shall have 25mm (‘1’) minimum cover of mortar. Where utilised as lintels over door and window, openings, of mortar, the reinforcement is to extend ‘450mm’ on the either side of the opening.

4.1.14 Fair-face Brickwork and Blockwork

1. Unless otherwise described fair-face brickwork shall be executed in ceramic bricks or selected sand/concrete bricks and shall have the joints racked out and pointed as described as the work proceeds. If the Contractor wishes to execute the raking out joints and pointing after the general brickwork has been completed, then he may do so but only with the prior approval of the Project Manager’s Representative. The Contractor must include in his rates for pointing by which ever method he wishes to adopt.
2. Fair-face brickwork shall be kept perfectly clean and rubbing down shall not be allowed.

4.1.15 Sundries

1. Brickwork shall include for raking out joints for plaster, plumbing angles, fitting between vertical concrete members and up to soffits of horizontal concrete members and up to soffits of horizontal concrete members and for all rough over sailing and set-backs.

4.1.16 Building-in Timber Frames and Steel Frames

1. Wooden door and window frames are to be carefully and accurately set up in position, levelled and strutted in position to prevent movement. The brickwork must then be built up hard against the jambs on both sides and pointed where necessary in (1:4) cement mortar where necessary.
2. Building in steel door linings are to be carefully and accurately set up in position braced sufficiently to prevent any possible distortion, and the soffit strutted up and logs built in solid in (1:4) cement mortar, including packing in solid at back of lining with fine cement concrete as the work proceeds and pointing in (1:4) cement mortar where necessary.

4.1.17 Building-in timber, frames and Steel Windows

1. Steel windows are to be carefully and accurately set up in positions, levelled off true and plain and braced sufficiently to prevent any possible distortion. The lugs are to be built into brickwork in (1:4) cement mortar as the work proceeds and the brickwork built up hard up against the frame all round, including pointing in (1:4) cement mortar where necessary.

4.1.18 Air Bricks

1. The precast concrete, terra cotta or moulded PVC air-bricks shall be of an approved type manufacture.
2. The air-bricks are to be supplied complete with an approved fine mesh copper or aluminium woven wire flyproof screening securely fixed to inner face.
3. The openings through walls are to be formed with the nett size required and rendered smooth in cement mortar.

4.1.18 Damp Proof Course

1. Damp proof courses, generally shall consist of one layer of an approved 3-ply bituminous felt sheeting, complying with BS 743, laid on a level bed of 1;4 cement mortar trowelled smooth and cut to cover the entire width of foundation walls. At all angles, intersections, etc, the sheeting must be lapped not less than the width of the sheeting.

4.1.19 Generally

1. Prices are to include for bedding wall plates, building in hoop iron cramps and ties, pinning up to underside of beams and for all rough cutting plumbing angles, forming holes, chases, grooves, openings and all other labours not specially measured.
2. Cutting of forming holes through brickwork shall include for supplying and building in plastic or galvanised mild steel sleeves suitable for the diameter of pipe to be used.

4.2. Treatment of Brickwork to Concrete Junctions

 Unless described on the drawings to the contrary, the detail at joints shall be as follows:

4.2.1. Vertical Joint between Brickwork and concrete Column or Wall

 For all brickwork walls galvanised mid steel butterfly pattern wall ties to BS 1243 Fig. 1 are to be cast in concrete at 400mm. Vertical spacing and then built in to mortar bed joints of the wall. In addition, for 110mm brickwork walls built directly on a ground bearing slab, two thickness of building paper or similar shall be provided in the joint to separate the wall from concrete element.

4.2.2. Vertical Connection between Brickwork and Brickwork at Changes of Direction

All walls must be properly bonded at intersections except where a wall which is built off a ground bearing slab joins a wall built off a ground beam of footing in which case a vertical joint shall be provided with two layers of building paper or similar in between. The walls shall be tied together with galvanised butterfly ties every four courses.

4.2.3. Horizontal Joint at the top of the Wall between the Wall and concrete Beam or Slab over

1. Load bearing wall - the concrete slab or beam shall be cast directly on the wall except where the drawings indicate a “slip strip” other type of movement joint.
2. Non load bearing 230mm or 110mm wall - the top course of brick-work shall be constructed and the props have been removed and a period of 14 days minimum has elapsed after the construction of the remainder of the wall. The joint between the top course of bricks and the structure over shall then be packed tight with semi-dry mortal well rammed in.
3. All 110mm walls shall be constructed as (b) above except the joint between the top course of bricks and the slab or beam over shall be pointed with a weak mix mortar.

4.3. Protection of Finished Wall

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

The Contractor is to protect 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 Architects Instructions in this matter. The Contractor shall in all cases cover newly erected walling with hessian or other material approved by the Architect and shall keep the same wet for at least three days.

The Contractor shall prop and stabilise all walls prior to erection of floors and/or roofs and shall not remove any props without the prior agreement of the Project Manager’s Representative.

4.4. Compressible Joint Fillers

 Compressible filler board consisting of wood fibres impregnated with a bitumen emulsion shall be used where specified at joints on drawings or requested by the Project Manager’s Representative.

Filler shall be used to exact widths and shall have all edges neatly trimmed, and recessed 10mm from all external faces.

Fixing of filler shall be strictly in accordance with the manufacturer’s printed instructions.

4.5. Reinforcement

Wall tiles of fabric reinforcement for bonding walls where shown on the drawings or requested by the Project Manager’s Representative shall be submitted to the Project Manager’s Representative for approval.

4.6. Movement Joints

Movement joints between top of block-work and underside of concrete shall be located as shown on the drawings and shall be made with two layers of 1.5mm thick pre-formed plastic slip membrane to be submitted to the Project Manager’s Representative for approval.

4.7. External Pointing of Joinery

Joinery bedded against brickwork (on concrete) shall be pointed in standard grade cream-colour mastic to be submitted to the Project Manager’s Representative for approval.

4.8. Damp Proof Courses

Damp proof courses in walls shall be bituminous three-ply felt to BS 743 type A or equal approved.

4.9. Sealing of Joints

AI vertical and horizontal joints in block-work shall be sealed with polysulphide sealant to be approved by the Project Manager’s Representative

4.10 Cavity Wall Insulation

Where required, insulation between leaves shall be External Polystyrene Rigid Foam to be approved the Project Manager’s Representative.

Thickness to be 50mm or as directed the Project Manager’s Representative.

 **ARCHITECTURAL**

 **SECTION 5**

**NON-STRUCTURAL METALWORK**

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5.2 Welding

5.3 Galvanising

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5.5 Protective Coating for Aluminium

5.6 Metal Surfaces to be Joined

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5.8 Bolts

5.9 Emulsion Paint on Metalwork

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5.13 Handrails

5.14 Internal Information Signs

5.15 External Traffic Signs

5.16 Directional and Information Signs

5.17 Curtain Track Systems

**SECTION 5**

**NON-STRUCTURAL METALWORK**

5.1 Steel

Steel shall be of approved manufacture to comply with BS 7668:1994, BS EN 10029:1991 and BS EN 10113:1993.

5.2 Welding

Welding shall conform to BS EN 1011-1:1998 and BS EN 1011-2:2001.

5.3 Galvanising

The surfaces of all steel described as galvanised are to be thoroughly and evenly coated and shall be free from pinholes, lumps or surface galvanising materials and all other defects.

All damaged galvanised surfaces and all edges exposed by cutting after galvanising shall be treated with two coats of zinc paint sprayed on in accordance with BS EN 22063:1994. Ends of metal sections exposed by cutting after galvanising shall be treated with two coats of zinc paint, brush applied.

5.4 Aluminium

The contractor shall store and fix, including assembling component parts, aluminium windows, screens and glazing in accordance with manufacturer`s written instructions and shall ease and adjust and leave in perfect working order on completion. The installation shall be in accordance and comply with BS 4873:2004.

The back of aluminium frames shall be painted with two coats of bitumen paint before fixing.

Aluminium shall comply with BS EN 12020-2:2008, BS EN 573. Where aluminium is described as bronze or silver anodised, the colour anodising shall be to a thickness of not less than 25 microns (0.25 mm.) and the materials shall be supplied by an approved manufacturer. The colour shall be from the B.S. range to the approval of the Project Managers’ Representative. All other aluminium surfaces shall have natural anodised satin finish of 24 microns minimum thickness to BS 3987. All aluminium items embedded in or in contact with concrete or masonry shall be given heavy shop coat of approved Zinc Chromate primer.

Aluminium described as bronze or silver powder coated shall comply to BS 6496.

5.5 Protective Coating for Aluminium

All items under this section shall be delivered with a shop coat of transparent lacquer or some other equivalent material recommended by the manufacturer to protect the Aluminium surface from cement, mortar and other materials during construction. Before handing over the building the lacquer coating shall be removed, when so instructed by the Project Managers’ Representative, very carefully with lacquer remover. Surfaces shall not be scratched. Care shall be taken to the satisfaction of the Supervisor’s Representative to prevent damage to the items during construction.

At the time of handing over the building all work shall be left absolutely neat, clean and in perfect working order to the satisfaction of the Supervisor’s Representative.

5.6 Metal Surfaces to be Joined

Where it is necessary to join aluminium to steel or iron the two surfaces shall be separated by an approved insulation material not less than 1.5 mm. thick, where two ferreous surfaces are to be in contact they shall first be given two coats of Bitumen Type 2 in accordance with B.S.3416:1991.

Where two aluminium surfaces are to be in contact they shall first be given two coats of Zinc Chromate primer.

5.7 Metalwork Generally

Metalwork generally shall be welded to the satisfaction of the Project Managers’ Representative. All welds shall be neatly ground smooth and the whole left smooth and clean of painting or galvanising.

5.8 Bolts

Bolts, nuts and washers shall be of the types indicated on the drawings and shall comply with the relevant Bristish Standards.

5.9 Emulsion Paint on Metalwork

The Contractor shall take every precaution to avoid the application of emulsion paint on metal surfaces. This promotes excessive rusting and should emulsion paint at any time come into direct contact with metalwork, the paint shall be washed off or otherwise removed immediately.

5.10 Metal Inserts in Reinforced Concrete and Brickwork

Anchors, bolts, rolled sections, sleeves, pipes, inserts. etc., shall, unless otherwise mentioned, be galvanised and shall be fixed or inserted as shown or directed. The Contractor shall supply and place in the shuttering all such inserts as may be required for sanitary, electric, air conditioning or work of any other trade. Work shall be done exactly as required for the purpose, to the satisfaction of the Project Manager’s Representative.

5.11 Measurements to be Checked

The Contractor shall check all measurements at site and within surrounding works and make necessary adjustments in the drawings if required to suit actual site conditions to the approval of the Project Managers’ Representative before starting fabrication. If the actual dimension of the fabricated member does not match with the clear dimension of the site, such members should be rejected and be redone to the approval of the Project Managers’ Representative.

5.12 Assembly

Work carried out in sections shall be carefully assembled. All members shall be secured together or to the anchors by welding or as shown in the details. All welds shall be ground smooth and made to match the surrounding surfaces and finished to the satisfaction of the Project Managers’ Representative.

5.13 Handrails

Handrails and balustrades to be formed from non-corrosive 52 mm. diameter stainless steel tube 2 mm. thick to comply with relevant British Standards. Rails, balusters and connections to be prefabricated and slot together in a continuous line with no uncomfortable projections. Stainless steel to be finished in a semi-matt finish. Tubular Steel Handrails and Balustrades where specified and detailed shall comply to BS 5950.

5.14 Internal Information Signs

Internal warning, prohibition and/or information signs shall be manufactured in 1 mm. thick rigid plastic complete with fixing holes and radiused corners. Signs shall be 300 x 250 mm. in size and lettered in English or French as directed by the Project Manager’s Representative.

5.15 External Traffic Signs

External traffic signs shall be manufactured to BS 8842:2006, BS EN 12899-1:2001 and BS EN 1463-1:199 from 11 swg aluminium faced with reflective sheeting. Signs shall be Class 2 reflective faced with grey backs. The signs shall generally be 900 mm. diameter in size and shall conform in layout to the most recent edition of the Design Standards for the applicable Country/Region. Signs shall be lettered in English or French and shall be supplied complete with fixing holes; radiused corners; and stainless steel clips (2 per sign) and stainless steel bolts and nuts for fixing to posts.

Posts shall be manufactured in 75 mm. diameter galvanised iron tube set in 0.5 x 0.5 x 0.7 m. concrete foundations (concrete Class C20/20). Posts shall be painted with 0.3 mm. vertical alternate bands of black and white paint.

5.16 Directional and Information Signs

External directional and information signs for post mounting shall be manufactured to BS 8842:2006, BS EN 12899-1:2001 and BS EN 1463-1:199 from 11 swg aluminium class 2 reflective faced. The background borders, logo and lettering of the signs shall be screen printed in accordance with the requirements of the Client's corporate identity brochure and to the sizes given on the Contract Drawings.

The signs shall be lettered in English or French and shall be supplied complete with radiused corners; fixing holes; stainless steel clips and stainless steel bolts and nuts for fixing to posts.

Posts shall be manufactured in 75 mm. diameter galvanised iron tube set in 0.5 x 0.5 x 0.7 m. concrete foundations (concrete grade C20/20). Posts shall be painted white.

External signs for wall mounting shall be manufactured in 22 swg aluminium Class 2 reflective faced, complete with radiused corners, fixing holes and stainless steel clips for wall fixing.

5.17 Curtain Track Systems

Curtain track and curtains as shown on drawings. Track shall be extruded aluminium alloy, etched and anodised silver finish and siliconised. The integral glider and hook shall be moulded from high quality nylon at the rate of 10 per metre track. The system shall come complete with all connectors, brackets, capping and end-stop pieces, and suspension hangers. The aluminium shall comply generally to BS EN 12020-2:2001 and BS EN 573:1995.

 **BUILDER'S WORK IN CONNECTION WITH BUILDING SERVICES**

 **INDEX**

6.1 Joint Sealants

6.2 Sealants Types

**SECTION 6**

 **BUILDER'S WORK IN CONNECTION WITH BUILDING SERVICES**

6.1 Joints Sealants

Joints sealants and caulking at junctions of sanitary ware and work tops with tiled splashbacks or wall tiling shall be approved gun grade one part silicone rubber sealant.

6.2 Sealant Types

**Type A** Structural expansion and isolation joints.

Floors and walls will have proprietary elastomeric joints.

The sealant shall be a one-part silicone sealant, type A to BS EN ISO 1160:2003 and capable of plus or minus 25 percent movement (minimum). The colour and sealant shall be to the Project Managers’ Representative’s approval.

**Type B** Crack -control joints in medium and heavy duty floors.

The sealant shall be a two-part chemical-fuel-and oil-resistant and abrasion-resistant elastomeric sealant capable of plus or minus 5 percent movement (minimum) and to the Project Managers’ Representative’s approval.

In areas subject to spillage of hydraulic fluid or other aggressive agents, suitable alternatives which will not be subject to attack shall be used as agreed with the Project Managers’ Representative, eg. to mechanical workshops.

**Type C** Sealant for Windows, doors, sanitary fittings, Ceramic tiling and general builders work.

The sealant shall be a one-part high-modulus silicone sealant, type B to BS EN ISO 1160:2003. The colour shall be to the Project Managers’ Representative’s approval.

**Type D** Glazing and Bedding compound.

The sealant shall be an oil-based material containing synthetic polymer, manufactured specifically for glazing bedding to be to the Project Managers’ Representative’s approval.

**Type E** Roads and Hardstandings.

The sealant shall be a chemical-fuel-and-oil resistant cold-applied two-part elastomeric compound to BS 5212-1:1990, BS 5212-2:1990 and BS 5212-3:1990 to the Project Managers’ Representative`s approval. It shall be capable of plus or minus 12.5 percent movement (minimum).

**Type F** Pipes and Services through Partitions

All pipes, ducts and conduits passing through partition walls or through slabs shall be sealed around the pass through hole with intumescent mastic.

Intumescent mastic shall be resistant to Ozone and Ultra violet radiation as well as to water, solvent and ice.

Density of mastic shall be not less than 1,35 gr/cm3

###### SECTION 7

 **FLOOR, WALL AND CEILING FINISHES**

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7.3 Granolithic Paving/Screed.

7.4 Cement Additives.

7.5 Angle Beads.

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7.7 Precast Terrazzo Tiles.

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7.13 Floor Screeds.

7.14 Insulation.

7.15 Protection of Finishes.

7.16 Plaster Board Ceilings.

 **SECTION 7**

 **FLOOR, WALL AND CEILING FINISHES**

7.1 Materials

Cement and water shall be as specified in concrete work.

Sand shall be clean and well graded and shall comply with BS EN 13139-2002 Table.1.

7.2 Rendering

All walls shall be prepared for rendering as follows:

A. Hack all concrete surfaces to provide an adequate key.

B. Secure over all joints of concrete to blockwork, except where expansion or movement joints are incorporated, a single layer of galvanised expanded metal mesh 400 mm. wide, stapled at 500 mm. centres.

C. Secure over all chases a single layer of expanded metal lath, as above, to extend 150 mm. minimum each side of chase.

D. For external rendering fix expanded metal external corner angle beads to external corners fixed with 1:4 cement/sand mortar `Dabs'.

E. Hand throw a 2 mm. coat of 1:3 cement/gravel slurry on to all surfaces to be rendered to provide a roughened face, allow to dry at least 24 hours before commencing rendering.

F. Rake out all joints in blockwork to 15 mm. below block face to provide key.

Rendering to ceilings shall be 10 mm. average thickness, applied in one coat. Internal rendering to walls shall be 15 mm. average thickness in total applied in two coats. The first coat shall be cross-hatched and combed to provide key for the second coat, before setting.

Rendering on walls and ceilings shall consist of cement, lime and sand in the proportions 1:1:6 measured by volume, finished with a steel skimming float and transversed with a floating rule to a true and even surface. Approved plasticising agent may be employed if required, with the written approval of the Project Manager’s Representative.

The rendering shall be kept damp for at least seven days after its application.

Rendering to receive tiles shall be cross-hatched and combed to provide key, before setting.

The Contractor shall carry out a suitable wall of his selection of approximately 10 m. sq., as a test panel for approval, before continuing his operation.

The Contractor may propose, as an alternative to “lime putty plaster”, a proprietary finishing plaster such as Rhinolite subject to Project Managers’ Representatives approval.

7.3 Granolithic Paving/Screed

Granolithic paving shall be composed of five parts of approved local hard stone chippings, free from organic impurities, crushed to pass a 10 mm. mesh screen in the clear and graded down to, but excluding dust, to two parts of cement by volume, mixed with water to form a homogeneous mass.

When granolithic paving is to be finished with sodium silicate, three coats of approved product shall be applied in accordance with the manufacturer's instructions.

Granolithic paving or (screed) described as having a carborundum finish shall be treated with carborundum dust evenly sprinkled on whilst concrete is still green at the rate of 1.5 kg/m. sq. and lightly trowelled in before final trowelling or alternatively incorporated in the finish by means of a mechanical power float.

Granolithic paving or screed described as painted with a matt sealer shall have one coat of clear matt liquid plastic dressing applied in accordance with the manufacturer's printed instructions.

7.4 Cement Additives

Additives will only be used with the approval of the Project Managers’ Representative and shall be used in accordance with the manufacturer's printed instructions.

7.5 Angle Beads Etc.

The angle and stop beads shall be obtained from a manufacturer approved by the Project Manager’s Representative, and shall be fixed in accordance with the manufacturer's instructions.

7.6 Full Bodied Porcelain (Non-slip))

Porcelain floor tiles shall be 600 x 600 x 9.5mm or 300 mm. x 300 mm. X 6.5 mm. fully vitrified to BS EN ISO 10545 of a colour selected by the Project Managers’ Representative from an approved manufacturer's standard range. Acid resisting tile with acid resisting grout shall be used where specified and/or shown in the drawings.

The tiles shall be laid in accordance with CP 202 using an approved tile adhesive on a cement and sand floor screed. All joints shall be kept narrow and of regular width.

All tiling shall be grouted up on completion, care being taken to fill all joints completely. The grout shall consist of an approved cement-based grout of a colour to match the tiling. Any surplus grout shall be cleaned off the face of the tiling and surrounding surface immediately and all tiling shall be carefully cleaned off on completion.

7.7 Precast Terrazzo Tiles

Precast terrazzo tiles and skirtings shall be made from cement and coloured stone chipping as approved by the Project Managers’ Representative. The tiles shall be polished hard, durable and non-absorbent, of exact shape and even thickness and shall have sharp true edges and be the best of their respective types. Wearing layer thickness shall be no less than 10 mm.

The tiles and skirtings shall be bedded and jointed in cement mortar (1:4) on a cement and sand (1:3) screed and the joints shall be kept narrow and surplus mortar wiped off immediately after laying. 6 mm. glass dividers to be provided for every 10 sq m of file area.

The tiling skirting shall be grouted up on completion, care being taken to fill all joints completely. The grout shall consist of neat cement of a colour to match the tiling. Any surplus grout shall be cleaned off the face of the tiling and surrounding surface immediately and all tiling shall be carefully cleaned off.

All terrazzo surfaces shall be ground down and polished on completion to a true even level, to the satisfaction of the Project Managers’ Representative.

7.8 Clay Quarry Tiles

The clay floor quarries shall be 200 mm. x 200 mm. x 16 mm. heavy duty non-slip acid resistant class I tiles to BS EN ISO 10545. Skirting shall be formed with similar tiles set one tile high.

The tiles shall be bedded and jointed in cement/sand mortar (1:4) on a cement and sand floor screed. All joints shall be kept narrow and or regular width, and surplus mortar shall be wiped off immediately after laying.

The tiles shall be laid so that cutting is kept to a minimum and cut tiles are next to the skirting or walls. Cut edges of tiles shall be rubbed smooth.

All tiling shall be grouted up on completion, care being taken to fill all joints completely. The grout shall consist of neat coloured acid resistant grout to match the tiling. Any surplus grout shall be cleaned off the face of the tiling and surrounding surface immediately and all tiling shall be carefully cleaned off on completion.

7.9 Compression/Expansion Joints in Tiled Floors

Perimeter joints and expansion joints in tile flooring shall comprise of a 10 mm Aluminium profile medium duty compression/expansion joint with a high performance polyurethane infill set in floor screeds.

Tile expansion joints as described above must be instituted at intervals not exceeding 30m² or as recommended by Tile manufacturer.

7.10 Interlocking Paving Blocks and P.C. Conc. Paviors (To be read in conjunction with PS-Struct/Civil Section 9)

Interlocking paving blocks shall be in approved colours and shapes as indicated on the drawings. Dyes used in manufacture must be colourfast.

 Thickness Min.Crushing

 Strength

Pedestrian traffic areas 50 mm 25N/mm²

Light traffic areas 60 mm 25N/mm²

Heavy Traffic Areas 80mm 30N/mm²

Exposed aggregate P.C. conc. paviors shall be 400x400x40 with smooth finish.

Blocks shall be laid to falls as indicated on the drawings on a sand bed layer of minimum compacted thickness of 35mm on a compacted sub-base, minimum thickness 150mm. Blocks shall be placed firmly together without disturbance to the laying course and the order of placing the blocks shall ensure this.

At the edges of obstructions such as gully gratings or manholes blocks shall generally be cut to fit. Where it is not possible to cut blocks to fit neatly to an obstruction, the obstruction shall be surrounded with concrete in advance of paving and the blocks cut to fit at the edges of the concrete. The sub-base shall be constructed in accordance with the specification for making up levels under ground slabs in the section Excavation and Earthworks.

The sandbed layer shall consist of graded sharp sand containing not more than 3% of silt and clay by weight and with not more than 10% retained on a 5mm sieve.

The sand shall be struck off to such a level that when blocks have been vibrated the upper face of the blocks shall be true to the finished level within the tolerances stated in this specification. Before the blocks are laid, the laying course shall not be subjected to any form of trafficking before, after or during screeding.

The surface course shall be subject to passes of vibrating plate compactor which shall have a centrifugal force of approx 26-20KN and a frequency of approximately 75-100 Hz and a plate area of between 0.35 and 0.5m². Sufficient passes shall be made to compact the laying course and produce an even surface.

Vibration shall not be carried out within one metre of an unrestrained edge.

After initial vibration, sand shall be brushed into joints followed by further passes of the vibration plate compactor, more sand being spread over the surface if required.

Vibration of the blocks shall be completed as soon as possible to ensure that the sand surcharge is correct and, if not, alterations made.

Edge restraint shall be provided to retain paving units by means of pre-cast concrete edgings anchored into the sub-base to be independent of the paving units. Unless otherwise described in the contract or agreed to in writing by the Supervisor’s Representative the edge restraint shall be provided in advance of the laying of the paving blocks.

7.11 Pre-cast Concrete, Kerbs, and Channels

Precast concrete, kerbs and channels shall comply generally with the requirements of BS EN 1340 manufactured from sulphate resisting grade 25 concrete. They shall be hydraulically pressed.

Kerbs and channels shall be bedded to line and level on plain sulphate resisting concrete mix grade 25 foundations and shall be haunched up as required in similar mix concrete.

7.12 Wall Tiles

White and coloured glazed wall tiles shall be cushion edge ceramic wall tiles complying with BS ISO 15552:2004 and shall be complete with all necessary round edge tiles and skirting system to match wall tiles all to the approval of the Project Managers’ Representative. All tiles shall be 300 x 300 x 6.5 mm. Thick or as otherwise specified on a detail drawing.

Wall tiles shall be fixed with approved adhesive to rendered walls. Joints shall be kept horizontal and vertical, and shall be neatly pointed in white or coloured grout as approved by the Supervisor’s Representative.

Design patterns are to be approved by the Supervisor’s Representative.

Rounded edge tiles and fittings shall be used as required or alternatively PVC or aluminium edging strips as approved by the Project Managers’ Representative.

Polysulphide cement joints to internal corners shall be one-part gungrade polysulphide based sealants to BS EN ISO 11600:2003.

7.13 Floor Screeds

Screeds shall be finished smooth to the required depth with a steel or wood float suitable for final finishes as specified and shall be covered to avoid too rapid drying out. Screeds shall be laid alternatively in bays not exceeding 11 m. sq., with joints over any construction joints in the concrete slab. Before laying screeds, the surface of the concrete slab shall be thoroughly cleaned and a coat of cement grout applied.

The mix proportions for floor screeds shall be one part ordinary portland cement to three parts sand.

7.14 Insulation

No polyurethane, silicones, epoxy based formed plastic or formed plastic treated with flame-retardant solution may be used where insulation is specified.

7.15 Protection of Finishes

The Contractor shall provide adequate protective measures to ensure that all finishes are perfect and undamaged before handing over. Any damaged finishing shall be replaced at the Contractor's expense.

7.16 Plaster Board Ceilings

Material: To be gypsum plaster board to BS EN 520:2004 with tapered edges. Thickness to be 10mm or as otherwise directed on the detail drawings.

Workmanship: Code of Practice: Comply with BS 8481:2006, BS EN13914-2 and PD CEN/TR 15123 in respect of the recommendations for handling and mechanically fixing plasterboard.

Brandering: GS brandering system and suspension system.

External Angles: Seal with reinforced paper tape and 3 applications of joint filler to give a clean smooth and crisp corner finish.

Surface Treatment Apply gypsum plaster slurry over joint finish about 200mm wide.

of Boards: in two coats at all joints and feather out. Finally apply another coat overall the boards and finish with sponge to produce a smooth consistent surface ready for direct decoration.

Nail and Screw Indentations to be made good with coats of spotting joint filler in the same way as treatment of joints.

7.17 Suspended Modular Ceilings

Module 600 x 600mm

Material Mineral wool tiles 15-20mm thick square or white bevelled edged as Specified by Architect.

Grid Exposed/recessed as specified by Architect installed strictly according to Manufacturers instructions.

Wall Angle Recessed wall angle. All gaps filled in with white silicone to finish.

#### SHIRE VALLEY TRANSFORMATION PROGRAMME 1 CHIKWAWA HOUSES- PARTICULAR SPECIFICATION

#### ARCHITECTURAL

#### SECTION 8

 **GLAZING**

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**SECTION 8**

**GLAZING**

8.1 Generally

All glass shall be of the type, quality and substance complying with BS 952 Part I Table 1.

8.2 Clear Sheet Glass

Clear sheet glass shall be 4, 6 or 10 mm. nominal thickness transparent float glass as indicated on the drawings (glazing glass grade GG).

8.3 Wired Glass

Wired glass shall be either polished or cast Georgian wired glass 6 mm. thick as indicated on the drawings.

8.4 Obscured Glass

Obscured glass shall be rough cast glass to an approved pattern and shall be 4 mm. or 6 mm. thick as indicated on the drawings.

8.5 Glazing

Glazing shall be in accordance with BS 6262:2005.

Glazing to timber doors and frames shall have all rebates in timber cleaned and primed prior to glazing. Edges of glass shall be bedded in imitation wash leather strips of approved colour and manufacture.

8.6 Mirrors

Mirrors shall be silvered 6 mm. clear float glass complying with BS 952.

Silvering shall be one side only and shall be protected with an electrocopper backing, shellac varnish and paint.

Mirrors shall be delivered to site cut to size and drilled for fixing. All exposed glass edges shall be ground smooth and bevelled to the approval of the Project Managers’ Representative.

Mirrors shall be countersunk drilled for an fixed with a minimum of four cover head screws with 15 mm. diameter detachable screw covers.

8.7 Reflective Glass

Reflective glass shall be 6.38mm laminated Solar Shield S10 Green, colour and manufacturer to the Project Managers’ Representative’s approval.

8.8 Laminated Glass (6.38mm thick)

Laminated glass shall be made by a tough clear plastic film of no less than 0.65 mm. sandwiched under heat and pressure, between layers of float, tinted or any other type of glass as specified for each type of opening.

8.9 Toughened Glass

Toughened glass shall be clear or tinted with the dimensions and thickness specified for each type of opening. It shall conform in all aspects with BS 6206 class A.

8.10 Handling and Storage

The Contractor shall exercise great care to ensure that the glass is not damaged in handling.

Glass shall be stored under cover in a vertical position in storage racks.

8.11 Cleaning Glass

All glass shall be cleaned inside and outside and all broken or cracked panes shall be replaced at the Contractor's expense prior to handing over the works.

**SHIRE VALLEY TRANSFORMATION PROGRAMME 1 CHIKWAWA HOUSES- PARTICULAR SPECIFICATION**

**ARCHITECTURAL**

 **SECTION 9**

 **PAINTING AND DECORATION**

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**SECTION 9**

**PAINTING AND DECORATION**

9.1 Generally

All paint and the like shall be brought on to the works in unopened and sealed tins and no paint shall be taken from the job to another.

All paint shall be used within six months of delivery.

Any residue left in a tin shall not be added to the contents of another tin.

Colours and tints to BS 4800:1989 shall be chosen by the Project Managers’ Representative who will furnish the Contractor with a schedule giving full details of all colours required.

Colours shall not be mixed except on the instructions and under the supervision of the Project Managers’ Representative.

All proprietary paints and decorative finishes shall be stored and applied in strict accordance with the manufacturer's instructions.

9.2 Materials

9.2.1. **Materials in General.** The materials to be used, shall be of the best quality and of approved types, obtained from an approved manufacturer, thoroughly mixed and ground.

 Paint shall show easy brushing, good flowing, spreading and levelling properties. These properties shall be demonstrated on test specimens at the request of the Supervisor’s Representative. Coats that have any noticeable pull under a large brush and that show poor spreading and flowing properties will not be acceptable.

 Paint shall dry to a uniform, smooth, flat or semi-gloss finish under ordinary conditions of illumination and wearing. There shall be no laps, skips, high-lighted spot or brush marks and no evidence of cracking, chipping or flaking. Tinted paints shall dry to a uniform colour.

 Recoating of a previous painted surface shall produce no lighting, softening or other film irregularities.

 Paint during and after application shall not be abnormally pungent, offensive or disagreable.

 The colour of the paint shall match the approved sample.

9.2.2. **Knotting.** Shall be composed of dissolved shellac or other resin which remains unaffected by the resinous materials in the wood or the following paint coating, thereby preventing the resinous materials in the timber leaching into the paint film and causing discolouration or defective drying and shall be in accordance with BS 1336:1971.

9.2.3. **Mordant Solution.** Shall be composed of a solution usually slightly acidic in nature and containing solvents, for applying to new smooth metallic surface to remove grease, organic soaps and provide a physical key, and shall be obtained from an approved supplier.

9.2.4. **Fillers.** Shall be an external grade cellulose base filler,

* + 1. **Stopping.** Shall be hard stopping composed of white lead paste, gold size (oleo resinous medium) and other fillers obtained from an approved supplier.

9.2.6. **Putty Filler.** Shall be composed of white lead and dry filler mixed with pure linseed oil, the content of the white lead shall be not less than ten percent (10%) of the mixture by the volume and shall be obtained from an approved supplier.

9.2.7. **Thinners.** Shall be an approved turpentine or white spirit. Where the paints are specified to be water thinned, fresh water shall be used.

9.2.8. **Pigments.** Shall be pure tint colours that will easily dissolve and mix with the various coatings and shall conform to the requirements of BS EN 12878:1999 "Pigments for cement, magnesium oxychloride and concrete".

9.2.9. **Rust Inhibitor.** Rust inhibitor shall be approved by the Project Managers’ Representative and shall be compatible with the subsequent paint coatings.

9.2.10. **Primers.** Primers applied to surfaces of different materials shall be as follows:

 a) Interior or exterior plastered surfaces. Alkali resistant primer recommended by the manufacturer of the finishing paint, white pigmented for cement and transparent for gypsum.

 b) Ferrous surfaces. Lead based or zinc chromate and Calcium Plumbate as recommended by the Manufacturer.

 c) Non-ferrous surfaces. Mordant solution of an approved brand and rust inhibiting primer.

 d) Woodwork surfaces. Leadless grey primer in accordance with BS 5082:2000.

9.2.11. **Epoxy Paint.** Epoxy paint shall comprise of one layer of primer over two coats of stopping, one layer of Acrylic resin based textured paint and two finishing coats of polyurethane epoxy paint. The paint shall be from an approved manufacturer to a colour, texture and finish as indicated on the Drawings, as specified elsewhere and/or as directed by the Project Managers’ Representative.

9.2.12. **Antifungus.** Anti-fungus emulsion paint shall be an approved polymeric self sterilising paint impervious to moisture, UV and carbonation resistant, sufficiently hard to allow it to be cleaned with normal hospital cleaning agents. It shall incorporate anti-bacterial or microbial agents to suppress mould growth and shall be applied by approved Sub Contractors in accordance with the manufacturer’s instructions.

9.3 Painting

All surfaces to be painted shall be properly prepared according to the approved paint manufacturer's recommendations.

No painting shall be carried out until floors have been washed over, and every possible precaution taken to keep down dust.

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

Exterior or exposed painting shall not be carried out under adverse weather conditions, such as rain, extreme humidity, dust storms, etc.

Surfaces shall be well cleaned and rubbed down between each coat.

All undercoats for oil paints and clear finishes shall be rubbed down to a smooth surface with abrasive paper and all dust removed before the succeeding coat is applied.

If, by the time the work is to receive the first undercoat, the priming coat has in any way deteriorated or has been damaged, the affected portions or whole if instructed by the Supervisor’s Representative, shall be rubbed down and repainted at the Contractor's expense.

In the case of articles primed at works, primer shall be touched up where required with a similar primer.

Each coat of paint, etc., shall be thoroughly dry before the application of a further coat. Not less than 24 hours shall be allowed between each coat, but the maximum intervals shall not exceed twenty one days.

The tint of each coat shall not vary from the previous one and each coat shall be approved by the Project Managers’ Representative before the next is applied.

Surfaces and items not to be painted or decorated shall be masked or removed and re-fixed.

The final coat of paint shall not be applied until immediately before handing over the building and when handed over all paint-works shall be free from imperfections, chips, scratches, etc., and shall be to the satisfaction of the Project Managers’ Representative.

9.4 Woodwork Preparation

Woodwork shall be brought to an even silky finish by the use of fine sand-paper. All woodwork for oil (alkyd based) painting shall be knotted, stopped and primed.

All holes and other imperfections in surfaces to receive a satin or clear finish shall be stopped and the whole surface rubbed down and all dust brushed off.

Small knots shall be treated with two thin coats of knotting. The knotting used shall be of approved make, free from resin and shall comply with BS 1336:1971.

Stopping of internal woodwork and plywood shall be with putty tinted to match the colour of the undercoat.

Stopping of clear finished or stained woodwork and plywood, shall be an approved stopping tinted to match the surrounding woodwork.

9.5 Metalwork Preparation

This Clause covers non-structural metalwork. For Structural Steelwork refer to Section 6 of the Particular Specifications for Civil and Structural Works.

Steelwork shall be thoroughly cleaned of all rust, dirt, etc., by wire brushing, oil and grease shall be removed with white spirit, washed off with soapy water, rinsed with clean water and primed with two coats of red-lead primer as soon as the surface is dry.

Galvanised metal surfaces shall be cleaned of oil and grease as specified for steelwork, treated with mordant solution and primed with calcium plumbate priming paint.

Copper pipe shall be cleaned of oil and grease as specified for steelwork, and primed with zinc chromate priming paint.

9.6 Rendering, Concrete and Brickwork-Preparation

All mortar splashes, etc., shall be removed from rendered, concrete and brickwork by careful scraping. All holes, cracks, etc., shall be stopped and the whole of the surfaces brushed down to remove dust and loose material. All traces of mould oil shall be removed from concrete surfaces by scrubbing with water and detergent and rinsing with clean water to remove all detergent.

Rendering to be painted shall be treated with one coat of primer sealer No. 1 followed by two coats of emulsion filler, rubbed down with fine sandpaper until a completely even surface is obtained.

Concrete or brickwork surfaces to be painted shall have all minor blemishes of "fair-faced" concrete or rendered brickwork made good with approved exterior quality stopping.

9.7 Colours

Colours and tints shall be chosen by the Project Managers’ Representative who will furnish the Contractor with a schedule giving full details of colour required.

All finishing tints shall be selected by the Project Managers’ Representative.

In general, colours will be selected from the manufacturer's standard range.

* 1. Finishing Paints

|  |  |  |
| --- | --- | --- |
|  SURFACE |  PAINT |  COATS |
| Emulsion PaintAlkyl Eggshell finishSpecialized Textured Acrylic Wall CoatingEpoxy paint on walls of water tankExternal rendering wall finishFerrous metalNon-ferrous metalJoinery internallyEggshell varnishRoad marking paintAntifungus paint | Alkaline resistant sealer.Diluited emulsion. Finishing copolymer emulsion thickness of dry finishing layer 30 microns.Sealer.Eggshell finish coat thickness of dry finishing layer = 30 microns.Acrylic PrimerFinishing textured Acrylic coat.Two component epoxy paint applied without thinner (10mm thick)Exterior masonry flat finish in four coats.Brush/roller applied 2 component epoxy undercoat.Airless spray 2 component epoxy middle coat.Roller/spray applied 2 component polyurethane flat finish.Zinc chromate epoxy ester primer.Epoxy ester micaceous iron oxide.Alkyd exterior gloss first quality finish coat.Zinc chromate epoxy ester primer.Epoxy ester micaceous iron oxide.Alkyd exterior gloss first quality finish coat.Wood dye.Matt laquer.Rub down between layers.Polyurethane varnish.Sanding to a smooth finish.Between coats.Alkyd based road marking paint.Glossy film.Approved polymeric emulsion paint. |  1 1 2 1 2 1 2 1  1 1 2 1x35 microns1x35 microns2x70 microns1x35 microns1x35 microns2x70 microns 2 2 3 2 2 |

9.9 Workmanship

The Contractor shall submit to the Project Managers’ Representative for approval the brand and quality of the paints he proposes to use.

If approval is given to a brand of paint the Contractor shall use the primers, undercoats, etc., manufactured or recommended by the manufacturer of that brand.

All paints to be used under this Contract shall be delivered and stored on the site in sealed, labelled containers, a minimum of 30 days prior to application. Upon notification by the Contractor that the material is at the site, samples of each material shall be obtained at random from a sealed container by the Project Managers’ Representative, in the presence of an authorised representative of the Contractor. Samples shall be clearly identified by commercial name, type of paint and intended use. If judged necessary by the Project Managers’ Representative the paint samples may be tested in a laboratory designated by the Architect at the Contractor’s expense.

Complete colour charts for the paints to be used shall be submitted to the Project Managers’ Representative for approval.

Pigmented paints shall be furnished in containers not larger than 25 kg. All paints shall be products that have a minimum of 2 years satisfactory field services.

Mixing and application of paint shall be in accordance with the specifications of the manufacturers concerned and to the approval of the Project Managers’ Representative.

The mixing of paints etc., of different brands before or during application will not be permitted. No dilution of painting materials shall be allowed except strictly as detailed by the manufacturers and approved by the Project Managers’ Representative.

Ironmongery and accessories, machine surfaces, plates, lighting fixtures and similar items in place prior to cleaning and painting, which are not intended to be painted, shall be removed or protected prior to painting operations and repositioned upon completion of painting work as directed by the Project Managers’ Representative.

Equipment adjacent or against walls shall be disconnected by workmen skilled in these trades and moved to permit the wall surfaces to be painted, and following completion of painting shall be replaced and reconnected.

Cleaning solvents shall be of low toxicity. Cleaning and painting shall be so programmed that dust and other contaminants from the cleaning process will not fall on wet or newly painted surfaces.

Brushes, pails, kettles, etc., used in carrying out the work shall be clean and free from foreign matter. They shall be thoroughly cleaned before being used for different types or classes of material.

No exterior or exposed painting shall be carried out under adverse weather conditions such as rain, extreme humidity, dust storms, etc.

Painting work shall be shaded from direct sun light to avoid blistering and wrinkling. Wherever possible, painting of exterior surfaces shall follow the sun so that it is carried out in shadow.

Edges, corners, crevices, welds and rivets shall receive special attention to insure that they receive an adequate thickness of paint.

All cracks and holes shall be cut out properly square and made good with suitable filler or cement sand mix as appropriate, such repaired portions being allowed to dry out and sand-papered smooth.

Painting work shall comply with BS 6150:2006.

9.10 Rendered Surfaces with Emulsion or Enamel Paint

Rendered surfaces shall be allowed to dry out completely before carrying out painting operation. Plaster applied in the winter season shall be at least ten weeks old and that applied in the summer shall be at least five weeks old before commencing painting operations.

Preparation of surfaces shall consist of vigorous brushing and rubbing down to remove loose surface material and dust.

Surfaces shall then be left for a week to determine whether efflorescence reappears, in which case it shall be brushed off dry and a further waiting period of one week allowed.

Alternatively, the surfaces may be neutralised by brushing on a solution of 3 percent phosphoric acid and 2 percent zinc chloride and removing all loose particles after drying. No painting shall be carried out until the Project Manager’s Representative is satisfied that no efflorescence is occurring.

Where required by the Project Manager’s Representative one or two coats of "alkali-resistant" primer shall be applied, sufficiently thinned to penetrate the surface.

All rendered and concrete surfaces shall be twice stopped with approved putty filler. The first coat of stopping shall be applied after the primer coat dries out completely and second coat after the first undercoat application. Each coat of stopping shall be sandpaper until a smooth surface is achieved.

A minimum of two (2) approved undercoats recommended by the manufacturers of finishing coat shall be applied by brushing well into the surface. Each coat shall be allowed to dry and harden thoroughly before the next coat is applied.

The finishing coat of paint shall be applied after the completion and testing of the mechanical and electrical works.

9.11 Ferrous Surfaces

The surface preparation and protective coatings for structural steelwork are as specified in Section 6 of the Particular Specifications for Civil and Structural Works. In other situations surfaces shall be thoroughly cleaned to remove grease and dirt, wire brushed and scraped to remove scale and rust. One coat of approved putty shall be applied on the surfaces and left to dry for at least twentyfour (24) hours. Surfaces shall then be rubbed with sandpaper or other approved means before primer is applied.

One coat of rust inhibiting primer shall be applied by brushing well into the surface and shall be allowed to dry and harden thoroughly before the application of subsequent coats. If ferrous works are delivered primed, the surfaces shall be examined to ascertain that the primer coat is hard. If not satisfactory the primer coat shall be removed and the surfaces cleaned to remove grease and dirt and re-primed as described above. Abraded spots on shop-coated surfaces shall be wire-brushed and touched up with same material as the shop-coat.

The under-coat and finishing coat shall be chlorinated rubber paint, interior or exterior grades and used all in accordance with the directions of the approved manufacturer.

Chlorinated rubber paint, interior or exterior grades shall not be applied in damp, foggy or freezing weather or to any surface which is not perfectly dry.

Brush application is recommended although this material may be sprayed if desired; only special thinners produced by the approved manufacturer may be added to achieve the spraying consistency required.

Special approved thinners may be used for cleaning brushes after use.

Ferrous works such as frames, covers to expansion joints, etc... which are to be built into walls shall be primed before installation.

Painting of ferrous surfaces shall comply with BS EN ISO 12944-1:1998 and BS EN ISO 12944-2:1998.

9.12 Non-Ferrous Surfaces

Galvanised steel and non-ferrous metal surfaces to be painted shall be solvent cleaned or painted with mordant solution before the application of paints as described above for ferrous surfaces.

9.13 Wood Surfaces

Wood surfaces where specified to be painted shall be primed, undercoated twice and final coated with semi-gloss enamel paint of approved manufacturer.

Wood surfaces shall be rubbed with abrasive paper to obtain a smooth surface. Surface mould where present shall be removed by washing, rubbing down and burning off as necessary. Oily wood shall be swabbed with white spirit. Resinous exudation and large knots shall be removed and replaced by approved filler or knot sealer and the surface shall be primed.

Parts of wood to be enclosed in walls shall be primed unless already impregnated with creosote or other preservative. Priming shall be brushed on and a minimum of two coats applied to end grain. After the primer coat is hard, all cracks, holes, open joints, etc shall be made good with hard stopping and rubbed with fine abrasive paper. If the first process of stopping is found to be unsatisfactory it shall be repeated after the first undercoating is applied and well dried.

Priming of joinery shall be applied only on the site after the Project Managers’ Representative has approved such joinery and before it is fixed. The two undercoat paints shall be applied on wood doors, panels, etc before they are fixed, to ensure that the bottom and top edge and sides are thoroughly painted. The finishing coat of paint to such wood doors, panels, etc shall be applied after fixing in position and as directed by the Project Managers’ Representative.

Wood surfaces specified as stained shall only be rubbed down with fine abrasive paper and two coats of oil stain Ducco sprayed to the satisfaction of the Project Managers’ Representative.

Wood surfaces specified as varnished shall be thoroughly cleaned down of all dirt, oil, grease, etc.. and rubbed to a smooth finish. Knots shall be treated with knotting and 2 coats of approved oil varnish applied.

9.14 Epoxy Paint for Water Tanks

Epoxy paint for internal rendered and concrete surfaces of water tank shall be non toxic, solvent free, two component epoxy resin system with water-proofing capabilities. The surface treatment and application of the paint shall be strictly in accordance with the manufacturer’s written instructions to a minimum thickness of 10mm and the satisfaction of the Project Managers’ Representative.

9.15 Epoxy Spray Paint

The surface treatment and application of the paint shall be strictly in accordance with the manufacturer’s written instructions and to the satisfaction of the Project Managers’ Representative.

9.16 Specialized Exterior Textured Acrylic Wall Coating (Marmoran Marakesh) or other approved such as Marmoran Polysheen.

Applied directly on well prepared sand-cement rendered walls. Preparation of the substrate includes removal of all loose and friable matter, stopping and filling as required to provide a clean, dry and sound surface.

Application to be strictly in accordance with manufacturer’s instructions and will comprise of a single coat of Acrylic Primer (select appropriate primer depending on the depth of shade, tinted to the required colour) applied with a sheepskin roller or brush and allowed to cure .

Two coats of the specialized acrylic textured coating is then applied with a lambswool roller and then immediately dragged with a blockbrush to achieve the desired pattern.

9.17 Marmoran Chromatex Suede Coating

A specialised decorative acrylic wall coating applied in strict conformance to manufacturer’s instructions.

9.18 Measurement and Payment Preambles

Subject to the following provisions the works in this section have been measured in accordance with the Standard Method of Measurement as published by the Royal Institution of Chartered Surveyors of U.K.

Rates for all Paint work shall include for supplying all necessary materials, machines, tools, brushes, etc. scaffolding, ladders, storage and protection, additives, mixing, hoisting, sampling and testing, and all other incidental requirements for the proper execution of paint work as specified.

Rates for paint work on rendered surfaces shall include for cleaning loose render and repairing all cracks and holes with patching render properly keyed to existing and sand-papered smooth.

Rates for paint work on rendered or exposed concrete surfaces shall include for neutralising alkaline surfaces by brushing on an acid solution and two percent zinc chloride or approved equal and removing all loose particles after drying as directed by the Project Managers’ Representative.

Rates for paint work shall include for painting in narrow widths and in short lengths to apertures, jambs, sills, reveals, soffits of lintels, sides and top faces of curbs, panels and trips, etc. All such areas have been included with their respective main items, unless otherwise stated in the Bills of Quantities. All openings have been deducted.

Rates for paint work on ferrous and non-ferrous metalwork shall include for cleaning with steel wire brushes or scrapping as may be required to remove all loose scale and rust from all unexposed surfaces of ferrous and non-ferrous metalwork in false ceilings, attics, shafts, etc. and shall include for applying two coats of rust inhibiting primer.

Rates for paint work on wood work shall include for rubbing down with glass paper before painting. All exposed surfaces of wood work covered with plywood lining, veneered, etc. shall receive two coats of approved wood preservative as specified.

Rates for paintwork shall include for painting in multicolour as required.

Rates for paintwork shall include for making good all paint work to the satisfaction of the Project Manager’s Representative.

**PARTICULAR SPECIFICATION**

**ARCHITECTURAL**

 **SECTION 10**

 **ALUMINIUM AND STEEL WINDOWS AND DOORS**

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10.10 Record Room

**SECTION 10**

**ALUMINIUM AND STEEL WINDOWS AND DOORS**

10.1 Window Sub-frames

Sub-frames to receive aluminium windows shall be formed by 20 x 20 mm. hot dip galvanised steel hollow section, 1,5 mm. of thickness.

Sub-frames shall be fixed to masonry walls.

10.2 Steel Door Frames

Steel door-frames shall be obtained from a specialist manufacturer approved by the Project Managers’ Representative and shall be in accordance with BS 1245, 1975.

Frames shall be 18 gauge (2mm) zinc-coated steel units with double rabbett. The rabbett shall be designed for 44mm thick doors.

Frames shall be finished in self etch stove primer ready to receive further coats and shall be reinforced and prepared for hinges lock strike plates, etc, frames shall be supplied with steel wall anchors for building into jambs.

10.3 Aluminium Windows and Doors - Generally

The aluminium windows, screens, doors and the like shall conform with BS 4873:2009 and shall be obtained from a manufacturer or supplier approved by the Project Managers’ Representative. Main frame and sash member shall have a nominal thickness of 2 mm.

The Contractor shall store and fix, including assembling component parts, all aluminium windows in accordance with the manufacturer's instructions.

The Contractor shall ease and adjust all aluminium windows including catches, locks, stays, etc. and leave in perfect working order at completion.

All windows shall be constructed in sections of extruded aluminium alloy 6063 conforming to B.S.4873:2009 and fully treated for added strength.

Sections for windows shall have a weight of no less than 0.75 kg. per linear metre.

Sections for doors shall have a weight of no less tan 1.20 kg. per linear metre.

Thickness of aluminium sections shall be 1.75 mm.

All windows shall be glazed using a water and dust protective gasket on rebates and PVC pressure gasket snapped into extruded profiles of sections.

All corners shall be of the mechanical type using aluminium cleats, and machine pressed to ensure tight joints. Alternatively, they can be screwed using anti-rust steel self-tapping screws provided adequate screw used. All butt joints shall be treated with a coat of compound grease or equal approved to ensure a water-tight joint before assembly.

Sections shall be etched and anodised to a guaranteed penetration of 0.0010" one hour, 25 micron conforming to BS 3987:1991 or powder coated conforming to BS 6496:1984.

Weather stripping shall be of neoprene or woven pile as applicable and shall continue around whole perimeter of casement from and outer frame, wherever groove is provided in extruded sections.

Aluminium Window Samples

The Contractor shall submit samples of all windows to the Project Managers’ Representative for approval prior to installation. All units shall conform to the standards of the approved samples and be fitted with the ironmongery that is to be submitted for approval prior to being included in window samples.

Aluminium Louvre Panels

To be to the sizes that suit the structural dimensions with allowance for finishes as indicated on the drawings. Louvre panels to be framed with rectangular hollow aluminium sections. The louvre blades (inverted Y section) shall be as indicated on the drawings and set at 45 degrees. Fly screens to be fixed to the inside of the louvre blades. Aluminium alloy for the construction of the frame to be U.S.A. Standard 6063 Temper Grade T5.

All aluminium surfaces shall be silver powder coated or anodised a minimum thickness of 25 microns to BS 3987:1991 or powder coated to BS 6496:1984.

All units to be supplied with protective tape to frames.

All external gaps between frames and openings to be sealed with mastic and polythene gaskets of a type to be approved by the Project Managers’ Representative.

Aluminium/Glass Louvre Sample

The Contractor shall submit samples of all louvres etc. to the Project Managers’ Representative for approval prior to installation. All units shall conform to the standards of the approved samples.

Aluminium Window Shop Drawings

The Contractor shall submit shop drawings for the approval of the Project Managers’ Representative showing such details as fixing cleats, drilled fixings, packing shims, architrave angles, etc., as appropriate. A programme for the submission of shop drawings shall be submitted to the Project Managers’ Representative at the start of the Contract.

10.4 Fixing Windows

All units are to be installed square, straight and plumb in prepared openings, screwed to galvanised steel sub-frames fixed to masonry. The units shall be sealed all round on both sides with an approved Mastic coloured to match the adjacent finish on 13 mm. x 10 mm. polyethylene backing strips.

Care must be taken to avoid distorting frame members when tightening screws or adjusting lugs.

The Contractor shall be wholly responsible for ensuring that all window and door components are delivered to the site in perfect condition. He shall also be responsible for ensuring that the components are protected from all possible damage during handling, storage and installation through to the date of the hand-over.

10.5 Fittings for Windows

Hinges shall be of anodised extruded aluminium and of the quality as the windows. Pivoting on stainless steel pins spaced by other stainless steel or nylon washers.

All windows shall be fitted with lockable handles and limiting stays of a material compatible with the window material and shall be of a simple but highly functional design approved by the Supervisor’s Representative.

Side and top hung casements shall be friction stays as approved by the Project Managers’ Representative.

10.6 Fly screens

Fabricate insect screen frame of extruded aluminium sections to BS EN 12020-2:2001, BS EN 573-3:1995 and BS EN 573-4 anodised to BS 3987:1991. Corners to be mitred and proprietary fixings finished to match anodised screen material. Fixings will allow removal of screens for maintenance. Mesh material is to be anodised aluminium in natural colour, with removable PVC splice-anchor concealing the edge of the screen fabric.

10.7 Cleaning

Aluminium shall be washed down only with clean soapy water. Metal polishes shall not be used as these may cause extensive damage to the anodising.

10.8 Steel Doors and Frames

The steel doors and frames shall be fabricated from mild steel plate, bars and sections all welded and bolted together to the details and sizes shown on the drawings.

10.9 Architraves, Door Stops, etc.

Architraves, door stops, etc, shall be properly mitred at intersections.

10.10 Anti-Bandit Doors

Anti-bandit doors where specified shall be supplied complete with painted undercoat steel frame. Frame construction is of rectangular steel tubing 100mm x 50mm with Steel rebates. Overall thickness of the door is 50mm, consisting of a timber and bullet resistant laminate finished in a hardwood veneer coated with a clear lacquer.

Locking: 5 - lever mortice dead lock.

Hinges: Purpose made heavy duty type. The top hinge is fitted with a “Needle” bearing and the bottom hinge with a thrust bearing. Both hinges have external lubrication points. Hinge bolts secure back edge of door .

Furniture: Satin Chrome pull handle fitted one side of door.

10.11 Record Room Doors

This is a specialist steel door fitted to the Archives rooms with the following minimum specifications:

Door: Overall thickness 115mm with main outer door plate of 6mm and

 hardened steel plate of 3mm protecting the lock mechanism.

Bolt Work: Eight 32mm bolts secure this door. Four chromed front moving and four fixed dog bolts at the back, all locking behind solid rebate bars.

Locking: One seven lever security key lock supplied with a duplicate key.

Fire rating: 2 hours.

Finish: Door and frame finished in zinc chromate undercoat ready for specified final coat. Furniture in chrome finish.

 **SHIRE VALLEY TRANSFORMATION PROGRAMME 1 CHIKWAWA HOUSES- PARTICULAR SPECIFICATION**

**ARCHITECTURAL**

 **SECTION 11**

 **LABORATORY UNITS**

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 **SECTION 11**

 **LABORATORY UNITS**

11.1 General

The carcasses of units shall be formed by a frame of steel tubes assembled with 20 mm. Formica faced MDF/Plywood or equal approved.

Panels shall be have easy to clean and abrasion proof surfaces.

The base units shall have side holes allowing easy assembly, and with inner holes for adjustment of the shelves to various heights. The base units shall have adjustable plinth feet, allowing a perfect levelling of the units, even on irregular floors. A space of 60mm shall be provided at the back of each base unit to allow room for any tubes or pipes, etc.

Design and fabrication shall generally be in accordance with BS EN 13150:2001 and BS EN 14056:2003.

The drawers shall be made of formica faced MDF/plywood. They shall be fixed on a special rail allowing a silent movement on metal runners protected by varnishes. Catch shall be provided to prevent accidental extraction of the drawer.

The hinges shall be made of stainless steel and shall have a built-in spring. The hinges shall allow the door to be adjusted in three positions and a wide corner opening.

11.2 Worktops

The worktops shall be made of compact epoxy resin panels 20 mm. thick.

The material shall be resistant to all normally encountered chemicals and reagents used in a Laboratory. Joints between the sheets shall be seamless and completely impermeable.

The backsplashes shall be 50mm high and integral to the worktop coved and of the same material as that of the worktop.

11.3 Physical Properties

Tensile strength (ASTM D638) 750 kg/cm²

Compressive strength (ASTM D695) 2580 kg/cm²

Flexural modulus (ASTM D790) 1638x105 kg/cm²

Flexural strength (ASTM D790) 1153 KG/cm²

Density (ASTM D792) 1,96 cm3

Hardness, Rockwell M (ASTM D785) 110

Heat distortion temperature

at 264 psi. (ASTM D648) 176 ºC

Thermal coef. of expansion

(75-350º) per ºC 2.05x105

Fire resistance self extinguishing

Impact resistance:

1.4 kg dropped from 2.75 m. no fracture

Electrical conductivity non conductor

Water absorption in 24 h. (ASTM D570) 0.0072%

11.4 Chemical Resistance Test

Worktops shall be highly resistant to the normally used laboratory reagents.

Procedure:

One cubic centimetre of each of the solutions listed below shall be placed on the surface of the test samples in individual squares and then covered with the watch glass, for a period of 24 hrs.

The test samples after being tested and cleaned using clear water and cellulose sponge, shall show no signs of damage.

Acetic acids, glacial

Acetone

Amonium hydroxide

Amyl acetate

Aqua regia

Benzene

Betyl alcohol

Calcium hypoclorite

Chloroform

Chromic acid

Ethylene alcohol

Formaldehyde

Glassware cleaning solution

Hexane

Hydrochloric acid, 10%

Hydrochloric acid, concentrate

Hydrogen peroxide

Kerosene

Methyl alcohol

Methyl alcohol ketone

Nitric acid, 70%

Phenol

Phosphoric acid, concentrate

Potassium hydroxide, 40%

Silver nitrate

Sodium hydroxide, 10%, 50%

Sulphuric acid 30%, 90%

Trichloroethylene

Xylene

Zinc chloride, saturated

11.5 Radioactive Test

Tops must conform to BS 4247-1:1981 and BS 4247-2:1982.

Test A

11.6 Heat Resistance Test

A high porcelain crucible, size 15 ml. capacity shall be heated over a Bunsen burner until the crucible attains a dull, red heat.

Immediately the hot crucible shall be transferred to the top surface and allowed to cool to room temperature.

Upon removal of the cooled crucible, there shall be no blisters, cracks or any breakdown of the top surface whatsoever.

The top surface shall show no blistering or cracking when an overturned 3/8" Bunsen burner, adjusted to a quiet flame with a 2 1/2 " inner cone, is allowed to remain on the surface for a period of five (5) minutes.

All workbenches shall have an aluminium electric channel to allow the installation of electrical outlets.

11.7 Reagant Shelves

These shall comprise of 10mm thick polished edge laminated glass shelves 300mm wide supported on powder coated steel support frames and brackets.

11.8 General Shelving

These shall comprise of 600 high x 300mm deep powder coated steel shelving with glass fronted doors where specified. Shelving unit shall be modular u to a maximum of 900mm long.

Where shelves are specified for Chemical Storage the material used must have appropriate chemical resistance.

11.9 Laboratory Sinks

These must be either white vitrified in fire clay material or approved chemical resistant polypropylene.

11.10. Drainage System

Vulcathere drain pipes and fittings in conformance with Particular Specifications Mechanical.

**SHIRE VALLEY TRANSFORMATION PROGRAMME 1 CHIKWAWA HOUSES- PARTICULAR SPECIFICATION**

**ARCHITECTURAL**

 **SECTION 12**

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**SECTION 12**

 **EXTERNAL WORKS AND LANDSCAPING**

Soft Landscaping and Planting

12.1 General

The Contractor shall include for preparing the ground, supplying delivering and planting, maintaining, etc., staking and tying watering, protection after planting and timing suitable planting periods for the trees and shrubs described in accordance with the following specification.

The preparation of the ground shall include for all excavations, backfilling and watering, in case of doubt, trees shall be regarded as `deep rooted varieties' and the ground shall be considered `very saline'.

12.2 Ground Preparation

Pits for trees, shrubs and climbers shall be excavated to the following sizes:

 Large tree pits 1.50 x 1.50 x 1.50 m.

 Small tree pits 1.00 x 1.00 x 1.00 m.

 Shrub pits 0.75 x 0.75 x 0.75 m.

 Climber pits 0.75 x 0.75 x 0.75 m.

Where trees occur in areas of shrub planting the whole area shall be filled to a depth of 750 mm.

Where shrubs occur in groups the whole area shall be filled to a depth of 750 mm.

Where the planting occurs in pits, the base of the pit is to be filled with clean washed aggregate 12 - 50 mm. diameter, to a depth equal to one quarter (1/4) of the total volume of the pit to be backfilled with planting medium.

Backfill to holes shall be good quality sweet sand, salt free, and approved by the Project Managers’ Representative. The sweet sand is to be mixed with manure to the approval of the Project Managers’ Representative, in the proportion of 20% manure to 80% sweet sand. Fertilisers may be used, type and quantity to be approved by the Project Managers’ Representative or his Agent.

12.3 Supply, Delivery, Storage, Planting, Etc.

All plant material shall be container grown, conform to heights as specified, have good fibrous root system, be free from any disease or disfigurement, be of uniform shape and in good vigorous health.

All plant material shall be obtained from a reputable nursery, approved by the Project Managers’ Representative. All plant material arriving on site must be inspected and approved by the Project Managers’ Representative.

All plant material obtained from nurseries or other sources, shall be suitably packed for transit to prevent exposure and damage. Any plant material damaged in transit shall not be acceptable.

Plant material arriving on site shall be planted immediately. If not, then plant material to be stored in a sheltered compound, and to be maintained and watered to good horticulture standards, until planted on site.

Plant material to be carefully removed from containers, plastic pots to be slit with a knife, and plants removed with all the soil intact around to roots, care shall be taken not to damage roots or foliage of plants.

Care shall be taken to plant on the `collar line' on the stem.

The planting medium is to be watered before receiving plants, and then after planting, the area is to be flooded with water.

A hole shall be made in the pit area sufficiently large to take the root ball, and the plant set upright and close to a stake (when required) which shall have been driven in previously, and the sides of the hole broken-in at the same time firming the sand around the base of the root ball. The sand shall be `firmed-in' and not rammed.

The ground surface after planting is to be left level or slightly dished, no more than 50 mm. below ground level, and sand shall not be mounded around the base of the stem.

No planting shall be carried out, during periods of heavy rain, sand storms, or heavy winds, or during the heat of the day.

12.4 Staking and Tying

One good timber stake of a suitable type approved by the Project Managers’ Representative shall be provided for each tree. Stakes shall be 50 mm. diameter and treated with a non-injurious preservative.

Stakes shall be tall enough and strong enough to support the tree securely until such time as it is established.

Stakes shall be driven in so as to have a firm hold in the bottom of the planting pit/area.

Rubber, plastic or webbing items shall be used to support the trees to the stake, trees over 1500 mm. high to have two ties. Ties are to be adjustable, so that they can be made larger as growth of tree trunk increase. The stake shall be positioned far enough away from the tree so as not to cause rubbing or chafing.

Climbers are to be tied to a supporting network of plastic coated wires. Climbers shall be encouraged to grow along the bottom wires first before spreading to the upper wires.

12.5 Watering

Watering shall take place at the following rates:

 Trees 22 litres/day

 Shrubs 5-9 litres/day/square metre

These amounts shall vary according to the weather but at all times the planting medium must be kept moist and not allowed to dry out completely. Plants must not be overwatered.

The water shall be sweet and free from salt and any other toxic matter or substances that might have a detrimental effect on the growth of the plant.

The water shall be allowed to flow gently around the plant and shall not be delivered at great pressure so as to cause disturbance, to roots or soil.

12.6 Protection After Planting

Planting is to be protected from all wandering and stray animals, where necessary.

12.7 Plant Guarantee

All plant material and grass shall be guaranteed for 12 months after the completion of the landscape works. Any plant material which dies or does not produce good growth, during this period of time, shall be replaced at the expense of the Contractor.

12.8 Maintenance

The Contractor shall be responsible for maintenance during the execution of the landscape works, and for the first 12 months, after completion of the landscape works.

The area around the plants shall be kept in a proper state of cultivation, free from weeds and well aerated by regular hoeing.

The ground shall be firmed in, if and when necessary to maintain stability.

Regular inspection of stakes and ties with a view to replacement and adjustment shall be made where necessary.

Watering shall be carried out in accordance with clause 12.5.

Watering shall take place in the evening or preferably in the cool of the early morning.

Plants shall be fed with nutrients during this period of 12 months. Type and quantity to be approved by the Architect.

Pruning in the early stages shall be limited to cutting out dead wood and cross branches.

Pruning shall be carried out in the later stages to reduce overcrowding, encourage new growth, and generally help to keep a desirable effect.

12.9 Suitable Planting Periods

All planting shall take place during the suitable months, subject to weather conditions. Planting may, in special circumstances, take place outside these dates only after written application to the Supervisor’s Representative to obtain approval. The Project Managers’ Representative must be notified before any planting commences.

12.10 Precast or Insitu Brushed Terrazzo Paviors

The cement and water shall be as specified under "Concrete Work". The terrazzo aggregate shall be well graded (up to 6 mm.), white, grey or red stone chips.

The precast paviors shall have dimensions of 600 x 600 x 50 mm. thick and shall be left with good sharp clean edges.

The moulds used for manufacturing shall be regularly cleaned to ensure proper profiling of paviors.

Prior to manufacture at least two samples of pavior shall be produced for the Supervisor’s Representative's approval.

Paviors shall be unloaded and handled carefully without chipping or damaging and those not approved by the Project Managers’ Representative shall be immediately removed from site at no cost to the Employer and replaced by satisfactory paviors.

The paviors shall be butt jointed laid on 50 mm. Sand and grouted.

Where insitu terrazzo paving is specified this will consist of 20mm thick brushed terrazzo finish laid in 1.8m x 1.8m panels on insitu mesh reinforced concrete slabs to Structural Engineers details.

12.11 Precast Concrete Paving Blocks for Pedestrian Areas

These shall be as specified under Roadworks except that the thickness of the blocks may be reduced to 50mm and their plan shape, dimensions and colour shall be as specified on the drawings.

12.12 Flagpoles

Flagpoles are to be free-standing galvanised steel 6 m. high x 100mm. diameter. Flagpoles shall be tabernacle mounted to a concrete foundation base. Flagpoles shall be continuously tapered along their length and not tapered in stepped sections. Flagpoles shall be supplied complete with all rope pulls and accessories and finials.

12.13 Fencing

* Chain link type shall be 2.0m high with 100mm outside diameter galvanised steel poles and 50x50 mm galvanised wire mesh, fixed to concrete foundations. Support poles not to exceed 2.4m apart.
* Steel palisade type fabricated from RHS framing and angle-iron fixed to brickwork or concrete piers’ as detailed on drawings.
* Razor wire type consisting of razor-wire strands 150mm apart tensioned between pre-cast concrete poles 3m high and maximum 2.4m apart.
* Solid type consisting of rendered brick construction to 2.1m high and finished with a precast concrete coping as detailed on drawings.

 2. Gates

 Gates shall be made up of a steel square tube frame with Intermediate vertical square tubing as detailed on drawings.

 3. Concrete

 Concrete shall be as specified under "Concrete Works.

 4. Setting Out

 The Contractor shall mark out on the ground the position of all walls and fences for approval by the Project Managers’ Representative prior to commencing operations.

 5. Workmanship

 The skilled work of erecting fencing and gates shall be carried out under competent supervision to present on completion true, aligned vertical fencing walls.

 6. Excavation

 The Contractor shall not commence excavations until a copy of the "Excavation Permit" has been obtained from the relevant clause under "Excavation and Earthworks".

 Post holes shall be excavated to the dimensions shown on the drawings or as directed by the Project Managers’ Representative.

 The use of explosives is subject to the requirements of the relevant clause under "Excavation and Earthworks".

 Material excavated from post holes shall be disposed of in approved manner.

# CIVIL AND STRUCTURAL WORKS

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1. Demolitions & Alterations

2. Excavations & Filling for Building Works

3. Concrete works

4. Roadworks

5. Reinforced concrete in water retaining construction

6. Structural steelwork

7. Blockwork

8. Precast concrete paving blocks

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**PARTICULAR SPECIFICATIONS**

**CIVL AND STRUCTURAL WORKS**

**SECTION 1**

**DEMOLITIONS AND ALTERATIONS**

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1.02 Protection

1.03 Workmanship

1.04 Trees, Shrubs, etc.

1.05 Clearing Away

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# Demolitions and Alterations

## 1.01 Inspection of the Works

The Contractor is to inspect the Site to ascertain for himself the full implications of the work required to be carried out in this Section.

No claim whatsoever will be allowed from the Contractor due to his failure to so inspect the Works.

## 1.02 Protection

The Contractor is responsible for ensuring that adequate protection is afforded to the structure, fabric and services of the buildings being altered or refurbished, including those parts not actually being refurbished but within, adjoining, adjacent to or forming a part of the affected building. Particular attention should be paid to the protection of doors and windows, their frames, and finishes generally and all equipment within the existing buildings. Any damage, howsoever caused, if in the opinion of the Supervisor’s representative, it could have reasonably been avoided shall be re-instated at the Contractor's expense to the entire satisfaction of the Supervisor’s representative.

## 1.03 Workmanship

All demolitions and alterations are to be carried out as indicated on the Drawings.

All requisite shoring, needling, strutting or other supports to foundations, walls, roofs and openings etc. necessary for the protection and safety of the existing buildings to be provided. The Contractor is to allow for maintaining, altering or adapting such temporary works as may be necessary from time to time including final clearing away and making good as may be directed by the Supervisor’s representative.

The Contractor will be held solely responsible for the safety of the existing building and the sufficiency of all temporary measures notwithstanding that such measure are to be agreed with the Supervisor’s representative prior to work commencing.

All necessary protection for the new and existing works against the effects of inclement weather to be provided and any damage caused by failure to do so shall be made good by the Contractor at his own expense to the entire satisfaction of the Supervisor’s representative.

Unless otherwise noted on the Drawings, making good is to be executed in materials and workmanship to match surrounding work and is to be properly bonded thereto all to the entire satisfaction of the Supervisor’s representative.

Before commencing demolitions and refurbishment all electrical and mechanical services, sanitation and any other services affected shall be either disconnected or diverted to the satisfaction of the Supervisor’s representative.

## 1.04 Trees, Shrubs, etc.

Unless instructed by the Supervisor’s representative, all trees and shrubs on the Site are to be protected and maintained throughout the period of the Contract and the maintenance period. Sundry vegetation is to be grubbed up and burned or cleared away completely to the satisfaction of the Supervisor’s representative.

## 1.05 Clearing Away

Materials arising from demolitions and refurbishment are to become to property of the Contractor and shall be carted away from the Site to a place provided by the Contractor and agreed by the Supervisor’s representative.

## 1.06 Obligations

Notwithstanding the above specific clauses related to this Section the Contractor is reminded of this obligations under all other clauses noted elsewhere in the Specification.

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**SECTION 2**

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# Excavations and Earthworks

2.01 General

Notwithstanding any information contained within any report of a site investigation for this project, the Contractor shall judge for himself the nature of the ground and shall be fully responsible for ascertaining all necessary information concerning permanent water table, periods of rainfall, flooding of the site and all matters affecting the excavation and foundation works.

The methods of excavation that the Contractor desires to use shall be at the sole discretion of the Contractor. The use of explosives may be permitted with the Supervisor’s representative's written consent. The Contractor shall take all necessary precautions to ensure the complete safety of all site personnel, including any third party, together with all buildings on site, including buildings completed on partly completed by any third party.

The Contractor shall obtain all necessary license and permission covering the purchase and use of explosives, and shall meticulously observe the requirements of the relevant authorities.

No explosives shall be stored at the site at any time.

The Contractor shall inform the Supervisor’s representative in writing when excavations are completed and are ready to receive blinding concrete, or foundation concrete if blinding is not required, and shall obtain consent in writing before depositing concrete.

In the event of excavations being made larger than the sizes shown on the drawings or as otherwise directed by the Supervisor’s representative, the Contractor shall fill in the excavated void to the correct profile with selected fill or with mass concrete as described in Section 3 - Concrete Work hereinafter, at his own expense.

The final 150 mm. depth of all excavations shall be taken out by hand unless allowed by the Supervisor’s representative otherwise and the bottom levelled and rammed immediately prior to placing concrete.

Where shown, the excavation shall be either blinded with concrete or concrete fill shall be placed as specified as soon as possible after the formation is approved, but not later than 24 hours after the final trimming of the bottom of the excavation, after which time fresh approval shall be sought and obtained from the Supervisor’s representative before proceeding with this work.

2.02 Poor Ground

Loose soil, bad ground or cavities met within any part of the excavations for foundations of structures shall be excavated to a solid formation and filled to foundation level with mass concrete as described in Section 3 - Concrete Work.

2.03 Shoring Excavations

The Contractor shall, to the satisfaction of the Supervisor’s representative, shore the sides of excavations for structures, trenches and pits to prevent the sides 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 Supervisor’s representative.

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

Timber or other materials used for shoring the sides of excavations shall be removed as the work proceeds except when ordered to be left in by the Supervisor’s representative.

The Contractor shall, not later than four weeks before commencing any excavation submit to the Supervisor’s representative 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 Works until receipt of the Supervisor’s representative's written consent.

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

The Contractor shall be responsible for the stability of all excavations, and for the maintenance and protection of any adjacent property, structures and roads.

2.04 Backfilling

Foundation trenches, column bases and the like are to be backfilled with selected excavated or imported materials as approved by the Supervisor’s representative, compacted to 95 % Maximum Dry Density (MDD)in layers not exceeding 150 mm compacted thickness:

2.05 Disposal of Surplus Excavated Material

Surplus excavated material shall be removed from Site and run to spoil by the Contractor or as otherwise directed by the Supervisor’s representative.

2.06 Trimming of Slopes

The slopes of cuttings and embankments shall be trimmed by hand or by approved mechanical means to uniform batters as shown on the drawings or as directed by the Supervisor’s representative. A tolerance of plus or minus 100 mm. measured at right angles to the batter and over a slope length of 2 metres, or pro-rata for other slope lengths, will be permitted.

Any rock or boulder 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 that in the opinion of the Supervisor’s representative is unstable shall be completely removed and the resulting void filled with compacted material to the approval of the Supervisor’s representative.

2.07 Making-up Levels under Ground Slabs

The area shall be trimmed to a clean, properly compacted uniform surface to the lines and levels shown on the drawings. Any soft areas considered unsatisfactory by the Supervisor’s representative shall be taken out and the extra depth filled with approved compacted fill material.

Compacted fill shall comprise non-plastic granular material, well graded and shall be laid over the foundation in layers as specified on the drawings not exceeding 150 mm thickness after compaction for each layer. It shall be laid properly compacted by mechanical means with a uniform surface and to the line and levels shown on the drawings. The density after compaction shall not be less than the maximum dry density obtained in accordance with BS 1377 – 4 : 1990.

Backfilling and compaction operations to make-up the levels under ground slabs shall proceed at the same time as backfilling to the final external levels. The difference in level of backfill between inside and outside of walls shall not be permitted to exceed 200 mm. unless noted otherwise.

2.08 Non-Compacted Fill

Non-compacted fill shall be non-plastic granular material to the approval of the Supervisor’s representative.

2.09 Protection of Services

The Contractor shall maintain and protect all permanent mains, services, etc., serving adjacent buildings where affected by the excavations.

2.10 Keep Excavations Free from Water

The Contractor shall be responsible for keeping all excavations free from water from whatever cause.

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

## 2.11 Polythene Sheeting

Polythene sheeting where shown on the drawings shall be 500 micron thick 1200 gauge, supplied in rolls, and laid by rolling over the prepared base at the levels and in the areas shown on the drawings. Where joint is necessary at the side or end of a sheet, this shall be a double welt folded joint made by placing the edges together and folding over twice. The joint shall be prevented from opening prior to concreting by blocks placed at intervals on top of the joints.

The Contractor shall protect the sheets from damage during laying and subsequent operations and shall replace all damaged sheets to the satisfaction of the Supervisor’s representative.

## 2.12 Ant-Repellent

Ant-repellent shall comprise a solution of one of the following chemicals in water: aldrin, dieldrin, chlordane, heptachor, and shall be to the approval of the Supervisor’s representative.

The repellent shall be applied in accordance with the manufacturer’s recommendations and the treatment shall be guaranteed for a period of not less than 10 years. Within this guaranteed period the Contractor shall undertake to re-treat, without further charge, any areas showing ~~re-~~infestation. The services of a specialists Sub-Contractor may be utilised for this section of the works, at the discretion of the Contractor.

## 2.13 Termite Nests

Any termites' nests on the site shall be excavated and the queen destroyed; the exposed nests and subterranean tunnels shall be treated with soil insecticide and backfilled with well rammed earth treated with soil insecticide.

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**SECTION 3**

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# Concrete Work

3.01 General

In this Specification, the terms `authorised' or `approved' shall mean as `authorised' or `approved' by the Supervisor’s representative.

3.02 Drawings

The Supervisor’s representative will supply to the Contractor key plans and detailed engineering drawings of all concrete work.

Should the Contractor find any discrepancies on the drawings he is to refer the matter to the Supervisor’s representative for decision before proceeding with the part of the work affected.

The Contractor shall be responsible for setting out the work on site and for obtaining all dimensions necessary for the proper execution of the Works. The whole of the work shall be accurately constructed in accordance with the drawings.

3.03 Materials

If the Contractor proposes to use any alternative materials to those required in this Specifications he must advise the Supervisor’s representative as soon as possible. He must also supply sufficient information, at least three weeks before the works commence, to enable the Supervisor’s representative to access these alternatives and to amend details of the works as the Supervisor’s representative considers necessary. Any variation which result and all the Supervisor’s representative's costs involved in making such assessments and variations shall be entirely at the Contractor's own expense.

### 3.03.01 Reinforcement

 The source of the reinforcement shall be subject to the approval of the Supervisor’s representative.

All reinforcement shall comply with the relevant British Standards or equivalant euro codes. If approval of reinforcement not complying with these codes is requested by the Contractor, the Contractor shall reimburse the Employer all costs incurred by the Supervisor’s representative or his representative in carrying out such checks or tests as he requires to be done before approval can be given.

The Contractor shall provide facilities on site for the accurate cutting and bending of reinforcement.

Bending Dimensions and Scheduling

BS 4466 : 1989 shall apply . Bars shall be bent cold to the shape described in the bending schedules.

Labelling & Storage

All bars or bundles of bars shall have a waterproof label securely attached stating the schedule number and bar mark.

Reinforcement shall be stored in a manner and place such that it is kept free from damage and mud, oil and any contaminants likely to impair its performance within the concrete.

Fixing

Immediately before fixing the Contractor shall ensure that all bars are free from scale, loose rust or any other matter which is likely to impair the bond with the concrete and where necessary shall remove those using appropriate means.

Bars which are damaged shall not be used in the works. Any bars which become damaged after fixing shall be removed and a replacement bar fixed in its position.

The Contractor shall securely fix the reinforcement in the positions indicated on the drawings and shall be responsible for maintaining it in this position until the concrete has hardened.

The Contractor is to provide sufficient support, by means of approved chairs, spacers etc, to ensure that all reinforcement is held in the correct positions whilst concreting is taking place. Reinforcement shall be rigidly bound together by 1.60 mm. (No 16 SGW) soft annealed iron wire binding. All starter bars shall be set in position prior to concreting and securely held during concreting.

The specified covers shall be maintained by the use of concrete spacer blocks securely fixed to the bars. Concrete spacer blocks shall be made from materials in no way inferior to those specified for the concrete in which the spacer block is to be used.

Plastic spacers shall not be used without consent.

Welding of rod reinforcement will not be permitted.

Bends in cold-worked high tensile steel shall not be re-worked in any manner.

In some instances bends in hot rolled high tensile steel may be straightened or re-worked with the application of heat. Such work must not be carried out except with the consent of the Supervisor’s representative.

Permitted Variation

Without affecting in any way the Contractor's responsibility for the fit of the reinforcement, the position of the reinforcement, or the dimensions of the finished concrete, the cover to reinforcement may vary in accordance with the following schedule.

Cover as specified or as Permitted

deducible from drawings Variation

assuming `perfect' fit

Up to 25 mm. - 0 to + 5 mm.

Greater than 25 mm. up to 55 mm. - 5 to + 5 mm.

Greater than 55 mm. - 5 to + 10 mm.

Testing

 The Contractor shall supply relevant rolling mill test certificates before any reinforcement is used.

Periodic testing of all reinforcement used on site will be required and will comprise:

a) Tensile tests

b) Bend tests

c) Rebend tests

The number of periodic tests will depend upon the total weight of steel used on site and shall be in accordance with the following:

Up to 50 tonnes - One test at the start of the Works.

Up to 100 tonnes - One test at the start of the Works and one other.

Over 100 tonnes - One test at the start of the Works and one test for each 100 tons.

The periodic tests shall be spaced out over the duration of the Works as directed by the Supervisor’s representative.

Each time periodic testing is carried out a set of six test pieces of each diameter and each type of bar delivered to site will be required. The length of each test piece shall be the greater of twenty times the nominal bar size or 600 mm. From each set of six pieces two pieces will be used for tensile tests, two for bend tests and two for re-bend tests. For each type of test the two pieces shall be taken from different bars.

Tests and results shall comply with the requirements of the appropriate BS as follows:

Cold worked steel bars BS 4461 2001

Hot rolled steel bars BS 4449 1988

Test results shall be collected together and dispatched without delay to the Supervisor’s representative.

In the event of a sample failing a test the batch represented by that sample shall be rejected.

The Contractor may be permitted to carry out, at his own expense, such additional tests as required by the Supervisor’s representative to establish that the material is complying with the relevant British Standard so that the decision to reject the batch can be reversed.

### 3.03.02 Cement

The type of cement to be incorporated into the concrete shall be indicated on the drawings and shall be one of the following types complying with the appropriate British Standard or equivalent eurocode:

Ordinary Portland Cement - to BS EN 197

Sulphate Resisting Cement - to BS 4027

The cement shall be obtained from an approved source, which source shall not be changed without the Supervisor’s representative's approval. Every delivery of cement shall be accompanied by the manufacturer's test certificates. If such certificates are not available, the Contractor shall take representative samples from different bags or containers of each consignment, which samples shall be packed and labelled and sent for testing to an approved testing laboratory for compliance with BS 12 or BS 4027, as appropriate, at the Contractor's expense.

For each variety of cement, separate storage shall be provided and contamination of one type by another shall be scrupulously avoided.

All cement delivered to site shall be delivered in approved containers, protected from contamination during transit and stored in an approved silo or silos or in weatherproof sheds, each large enough to allow proper separation between different consignments. The storage shall also be arranged so that the cement is used in the order which it was delivered and in such a way that the Supervisor’s representative can readily identify any particular consignment, for sampling and testing purposes. The floor of the shed shall be raised clear above the surrounding ground by at least 150 mm. and any cement which becomes contaminated shall be removed from the site.

Prolonged storage of cement on site is to be avoided and any cement stored on site for a period greater that 21 days shall be liable to rejection by the Supervisor’s representative and, if so directed, the Contractor shall remove such cement from site at his own expense.

Any bag or package or sample of cement which has been damaged, or rebagged or that in any way has deteriorated shall be rejected either as an individual bag or package or as the whole consignment in which such bag, package or sample is contained.

The Contractor shall keep records of the various consignments of cement in store, giving quantities received and used, and the sections of the work in which the cement has been used, on a weekly basis and make a weekly return to the Supervisor’s representative accordingly.

At the time any cement is used in the Works it shall be free from lumps.

### 3.03.03 Aggregates

Fine and coarse aggregates for concrete shall comply with BS 882 or equivalent eurocode.

Notwithstanding such compliance, the nature and particle shape of the aggregate must be such as to ensure that the necessary strength and workability requirements can be met. The Flakiness and Elongation indexes of the predominant size fraction in each single sized course aggregate, determined in accordance with BS EN 932-6:1999, shall not exceed 20% and 35% by weight respectively.

The fine aggregate shall consist of clean sand and be within Zone 2 and Zone 3 grading as defined in BS 882. The coarse aggregate shall consist of graded crushed stone complying with BS882.

Aggregates shall not contain any deleterious matter either in any form or sufficient quantity such as to adversely affect the strength and durability of the concrete. In particular, the following shall apply:

1. The sodium chloride content of the aggregate shall not exceed the following percentages of the dry weight of the aggregates:

Fine aggregate 0.08%

Coarse aggregate 0.04%

If the content of either aggregate exceeds these limits the material shall still be considered acceptable provided that the total sodium chloride of the aggregates does not exceed 0.32% by weight of the cement in the mix.

1. The maximum sulphate content expressed as SO3 (sulphur trioxide) shall not exceed 0.25% of the dry weight of the aggregate, or it shall be such that the maximum sulphate content does no more than double the sulphate content already in the mix and which is attributable to the sulphate (gypsum) content of the cement.
2. The allowable shell content, expressed as a percentage by weight of dry aggregate, as calcium carbonate shall not exceed the following:

|  |  |
| --- | --- |
|  | **Allowable Shell Content** |
| **Nominal Size of Aggregate** | **Total** | **Hollow** |
| **40 mm** | **6.0%** | **1.0%** |
| **20 mm** | **10.0%** | **1.0%** |
| **Fine** | **15.0%** | **2.0%** |

1. The Contractor shall satisfy the Supervisor’s representative that the proposed aggregate is compatible with the cement and that its use will not give rise to a chemical reaction between the alkali in the cement and the aggregate which would affect the durability of the concrete.

The contractor shall supply to the Supervisor’s representative for approval full details of the aggregate he proposes using prior to any concrete being placed in the Works. Such information shall at least include the source of each aggregate, current certificates of grading of the aggregate, test certificates covering sulphate, chloride and shell contents and alkali/aggregate relationship prior to any concrete being placed in the Works. Consequently during the course of the Contract, further grading and test certificates shall be supplied to the Supervisor’s representative at approximately monthly intervals, or at such longer intervals as the Supervisor’s representative may direct. The costs of all testing shall be allowed for by the Contractor.

The source of aggregate shall not be changed without the approval of the Supervisor’s representative.

The aggregate shall be stored on a concrete slab suitably bounded to prevent contamination and inter-mixing of different aggregates. The aggregates shall be deposited in such a way as to prevent segregation through dropping. The aggregates shall be kept cool by shading the stockpiles from the sun or by sprinkling them with water so that cooling results from evaporation.

### 3.03.04 Water

Mixing water for concrete and for spraying aggregates and shutters, for curing and like purposes shall be from a source approved by the Supervisor’s representative. The water shall be clean, fresh, free from oil, organic matter and other deleterious substances.

Prior to the commencement of concreting and subsequently once every three months the Contractor shall sample and test the water supply for the presence of sulphate and chloride salts. The amounts of dissolved solids in the water shall also be checked on a weekly basis by conductivity method during the period which concrete work is being carried out, and any significant change in the amount of dissolved solids recorded shall be immediately investigated by further testing for sulphate and chloride salts.

Water for concreting shall not contain more than 1000 parts per million of sulphate (SO3) nor more than 500 parts per million of chloride.

If at any time when tested with Universal indicator the water supply has a pH value outside the limits of 5.5 to 8.5 then the Supervisor’s representative shall be informed and the water shall be tested in accordance with the recommendations of BS EN 1008:2002 in order to determine the acceptability of the supply for further use. In the interpretation of the test results the Supervisor’s representative's decision shall be final.

### 3.03.05 Admixtures

The use of admixtures and additives to promote workability or any other purpose shall only be allowed with the prior approval in writing of the Supervisor’s representative.

Where such approval is given, the additives shall be applied strictly in accordance with the manufacturer's recommendation.

Additives containing calcium chloride shall not be permitted.

### 3.03.06 Release Agents

The Contractor shall submit details of the release agent he proposes to use for the Supervisor’s representative's approval. When concrete surfaces are to receive an applied finish the Contractor shall ensure that the release agent used will not affect the finish or bonding to the concrete.

### 3.03.07 Jointing Materials (All to be approved by the Supervisor’s representative)

Expansion and movement joints shall be filled as indicated on the drawings with either:

1. compressible filler board consisting of wood fibres impregnated with a bitumen emulsion
2. compressible polyethylene sheet.

The material shall be stored, protected and laid in accordance with the manufacturer's recommendations.

Vertical joints shall be sealed with a gun applied polysulphide liquid polymer sealant.

Floor joints shall be sealed with a bitumen based sealant. Both to be approved by the Supervisor’s representative.

All joints sealants shall be stored and used strictly in accordance with the manufacturer's recommendations, and the rates shall include for the provision of backing cords, primers and preparation of the joints so that the compliance with the manufacturer's recommendations is attained.

## 3.04 Concrete Mix Design and Control

### 3.04.01 Mass Concrete

The following nominal mixes for blinding concrete and mass concrete fill shall be used where specified on the drawings:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Mix Ref. No. | Max Size of Coarse Aggregate | Cement | Fine Aggregate | Coarse Aggregate |
| C15/20(Nominal 1:3:6) | 20 mm | 50 kg | 0.1 m3 | 0.2 m3 |

Where sulphate resisting cement is required to be used, the mix references will be shown on the drawings as C15S/20, C20S/20 etc.

### 3.04.02 Designed Strength Specified Concrete

The concrete mixes to be used in each section of the work shall be designed to give a guaranteed minimum strength which shall be referred to by a number which denotes the nominal crushing strength in Newtons per square millimetre which must be obtained from any 150 mm. cube tested at 28 days in the Works test specified in Clause 3.06 together with a number to show the maximum aggregate size to be used. The classes of concrete are set out in Table A.

For each specified mix, the concrete shall be such that it has the lowest cement content and maximum practical size of aggregate which are necessary to attain the required crushing strength and workability with minimum water/cement ratio in order to ensure full compaction when used under the conditions that will be encountered in the work, provided that the cement content, and where shown the free water/cement ratio, are within the limits given in Table A.

The aggregate size to be used is added to the mix reference, eg C25S/20 indicates 25 N/mm² concrete with sulphate resisting cement with 20 mm. maximum sized aggregate.

The design and quality control of each guaranteed strength concrete mix shall be in accordance with the recommendations of BS 5328: 1 &2: 1997 amended.

|  |
| --- |
| Cement Content of Finished Concrete kg/m3 |
| Mix Ref No  | 28 day Compression strength N/mm² | Min. Cement for Aggregate sizes of 40mm 20mm 10mm | Max. Cement all sizes of aggregates | Max water/cement ratio |
| C20/20 | 20.0 |  250 | 320 |  0.55 |
| C25/20 | 25 |  290 | 350 |  0.50 |
| C30/ 20 | 30.0 |  330 | 380 |  0.45 |
| With Sulphate Resisting Cement |
| C15S/20 | 15.0 |  250 | 320 | 0.55 |
| C20S/20 | 20.0 |  280 | 320 | 0.55 |
| C25S/20 | 25.0 |  330 | 350 | 0.50 |
| C30S/20 | 30.0 |  360 | 380 | 0.45 |

The mixes shall be designed by the Contractor and, before any concreting is commenced, details of the mixes must be submitted, preliminary samples of the mixes prepared and 28 days test results obtained for approval by the Supervisor’s representative before any concrete is placed in the Works.

The 28 days strength of trial mixes prepared in a laboratory shall be one-third greater than the required works 28 days strength.

### 3.04.03 Controls and Records

Notwithstanding approval of the Preliminary Sample test results, the Contractor shall be responsible for producing the specified concrete throughout the Contract.

Should any variations in the mix become necessary or in the Contractor's opinion desirable, approval must be sought from the Supervisor’s representative. Any extra cost in such variations shall be borne by the Contractor.

The Contractor shall keep a complete record of the concreting showing the date and time of placing and location of the concrete in the work.

## 3.05 Workmanship

### 3.05.01 Supervision

The Contractor shall employ on site for the duration of the concreting works a person who is competent to supervise all stages of the production, testing and placing of concrete to the standards required by this Specification. The Contractor shall supply the name, status and qualifications of this person to the Supervisor’s representative for his approval.

### 3.05.02 Mixing of Concrete

All mixing carried out on site will be by power driven batch machines having an accurately calibrated device for the delivery of water and shall be of an approved size and type manufactured in accordance with BS 1305, and tested in accordance with BS 3963.

The weighing and dispensing mechanisms shall be maintained in good order throughout the Contract. Their accuracy shall be within the tolerance described in BS 1305 and checked against accurate weights and volumes. The mixer shall be properly maintained in accordance with the manufacturer's recommendations.

All constituents shall be batched by weight. The weight of the fine and coarse aggregates shall be adjusted to allow for the free water contained in the aggregate.

Cement supplied in bags shall be placed directly from the bag into the intake of the mixing plant and each batch must contain one or more complete bags of cement. No mixer having a rated capacity of less than a one-bag batch shall be used and the mixer shall not be charged in excess of its rated capacity.

The materials shall be mixed to an even colour and consistency. The period of mixing shall be kept to a minimum consistent with achieving satisfactory quality but shall not be less than 1.5 minutes. Prolonged mixing must be avoided. The mixer shall be operated at the manufacturer's recommended speed.

Notwithstanding the provisions of paragraphs 1 & 2 above in special circumstances authorisation may be given for small quantities to be mixed by hand in which case the cement content of the mix must be increased by 25% over that in use for machine.

Mixing plant that has been out of action for more than 30 minutes shall be thoroughly cleaned before any fresh concrete is mixed in it. The first batch of concrete materials through the mixer shall contain an excess of cement to coat the inside of the mixing drum without reducing the required mortar content of the mix. When a change of mix is made to one using a different type of cement, the mixing plant shall be thoroughly cleaned of all traces of the previously used cement, whatever the time interval between successive mixes.

During hot weather the Contractor shall take steps to reduce the concrete temperature by spraying the aggregates with water, shading the materials and mixer plant or any other method of protection he may consider necessary. Moisture content in the aggregates will be taken into account in determining the water/cement ratio and the quantity of free water to be added to a batch.

### 3.05.03 Ready Mixed Concrete

Ready mixed concrete batched off site shall only be used with the written approval of the Supervisor’s representative, who will lay down additional conditions.

### 3.05.04 Transporting and Placing

The method of transporting and placing concrete shall be agreed with the Supervisor’s representative before concreting commences and shall be such that segregation of the constituents is avoided and that the concrete is placed in the Works as soon as possible after mixing.

Plant and equipment used shall be kept free of any material which may cause contamination of the concrete.

In no circumstances shall concrete which has reached its initial set be placed in the work and re-mixing or the addition of extra water, cement or aggregate shall not be permitted, and time elapsing between initial mixing and final compaction in the work shall not exceed 30 minutes.

Any concrete which has become segregated, contaminated or is otherwise not in compliance with this specification shall be rejected.

Except where otherwise agreed by the Supervisor’s representative, concrete shall be deposited in layers which for large areas such as deep slabs or vertical sections such as walls or columns shall not exceed 300 mm. compacted thickness. Concrete shall not be dropped into place from a height greater than 1.5 metres. For placing concrete through heights greater than this, Contractor shall use special methods such as chutes or tremies.

Placing and compaction methods must be arranged not only to ensure complete compaction of each layer, but also so that successive layers shall follow as closely as possible and in no circumstances after initial set has occurred in the preceding layer.

With the exception of oversite blinding concrete, all mass and reinforced concrete must be mechanically compacted using immersion vibrators. Other forms of compaction may be used subject to the Supervisor’s representative's approval but the essential requirement is to obtain complete compaction both in plain and reinforced concrete around reinforcement, spacers, built in fixing devices, holding down bolts, etc. without segregation or the formation of excessive surface laitance.

The Contractor shall be responsible for selecting the type and size of vibrator having regards to the size of the concrete member and the spacing of the reinforcement. Immersion vibrators shall not be allowed the rest against the side of the formwork.

The Contractor shall ensure that an adequate supply of stand-by vibrators in usable condition is on site so that spare equipment is available in the event of breakdown.

Vibration shall only be carried out by personnel competent in the handling of vibrators. Approved labourers will be identified to the supervisor’s representative.

Vibration shall not be used to force concrete to flow horizontally along the forms and placing of concrete shall be adequately in advance of the vibrator to prevent this.

All surfaces including reinforcement not shielded from the direct rays of the sun shall be kept sprayed with water to keep them cool and / or to prevent excessive absorption of water by the surfaces from the fresh concrete. However, concrete is not to be placed in pools of water or flowing water.

Prior to placing concrete, the formwork shall be thoroughly cleaned of all dust, sawdust, chippings and debris, and the reinforcement shall be clean and free from oil, rust, mortar droppings, etc.

No concrete shall be placed in the structure until the Supervisor’s representative has approved the formwork and reinforcement.

The Contractor shall give reasonable notice to the Supervisor’s representative of the time he proposes to pour concrete to allow inspection to take place, and the Supervisor’s representative may order that no concreting shall take place until either he or his representative is present.

If concreting is not carried out within 24 hours of approval being given, fresh approval shall be sought.

Concreting shall proceed continuously over the area between construction joints, and fresh concrete shall not be placed against concrete that has already been placed for more than 30 minutes unless a construction joint has been properly formed.

Concrete when deposited in the work shall have a termperature not exceeding 32 deg C, and it shall not be obtained by increasing the water content of the mix. It may, if authorised, be obtained by the addition of a mortar consisting of sand and cement in equal proportion mixed to the necessary consistency but not having a water/cement ratio exceeding that in use in the concrete mix.

During placing of concrete in reinforced work, a competent steelfixer shall be present.

### 3.05.05 Joints and Stoppages

Stops in concrete at the end of a period of work shall be made only at construction joints which shall be located where shown on the drawings and/or in such positions as may be authorised.

Where the positions of construction joints are not indicated on the drawings they may by assumed for estimating purposes to occur at 5 metre intervals in foundations and retaining walls and at one-third to one-quarter span in slabs and walls and beams subject to a maximum spacing of approximately 9 metres. The sequence of pours shall be arranged to minimise thermal and shrinkage strains.

At construction joints the surface of the completed concrete shall be prepared by spraying with clean water, wire brushing of chipping so that it is free from all laitance, scum and loose material and shows a slightly roughened texture in which the tips of the coarse aggregate are exposed. Immediately prior to resuming concreting operations the exposed concrete face shall be throughly wetted with a cement slurry consisting of cement and fine aggregate in the same proportion as the main concrete and with just enough water to achieve a similar consistency.

In the ground floor slab (where ground bearing), construction joints, crack inducer joints, contraction joints and expansion joints, as detailed on the drawings, shall be incorporated into the work as appropriate. The arrangement of all such joints shall be agreed with the Supervisor’s representative prior to casting the slab.

In all walls and columns, the initial 150 mm up from the bottom of each lift shall be cast separately to provide a stop or `kicker' for securing the shutter for the wall or column thereto. The surface accepting the kicker and the top surface of the kicker shall be treated as described above. The kicker shall be vibrated.

Proposals for the casting sequence and the layout of joints shall be submitted by the Contractor for the Supervisor’s representative's approval.

### 3.05.06 Curing

Freshly placed concrete shall be protected from sun, wind, exposure and excessive drying out and will be cured continuously for a minimum period of 14 days.

Curing should be carried out by covering the surface of the concrete with wet hessian and the covering the hessian with polythene to reduce evaporation. Additional water should be introduced when necessary to keep the hessian thoroughly and permanently wet.

Sprayed curing compounds will not normally be permitted on surfaces which are to receive an applied finish.

Where permitted they shall contain a fugitive dye to give visual indication of even and complete application.

Water used for curing shall be clean. Where water is used for curing concrete work buried in the ground, care should be taken to avoid excessive curing water from running below the foundation of the footing.

All concrete during setting and hardening shall be protected form shock, vibration or damage from any cause. Where damage does occur, all remedial works and consequential delays shall be at the Contractor's expense.

## 3.06 Testing of Materials

### 3.06.01 Approved Tester

All testing specified shall be carried out at an independent testing station approved by the Supervisor’s representative, and immediately following the letting of the Contract, the Contractor shall submit for approval the name of the Tester he proposes to use.

### 3.06.02 Certificate and Reports

Certified copies of all test certificates and reports prepared by the Tester shall be submitted direct to the Supervisor’s representative.

### 3.06.03 Cost of Testing

The Contractor is to allow for the cost of all testing of reinforcement, cement, aggregates, water and concrete as described in this specification, including the cost of sampling and transportation to the Tester.

### 3.06.04 Concrete

1. Preparation and sampling of concrete shall be in accordance with the requirements of BS EN 12350-1:2000.
2. The size of concrete cubes shall be 150 x 150 x 150 mm.
3. A number of works cubes shall be taken on each of the first seven days during which concreting work is being carried out at the beginning of the Contract, and subsequently at such times as required to provide adequate information on the concrete being used. A minimum of one set of cubes shall be made from each different concrete mix used during each working day. Thereafter one set of cubes shall be taken from every fifteen cubic metres of concrete placed, at any time that the Supervisor’s representative may direct. A set shall comprise six cubes.
4. A slump test shall be carried out on each sample from which cubes are made. The slump test shall be carried out immediately after taking the sample. The amount and type of slump shall be recorded and related to the cubes of which it is representative. The results of the slump test shall accompany the relevant test cube results.

Testing Methods

1. Works cube tests for control purposes shall be made in accordance with the recommendations of BS 8500 – 1 & 2: 2000 and the sample of concrete for preparation of the set of cubes shall be taken at the point of discharge of the concrete into the work. The cubes shall be cured by storing in water, and the Contractor shall provide a suitable lagged tank of adequate size with approved automatic temperature control. The Contractor shall provide all necessary moulds and equipment for making and curing the cubes. From each set of cubes three shall be tested at seven days and the other three at twenty eight days.

The test results shall include the information specified in BS EN 12350-1:2000. The Contractor shall take particular care over the marking and recording so that the Supervisor’s representative can identify any particular cube with the part of the work in which the concrete was placed. The cubes shall also be numbered consecutively.

Seven Day Tests

1. The seven day tests should show a crushing strength at least two-thirds of the twenty eight day strength where Ordinary Portland Cement is used, or at least 50% of the twenty eight day strength where sulphate resisting cement is used.

Acceptance of Concrete Works

1. The concrete works shall be considered in compliance with the strength requirements of the specification, if the 28 day cube test results comply with BS 8500 – 1&2:2000.
2. Cylinder Tests

 Cylinder tests may be used instead of cube tests with the approval of the supervisor’s representative.

### 3.06.05 Concrete - Other Tests

Slump Test

The Contractor shall carry out slump test as required in 3.06.04 (iv) or as otherwise directed by the Supervisor’s representative. Slump tests shall be performed in accordance with BS EN 12350-2:2000. and the Contractor shall provide the necessary apparatus at his own expense.

Compacting Factor Tests

If so directed by the Supervisor’s representative the Contractor shall carry out compacting factor testing in accordance with BS EN 12350-4:2000., and shall provide the necessary apparatus at his own expense.

### 3.06.06 Unsatisfactory Concrete Work

Should any of the test results be unsatisfactory, the Supervisor’s representative may order the work to be stopped pending his further instructions. Executed work for which test results are unsatisfactory shall be liable to rejection and if so directed the work rebuilt at the Contractor's expense.

In the case of 7 day Works cube tests providing unsatisfactory, the work may be stopped but shall not be liable to rejection pending the result of the 28 day test.

If the test results fail to comply with Clause 3.06.04, the work represented shall be immediately liable to rejection. The Contractor may however, be given the option of cutting three approved specimens from the completed work and preparing therefrom test cubes or cores which shall be tested as for Works test cubes. Should the average strength of these specimens attain the minimum 28 day strength the work will be accepted but otherwise the work will remain liable to rejection as above.

The cost of all such cuttings, preparation of specimens, transportation and testing, and of making good the portions of the structure affected shall be borne by the Contractor.

Regardless of satisfactory test cube results any concrete work which, in the Supervisor’s representative's opinion, is excessively honeycombed or in any other way defective shall be liable to rejection. Minor defects apparent on stripping the shuttering must be made good at the Contractor's expense but no such making good shall be carried out until after inspection by the Supervisor’s representative and his approval of the proposed treatment has been given. Work which has been previously inspected but which shows signs of such treatment shall be liable to rejection as defective work.

The cost of all delays on site due to faulty concrete work shall be met by the Contractor.

## 3.07 Watertight Construction

Where watertight construction is specified on the drawings:

1. The Contractor shall be responsible for achieving water tightness of the work so specified.
2. Joints in concrete shall be located only at positions shown on the drawings.
3. Continuous waterbars shall be incorporated in all joints, the locations of which shall be as shown on the drawings or as agreed with the Supervisor’s representative.
4. In addition to Clause 3.04.02 the design of the mix must be such as to produce a dense waterproof and damp proof concrete with the lowest possible shrinkage characteristics.
5. After completion, a thorough check shall be made on all joints to ensure that no imperfection exists.

3.08 Formwork

3.08.01 General

Formwork shall include all temporary or permanent moulds for forming the concrete, together with all temporary construction required for their support.

The Contractor shall be entirely responsible for the sufficiency of the formwork but shall if required submit details thereof for approval. The drawings submitted shall show all general fixing and support details. The Supervisor’s representatives approval does not absolve the Contractor of his responsibility. All timber used for forms, falsework and centering shall be sound wood, well seasoned and free from loose knots, shakes, large cracks, warping and other defects. The formwork shall be so designed and constructed so that the concrete can be properly placed and thoroughly compacted.

All formwork whether metal or timber, shall be securely placed and supported to prevent excessive sagging, bulging or tilting.In this regard the thickness of walls and slabs, width and depth of beams and columns shall have a tolerance of +10% or +20 mm whichever is the lesser; the verticality of the centre line of columns and walls shall be within 10 mm in one storey and 20 mm in two or more storeys. All joints are to be closed to prevent leakage of liquid from the concrete, with special care being taken where vibration of concrete will take place. Formwork panels shall have true edges to permit accurate alignments at sides and provide a clean line at construction joints in the concrete.

Formwork shall be so designed that no damage to the concrete shall occur when the formwork is removed. It shall be constructed so that the formwork to the sides of members can be removed without disturbing the soffit formwork or its supports. Props and supports shall be designed to allow the formwork to be adjusted accurately to line and level, and due allowance shall be made for any settlement or deflection of the formwork that may arise during construction so that the hardened concrete conforms to the specified line and level.

Formwork shall be treated on those surfaces against which the concrete is to be poured with an approved shutter oil or similar dressing. To facilitate the removal of dirt, debris, etc. wash out holes are to be left where access is difficult.

The responsibility of the removal of the formwork shall rest with the Contractor, and in no circumstances shall the formwork be struck until the concrete has attained adequate strength to resist damage, in particular to arrises and features. The minimum time that must elapse between casting of the concrete and removal of formwork is given for the Contractor's guidance as follows:

Formwork to vertical surfaces

walls, columns, beams, sides 24 hours

Soffits of slabs (props) 10 days

Soffits of beams (props) 16 days

Formwork shall be removed without shock or vibration which may damage the concrete.

Formwork which is to be re-used must have its surfaces scraped smooth and clean and be re-dressed.

Where concrete is to form a finished surface spacers used for positioning reinforcement are to be of the same mix as that used in the concrete so as to present a uniform appearance.

The Contractor should note that the loading from the falsework and wet concrete, during the construction of a floor, will exceed the permissible loading on the floor immediately below, unless this is a slab bearing on the ground. Where there is a concrete roof above the first floor the latter will have to be supported off the ground floor during the concreting and curing of the roof slab.

In such situations this shall be done by ensuring that the props beneath the first floor are released over its full extent as soon as the concrete has achieved sufficient strength to support itself plus any superimposed loading, but not sooner that the periods given in Clause 3.08.01. The props shall then be re-tightened so that they may be used to share the construction loading from the roof slab.

3.08.03 Construction Joint Formwork

In all temporary daywork or other joints at the end of a period of work in horizontal and inclined work, stop end boards are to be securely fixed across the mould to form a watertight joint.

Unless otherwise detailed on the drawings, such joints shall be formed square and at right to the main reinforcement .

Where reinforcement or dowel bars pass through the stop end board, the board shall be drilled to allow the bars to pass through, or half round indentations made in such a way that the leakage of grout does not occur.

 3.08.04 Ties

The Contractor shall submit to the Supervisor’s representative for approval details of any ties or cast in fixings that he proposes to use in connection with his formwork.

Any embedded metal ties shall not have any part of the tie closer to the finished concrete surface than the specified thickness of cover to the reinforcement. Holes left after removal of any ties shall be filled with mortar.

3.08.05 Cast-in-Fixings and Sundry Items

The Contractor shall be responsible for accurately casting the concrete work and fixing to the formwork any fixings, ties, dowels, slots, holding down bolts, etc. required for securing blockwork, pre-cast concrete work, steelwork or electrical and mechanical services for other trades and suppliers.

Provision shall be made for forming holes, chases, ducts, rebates, the building in of pipes, conduits and other fixings as shown on the drawings. Holding down bolts and washer plates shall be firmly set in the formwork in taper boxes, polystyrene blocks or other approved sleeves as shown on the drawings.

After concreting, but before the concrete has set, the bolts shall be turned and loosened so that they are free to move in the finished work.

Except where shown on the drawings, no fixtures shall be attached to the concrete by shot fixing or drilling without approval of the Supervisor’s representative. Notwithstanding any such authorisation, the Contractor shall be responsible for all damage so caused to the concrete and make good at his own expense.

3.08.06 Surface Finishes

"Fair Faced" (F1 Formwork)

Where surface finishes are described on the drawings as `fair faced', the Contractor shall obtain an even finish to the concrete by the use of steel forms or good quality plywood having a clean smooth impervious surface, free from all defects and with true clear arrises.

The resulting concreting shall be free from honeycombing, stains, fins, lipping, nail or screw marks or any other imperfections and shall be of a uniform surface texture and colour.

Only very minor surface blemishes caused by entrapped air or water will be accepted provided that they do not exceed 0.5% by area of each square metre considered separately and in addition they shall not be concentrated in a manner such that they are noticeable.

No attempt shall be made to rub down or fill blemishes without the prior approval of the Supervisor’s representative.

3.08.07 Covered Concrete Surfaces

"As Struck" (F2 Formwork)

The formwork for all concrete which is to be covered by render, plaster, or otherwise hidden shall be constructed in wrought board or other suitable materials. The removal of minor fins or form marks shall not be required, but all holes, cavities, and irregularities shall be made good after inspection by the Supervisor’s representative and to his approval.

3.08.08 Exposed Aggregate Finish

The Contractor shall be required to produce an exposed aggregate finish of uniform appearance, free of construction and formwork joints, in addition the resulting finish shall be free from honeycombing, stains or other imperfections.

The exposed aggregate finish is to be produced by the use of concrete retarders and `brush and wash' techniques. The Contractor shall ensure that when placing the concrete care is taken to see that the concrete is not discharged against the treated face of the formwork and that vibrators do not come into contact with the treated face. The Contractor must also ensure that close contact is maintained between the fresh concrete and the retardant.

The Contractor shall provide the Supervisor’s representative with details of any proposed concrete retarding agent, together with his proposed methods of application, and shall obtain the Supervisor’s representative's approval before the retardant is applied to the formwork.

Subject to the approval of the Supervisor’s representative an exposed aggregate finish may be produced by tooling, bush hammering or sand blasting, but at no extra cost to the Contract.

The method of forming the exposed aggregate finish shall not be changed during the contract without the prior approval of the Supervisor’s representative.

At the start of the contract the Contractor shall produce a sample panel, not less than 1.0 metre square, of the exposed aggregate finish he intends providing throughout the contract. He shall seek and obtain the Supervisor’s representative's approval before any such finish is incorporated into the Works.

The Supervisor’s representative may require the Contractor to provide, at no extra cost to the contract, additional samples of exposed aggregate finish before granting approval to the Contractor's methods.

The approved samples shall be retained on site and shall form a reference sample. The Supervisor’s representative reserves the right to instruct for the removal and reinstatement, at no extra charge to the contract, of any areas of exposed aggregate finish, in the Works which, in his opinion, fail to reach the standard and appearance of the reference sample.

3.08.09 Slabs

1. Screeded Finish

Where the floor slab is to receive a screeded finish the slab shall be laid to the slopes and levels shown on the drawings and the top surface shall be tamped whilst unset to produce a suitable keyed surface for the receipt of the appropriate finishing materials.

1. Floated Finish

Where a floated finish is required to the floor slab the top surface shall be levelled and floated whilst unset to a uniform finish to the slopes and levels shown on the drawings. The floating shall be done in such a manner as not to bring an excess of mortar to the surface.

1. Dustproof Finish

Where concrete surfaces are required to provide a dustproof finish these shall be treated. Each coat shall be applied with a soft brush on a clean and dry surface in accordance with the manufacturer's printed instructions. Treatment to be approved by the Supervisor’s representative.

1. Non-slip Finish

Concrete surfaces described on the drawings as having a non-slip finish shall be treated with carborundum dust, evenly sprinkled on whilst the concrete is still green, at a rate of 1.5 kg/m² and lightly trowelled in before final finishing. Alternatively, the carborundum dust may be incorporated into the finish by means of a mechanical power float.

1. Hardened Finish

Where a hardened finish is required to the floor slabs these shall be treated with a suitable hardener compound. Compound to be approved by the Supervisor’s representative. Compound to be applied in accordance with manufacturers printed instructions.

3.09 Blinding Concrete

Blinding concrete shall be laid with its top surface free of projecting aggregate, irregularities or ridges. Where it is to receive polythene sheeting it shall be satisfactorily smooth so as to prevent puncturing or tearing of the polythene sheeting.

3.10 Tolerance and Setting Out

1. The Contractor shall be responsible for setting out the work accurately and for accurately making all concrete sections and members in accordance with the dimensions shown on the drawings. He shall generally construct the Woris Works in such a way that the fitting together of various components of the building such as steelwork, blockwork, doors, windows, finishes can be properly carried out.
2. Any work which is significantly out of level or alignment shall be liable to rejection and rebuilt at the Contractor's expense. No cutting away or making up of hardened concrete work shall be allowed without the Supervisor’s representative's approval.

3.11 Damp Proof Membrane

1. The damp proof membrane under all ground slabs shall be as described in Section 2 - Excavation and Earthworks.
2. The outer vertical face of all tanks and ducts within the ground and any other areas indicated by the Supervisor’s representative shall where required be finished with three coats of brush applied waterproof bitumastic coating to the Supervisor’s representative's approval. Bitumastic coating to be submitted to Supervisor’s representative for approval.

3.12 Precast Concrete

Where items of precast work such as lintels, rainwater chutes, cover slabs, etc. are required, the general provisions of this specification shall equally apply.

No precast items that are damaged, chipped or otherwise defective shall be set in the work.

3.13 Grouting up of Base Plate

Where holding down bolts, base plates or other fixings are to be grouted up after erection, an approved non shrinking cement grout shall be used mixed in accordance with the manufacture’s recommendation. It shall be poured under a suitable head and tamped until the space or voids have been completely filled. Where necessary, temporary shutters should be used to retain the grout.

The minimum compressive strength of the grout and mortar shall be 25 N/mm² at 28 days.

3.14 Pumped Concrete

Mix design details for pumped concrete must be submitted to the Supervisor’s representative a minimum of 14 days before it is proposed to use a pump mix.

Concrete shall not be pumped more than 80 metres horizontally or more than 30 metres vertically.

The first 0.25 cubic metres of concrete passing through the pump at the start of each pour shall not be incorporated in the works

**PARTICULAR SPECIFICATIONS**

**CIVIL AND STRUCTURAL WORKS**

**SECTION 4**

**ROADWORKS**

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# Roadworks

4.01 General

4.01.1 Forward

Work of construction of all roads and footpaths will be carried out to the complete satisfaction of the Supervisor’s representative; facilities will be given to him at all stages of construction for the inspection, checking and testing of the works in progress. The whole of the works will be constructed in the positions and to the levels shown on the drawings, unless otherwise agreed with the Supervisor’s representative. The works will be maintained by the Contractor for a period as stated in the contract from the date of completion, as certified in writing be the Supervisor’s representative.

The Contractor shall restore, to the satisfaction of the Supervisor’s representative, any streets, roads, fences and other existing surfaces or erections which may be interfered with by the constructions of the works. All services, pipes and culverts or other property which may be interfered with in the progress of the work or any existing sewers to be retained are to be carefully supported or re-laid where necessary and in such a manner as the Supervisor’s representative may direct, and any damage done to services, sewers, etc. must, without delay, be made good by the Contractor.

All surplus materials shall be carried off site by the Contractor and the site left to the approval of the Supervisor’s representative. During building operations all highways adjacent to the site used by the Contractor for reasons of transporting materials to and from the site shall be kept clean and free from debris by the Contractor at all times. Any existing accesses to property bordering the site must be maintained at all times throughout the construction period.

The Contractor shall submit for the Supervisor’s representative's approval details of access routes for construction traffic prior to the commencement of work.

4.01.2 British Standards and American Standards

Reference to British Standard and American Standards (AASHTO and ASTM) shall refer to the latest edition or include the latest amendments of such standards.

4.01.3 Approved

Throughout this Specification, the term `approved' means approved by the Supervisor’s representative.

4.01.4 Work on Existing Roads

Where work has to be carried out on or adjacent to an existing public road or a road to which the public have access the Contractor shall provide, erect and maintain such traffic signs, lamps, barriers and such other measures as may be necessitated by the construction of the Works in accordance with the requirements of the local authorities and any additional requirements stated in the Contract. Where the circumstances of any particular case are not covered by the aforementioned requirements, the Contractor shall submit proposals for dealing with such situations to the Supervisor’s representative for approval. Compliance with this clause shall not relieve the Contractor of any of his other obligations and liabilities under the Contract. Where the works involve the obstruction of a foot-way, the Contractor shall provide an alternative safe foot-way properly signed, guarded and lit.

4.01.5 Debris and Dust on the Public Roads

Debris or other materials must not be deposited on the highway so as to damage it, obstruct it, or create a nuisance or a danger.

Highways in the vicinity of the works must be kept free from debris and dust falling from vehicles or the wheels of vehicles connected with the works or spreading from the works of associated tips.

Warning signs must be exhibited whilst work is in progress and carriageways and foot-ways affected must be regularly cleaned.

4.01.6 Prohibition of use of the road

Existing public roads must not be used as sites for stock piling and storing plant, vehicles, materials or equipment. The Contractor shall be liable for the cost of reinstatement if damage has been caused to roads.

4.01.7 Existing Ground Levels

The Contractor shall satisfy himself that the existing ground levels as indicated in the Contract are correct. Should the Contractor wish to dispute any levels he shall submit to the Supervisor’s representative a schedule of the position of the levels considered to be in error and a set of revised levels. The existing ground relevant to the disputed levels shall not be disturbed before the Supervisor’s representative's decision as to the correct levels is given.

4.01.8 Alternative Materials

Where alternative specified materials are permitted, the Contractor shall inform the Supervisor’s representative of his choice at least 4 weeks before the material is to be used, or longer if such period is required for testing of the material by the Supervisor’s representative. The material shall not then be changed without the Supervisor’s representative's approval.

4.01.9 Finished Levels

The finished level of the work shall be as shown on the drawings.

4.01.10 Setting Out

All sections of the work shall be properly set out and such setting out, together with proposed levels, shall be approved by the Supervisor’s representative prior to the commencement of the particular section of the work.

4.01.11 Programme/Method of Working

The Contractor shall submit in writing to the Supervisor’s representative for approval full details of all plant and method of working, programme proposals, mix designs of materials for the works prior to the commencement of the work. No operation shall be commenced until such approval has been given.

The foregoing provisions shall not prevent the Supervisor’s representative from requiring the Contractor to vary his plant or methods at any time during the execution of the works, should the Supervisor’s representative consider it essential to ensure compliance with the Specification.

4.01.12 Protection of Works

The Contractor shall protect partially completed work, and shall not allow traffic or plant to pass over, nor use any part of partially completed work for storage or stockpiling of materials.

The Contractor shall protect completed work from damage from whatever cause until handed over to the Client.

4.01.13 Testing

The Contractor shall allow for all testing specified for workmanship and materials.

4.01.14 Testing Facilities

The Contractor shall submit details of all testing facilities, laboratories, etc., that he has available, or proposes to provide, for the performance of testing as required.

4.01.15 Drains, etc., to be completed

All drains, services, cable ducts and other necessary work below formation level shall be completed and inspected and passed by the Supervisor’s representative, before the construction of any road or paved area is commenced.

The Contractor shall protect all service ducts, cables and pipes during construction of roads and paving, and while the depth of cover over them is reduced.

4.02 Site Clearance and Earthworks

4.02.1 General

Notwithstanding any information contained within any report of a site investigation for this project the Contractor shall judge for himself the nature of the ground and shall be fully responsible for ascertaining all necessary information concerning permanent water table, periods of rainfall, flooding of the site and all matters affecting the excavations and foundation work.

The method of excavation which the Contractor desires to use shall be at the sole discretion of the Contractor. The use of explosives may be permitted only with the Supervisor’s representative's written consent. The Contractor shall take all necessary precautions to ensure the complete safety of all site personnel, including any third party.

The contractor shall obtain all necessary licences and permission covering the purchase and use of explosives, and shall meticulously observe the requirements of the relevant authorities.

No explosives shall be stored at the site at any time.

The Contractor shall report to the Supervisor’s representative when excavations are completed and are ready to receive new works and shall obtain consent before commencing the new works.

In the event of excavations being made larger than the sizes shown on the drawings or as otherwise directed by the Supervisor’s representative, the Contractor shall at his own expense fill in the excavated void to the correct profile with suitable material as instructed by the Supervisor’s representative.

4.02.2 Site Clearance

The Contractor shall remove all anthills, ants' nests, grass, bushes, clearing trees, stumps, roots and other vegetation, boulders, buildings, walls, fences, spoil form the existing road or similar obstructions occurring within the boundaries of the permanent Works as defined by the Supervisor’s representative. Unless excavation is to be carried out, cavities left by clearing operations shall be properly cleaned out and backfilled with suitable material as defined in Clause 4.02.9 and compacted in compliance with Clause 4.02.15.

Cleared materials shall be burned or disposed of by the Contractor in a manner acceptable to the Engineerand such materials shall be the property of the Contractor unless prohibited by local regulations.

4.02.3 Topsoil

Topsoil shall not be removed form any area unless the Supervisor’s representative so instruct and then not until excavation or filling operations are about to commence in that area. Where the Engineer instructs the removal of topsoil on the sites of cuttings and embankments it shall be excavated the average depth and over such widths as the Supervisor’s representative shall direct. Such topsoil as will be required in the Works shall be stockpiled within the road reserve.

* + 1. Definitions

Earthworks shall include all excavations, filling, embankment and cut forming, and all other work, operations and processes contingent upon or related to excavation as required by the nature of the Contract.

In relation to earthworks the following words and expressions shall have the meaning hereby assigned to them:

1. "Existing ground level" means the ground level existing before the commencement of the Works.
2. "Stripped ground level" means the level calculated by subtracting the thickness of topsoil directed by the Supervisor’s representative for removal on any section of the Works from existing ground level.
3. "Finished excavation level" means level of completed excavation after any trimming, compacting and preparation of the excavation as calculated from the Drawings or as instructed by the Supervisor’s representative.
4. "Construction width: "shall mean the width of the Permanent Works measured between the outer extremities of the side drains, cutting or embankment slope as the case may be.
5. "Formation width" shall mean the level of completed earthworks ready for pavement construction and shall be synonymous with "Subgrade level".
6. "Formation width" shall mean the width of the earthworks measured between the points of intersection of side drain or embankment slopes at formation level.

4.02.5 Classification of excavated material

The following definitions of earthworks material shall apply this and other Clauses of the Specifications in which reference is made to the defined materials:

1. "Topsoil" shall mean the top layer of soil that can support vegetation.
2. "Suitable material“ shall comprise all material that is acceptable in accordance with Clause 4.02.9 for use in the Works and which is capable of compaction to the standards specified in Clause 4.02.13 term a stable fill having side slopes as shown on the Drawings.
3. "Unsuitable material" shall mean other than suitable material and shall include-
	1. Material from swamps and marshes;
	2. Logs, stumps, roots, vegetable matter and perishable material;
	3. Slurry and mud;
	4. Anthill material.

For the purpose of measurement and payment excavated material will be classified as follows:

1. “Soft Material”
2. This shall be material that can be excavated by hand or bulldozer of weight 18 tonnes and flywheel power 123 kW (equivalent to a Caterpillar D6) fitted with a single shank ripper if necessary. Soft material may include boulders up to 1 m3 in size, and tenderers must allow for this in their rates.
3. In the case of restricted excavation soft material shall be material that can be efficiently removed by a back-acting excavator of flywheel power to 0.1 kw for each millimeter of tyned-bucket width, without the assistance of pneumatic tools.
4. “Intermediate Material” (Hard Rippable)
5. This shall be material that cannot be excavated with the machine described in (iv) (a) , ie, a Caterpillar D6 in good condition and fitted with a single shank ripper, but may be excavated with a bulldozer of weight 37 tonnes and flywheel power 212 kw (equivalent to a Caterpillar D8) fitted with a single shank ripper if necessary. Intermediate material may include boulders up to 2 m3 in size, and tenderers must allow for this in their rates. Boulders larger than 1 m3 but smaller than 2 m3 encountered in Soft Material shall be classed as Intermediate Material.
6. In the case of restricted excavation this shall be material (other than soft) that requires a back-acting excavator of flywheel power exceeding 0.1 kw for each millimeter of tyned bucket width, or the use of pneumatic tools, before the material can be removed.
7. “ROCK”

This shall be material which can only be excavated by the use of explosives or pneumatic tools. Solid boulders exceeding 2 m3 in size encountered in general excavation shall also be regarded as rock.

The Supervisor’s representative will decide on the classification of the materials based on inspection and on the criteria given in the clauses above, irrespective of the Contractor’s chosen method of excavation.

Although particular items of plant are specified above, the Contractor is not obliged to provide or use those particular items of plant for executing the works. However, should those items of plant not be freely avilable in good working order on site, the Supervisor’s representative shall be entitled to decide the classification of materials on the basis of the good-working-order perfomance of the ítems of plant provided by the Contractor pro rata to the theoretical perfomance of the ítems specified.

In the event of disagreement between the Contractor and the Supervisor’s representative it shall be the responsibility of the Contractor, to make available at his own expense such mechanical equipment as is specified in the above clauses, in order to enable the efficient removability or otherwise of the material to be assessed. The decision of the Engineer shall then, subject to the conditions of the contract, be final and binding.

4.02.6 General Use

The use of topsoil shall be restricted to surface layers in positions not subject to loading by pavements or structures.

No excavated suitable material other than surplus to requirements of the Contract shall be removed from the Site except on the direction or with the permission on of the Supervisor’s representative.

If any suitable material excavated from the Site is, with the permission of the Supervisor’s representative, taken by the Contractor for purposes other than the forming of embankments and other areas of fill, sufficient suitable material to occupy, after full compaction, a volume equal to that which the excavated material occupied shall, unless otherwise directed by the Supervisor’s representative, be provided by the Contractor from his own resources.

Suitable material and topsoil surplus to the total requirements of the Works and all unsuitable material shall, unless the Supervisor’s representative permits otherwise, be run to spoil in tips provided by the Contractor.

Where excavation reveals a combination of suitable and unsuitable materials, the Contractor shall, unless otherwise agreed by the Supervisor’s representative, carry out the excavation in such a manner that the suitable materials are excavated separately for use in the Works without contamination by the unsuitable materials.

The Contractor shall make his own arrangements for the stockpiling of topsoil and/or suitable material and for the provision of sites for this purpose.

No excavation for any purpose whatever shall be made on the site, except as shown on the drawings, without the permission of the Supervisor’s representative.

4.02.7 Excavation of Cuttings

Hauling of material from cuttings or borrow pits to embankments or other areas of fill shall proceed only when sufficient compaction plant is operating at the place of deposition to ensure compliance with Clause 4.02.13. Any excess depth excavated below the formation level tolerance specified in Clause 4.04.3 shall be made good by scarifying and backfilling with suitable material of similar characteristics to that removed, and compacted in accordance with Clause 4.02.15. The slopes of cuttings shall be cleared of all rock fragments which move when prised by a crow-bar. Where in the slopes of cuttings layers of rock and softer materials alternate and the Supervisor’s representative considers that the slope immediately after dressing will not permanently withstand the effect of weather, the Contractor shall excavate any insecure material to an approved depth and build up the resulting spaces with Class C15/20 concrete or masonry using rock similar to the adjoining natural rock so as to ensure a solid face.

4.02.8 Explosives and Blasting

Blasting shall be carried out in strict accordance with the latest Government regulations, and at all times shall be carried out and supervised by fully qualified persons in terms of these regulations. If in any situation blasting is considered dangerous, the Supervisor’s representative's decision in this respect shall be final. Should any damage of any kind occur, the Contractor shall be solely responsible for such damage or any claims that may arise therefrom, and shall, at his own expense, carry out repairs or restoration as the Supervisor’s representative may direct.

Care shall be taken that no undischarged cartridges are allowed to remain in the excavation. Careless or indiscriminate use of explosives will result in the Supervisor’s representative withdrawing permission from their use and under such circumstances the Contractor shall resort to other methods of excavation.

The Contractor shall obtain the written permission of the Supervisor’s representative for each location where the Contractor requires to use explosives.

* + 1. Suitable Material for Filling

Soils for fill shall be obtained from areas of cut, including side drains, or from approved borrow pits.

Suitable fill material shall meet the following requirements:

1. The Plasticity Index (P1) shall not exceed 30%.
2. The percentage passing a 075 mm sieve shall not exceed 40%.
3. The CBR swell shall not exceed 1 % after soaking for 48hours.

4.02.10 Forming of Embarkments and other areas of fill

Embankments and other areas of fill shall be formed of material defined as "suitable material" in Clause 4.02.9.

All earthworks material placed in or below embankments, below formation level in cuttings or elsewhere in the Works shall be deposited and compacted as soon as practicable after excavation in layers not exceeding 250 mm thickness before compaction. Subject to the Supervisor’s representative’s approval the loose depth of these layers may be altered following the results of compaction trials.

Embankments shall be built up evenly over the full width. During the construction of embankments the Contractor shall control and direct constructional traffic uniformly over the full width. Damage to compacted layers of material by constructional traffic shall be made good by the Contractor to the satisfaction of the Supervisor’s representative .

The Contractor shall provide adequate supervision and ensure that only approved materials are incorporated in the embankment. If any unsuitable or oversized material, or material which has not been approved, is included it shall be removed from the embankment and replaced with approved material at the Contractor's expense.

4.02.11 Preparation of material for compaction

The material to be compacted shall be thoroughly broken up over the full width and depth of the layer and all stones, clods and lumps shall be broken down to comply with Clause 4.02.09.

If the material deposited as fill subsequently reaches a condition such that it cannot be compacted in accordance with the requirements of the Contract the Contractor shall either:

1. make good by removing the material off the embankment either to tip or elsewhere until it is in a suitable physical condition for re-use, and replacing it with suitable material; or
2. make good the material by mechanical or chemical means to improve its stability; or
3. cease work on the material until its physical condition is again such that it can be compacted
4. as described in the Contract.

4.02.12 Watering and Mixing

The Contractor shall take advantage of the natural moisture content of the material and add water as necessary in successive applications, evenly and uniformly over the area to be compacted.

The water shall be thoroughly mixed with the material to be compacted by means of suitable equipment.

The material shall be compacted at the optimum moisture content of the material for the compaction plant to be used, with an allowable tolerance of plus one per cent and minus two per cent of moisture by weight of dry material.

Following approval by the Supervisor’s representative the Contractor shall not vary his plant or methods without first obtaining the Supervisor’s representative’s approval of such variation

* + 1. Compaction of fill

The level of compaction to be obtained in any part of the earthworks shall be expressed as a percentage of the maximum dry density (MDD) of the soil at optimum moisture content as measured in the BS (Heavy) Compaction Test.

The minimum standards of compaction to be achieved in fill shall be as follows:

Depth below-finished Minimum permissible road level percentage of MDD

0mm-400 mm 95%

Over 400 mm 93%

Compaction shall be carried out evenly in a series of orderly and continuous operations over the width of the layer concerned.

The provision, trimming and disposal of additional material to ensure proper compaction in side slopes shall be the Contractor's responsibility.

Testing will be carried out in accordance with Clause 4.02.14, although the Supervisor’s representative may at any time carry out tests on compacted fill. If the test results when compared with the results of similar tests made on adjacent approved work show the compaction to be inadequate, the Contractor shall at his own expense carry out such further work as is necessary to bring the compacted fill within the specification.

* + 1. Testing

The Contractor shall make such tests in advance of excavation as are considered necessary by the Supervisor’s representative to determine the suitability of materials to be excavated for use as fill. Tests may include gradings, Atterberg Limits, compaction and CBR tests and shall normally be carried out not less than once for every 2,000 m3 of material to be excavated.

In situ density tests shall be carried out at a frequency of one per 100 m per layer or as directed by the Supervisor’s representative and shall be reported as a percentage of the BS (Heavy) MDD.

* + 1. Compaction under embankments and in cuttings

Before the placing of any fill, or after the removal of unsuitable material, the surface of the ground shall be compacted to a depth of 150 mm to 90% of the maximum dry density (MDD) of the soil at optimum moisture content as measured in the BS (Heavy) Compac­tion Test.

Where the depth of construction below finished road level is less than 600 mm on embankment, or where the road is in cutting, the Supervisor’s representative may, following the results of tests, instructthe Contractor to excavate below ground level, or below formation level, over such areas and to such depths as the Supervisor’s representative may consider necessary. The surface exposed by this operation shall be compacted to 93% of MDD to a depth of 150 mm and the void refilled with suitable material compacted to 95% of MDD. The rates of these operations shall be deemed to allow for any additional compacted fill which may be required to make up the compacted surfaces to the original levels or the levels as reduced by the removal of unsuitable material.

* + 1. Borrow Pits

Fill material which is required in addition to that provided by excavation for Permanent Works, including side drains, shall be obtained from borrow pits which shall be located by the Contractor and approved by the Supervisor’s representative . The Contractor shall at his own expense provide all accesses, clear and remove all anthills, ants' nests, vegetation, topsoil, rock, boulders and unsuitable or oversize material and shall provide adequate supervision to ensure that approved material is not contaminated with unapproved or unsuitable material.

Borrow pits shall be excavated to regular width and shape and shall be cleared upon completion so that the sides are neatly trimmed, topsoil replaced and the bottom levelled and drained away from the Works in such a manner that no water will collect or stand in them

* + 1. Soiling and Grasing

Where shown on the Drawings or directed by the Supervisor’s representative the slopes of cuttings, embankments and verges shall be covered with topsoil and lightly rolled to the compacted thickness stated in the Contract.

All surfaces to be grassed shall immediately before grassing be reduced to a tilth and be free from stones.

Grass of an approved species shall be planted by the Contractor at 250 mm centres and watered at frequent intervals to ensure a quick and regular growth.

The Contractor shall be responsible for the watering, cutting and maintenance of all grassed areas during the period of the Contract

4.03 Drainage, Flood Protection and Service Ducts

4.03.1 Culverts

1. Excavation

The excavation for culverts shall be to the levels and net widths required. Excavated material shall be hauled to areas of fill where suitable, or disposed of off site where unsuitable for filling or surplus to requirements.

b) Culverts

Culverts shall be pre-cast concrete pipes, boxes or in-situ concrete as shown on the drawings.

c) Inlets and Outlets of Culverts

Inlet and outlets shall comprise reinforced concrete walls and aprons as shown on the drawings. The Contractor shall submit his proposals for construction of the Inlets and Outlets to the Supervisor’s representative for approval prior to starting construction.

4.03.2 Embankment Protection

a) Rip-Rap

Rip-rap shall be single size stone, comprising crushed rock or boulders of nominal size 450 mm 250 mm or 150 mm as shown on the drawings. The material shall be placed in trenches or on the ground, or on embankment faces as shown. Grouted rip-rap shall be placed in layers and shall be set in and surrounded with concrete of the following mix proportions:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Max Size of Coarse Aggregate | Cement | Fine Aggregate | Coarse Aggregate | Water |
| 12 mm. | 50 kg. | 160 kg. | 200 kg. | 30 litres |

b) Gabions

1. Gabion boxes and Gabion mattresses shall comprise complete cages made of welded or woven wire mesh to dimensions shown on the drawings.
2. Wires forming the mesh shall be 2.7 mm minimum diameter and shall be galvanised before weaving or after welding. Tying wire for wiring the units together hall be 2.2 mm minimum diameter and galvanised.
3. The gabions shall be provided with diaphragms at 1.0 m intervals except for mattresses which are laid at slopes greater than 1 vertical: 2 horizontal when diaphragms at 600 mm intervals shall be provided.
4. The gabions shall be assembled, wired together and filled in the manner recommended by the manufacturer.
5. Filling material shall generally be of 150 mm nominal size but may comprise materials in the size range 125 mm to 200 mm.

c) Drainage Layer

A drainage layer of crushed rock or boulders shall be placed at the positions shown on the drawings. The stone shall be well graded, between 10 and 35 mm. in size, and shall be placed and compacted with the appropriate plant.

d) Filter Membrane

A geotextile filter membrane shall be placed in the positions shown on the drawings. The membrane shall be approved by the Supervisor’s representative and shall be positioned in accordance with the manufacturer’s recommendations.

4.03.3 Ducts for future services

 Ducts for future electrical and telephone cable crossings of the roads are to be laid where shown on the drawings. These normally consist of a two-way duct for each of the services at each location.

 The ducts are to be of a type approved by the relevant Local Authorities for use in connection with local electricity and telephone services. All ducts shall be laid and jointed so that no earth, silt, grout or concrete is able to enter the duct. Ducts shall be surrounded by sand or granular material and shall contain draw wires. Immediately after laying the duct the ends shall be suitably plugged and immediately marked by permanent markers of the appropriate colour as shown on the drawings.

4.04 Subgades, Sub-bases and Bases

* + 1. Definitions

The term "pavement" shall mean the layers of construction above subgrade level consisting of sub-base, base and surfacing.

* + 1. Prevention of Damage to Partially Completed Subgrade and Pavement

After any section of subgrade or pavement layer has been completed and has been approved by the Supervisor’s representative, the Contractor shall ensure that it is not damaged or allowed to deteriorate. Any damage which may occur shall be made good to the satisfaction of the Supervisor’s representative.

* + 1. Tolerance

The carriageway and shoulder levels as shown on the Drawings or as directed shall be the surface levels before the application of bituminous surface dressing and shall be set out in relation to the datum shown on the Drawings.

The level at any point on the surface of each course shall conform to the tole­rance shown in Column 2 of Table 4.04.3. In addition, the surface of the subgrade, sub-base, base and shoulder level shall, when tested with a 3 m straight edge placed in any position of the finished surface parallel to the centre line, have no depression greater than that shown in Column 3 of Table 4.04.3. The transverse profile shall conform to the same accuracy, using a correctly shaped template instead of a straight edge except on superelevation.

The longitudinal profile of the pavement layers shall be free from any pattern of undulations which, although individually within the tolerances overall, would adversely affect the riding qualities of the finished surface.

TABLE 4.04.3

|  |  |  |
| --- | --- | --- |
| Surface of Course | Tolerance from true surface level | Maximum depression tested with 3 m straight edge |
| SubgradeSub-baseBaseShoulder | +0 to -25mm+0 to -25mm+13mm to -0+13mm to -0 | 13 mm13 mm6mm13mm |

The surface of the shoulder where it joins the base shall in no case be at a higher level than, nor more than, the level of the adjacent surface of the base.

* + 1. Sub-base

All sub-base material shall be homogeneous throughout, shall consist of a natural or artificial mixture of hard durable particles and soil binder and shall have the following characteristics:

1. The CBR, obtained either unsoaked or after soaking for 96 hours as specified in the documents, of the material compacted to 95% of the maximum dry density at optimum moisture content as obtained in the BS (Heavy) Compaction Test, shall be not less than 25%. When appropriate a shorter soaking period than 96 hours may be used with the specific approval in writing of the Supervisor’s representative.
2. The product of the Plasticity Index and the percentage passing the 0.075 mm sieve (hereafter termed the Fineness Index) shall not exceed 600. In addition the Plasticity Index shall not exceed 20%.
3. The CBR swell of the material shall not be greater than 0.5%.
4. The maximum size of aggregate shall be not greater than 65 mm except where the material is laid in layers of 100 mm, when the maximum size of aggregate shall be not greater than 40 mm.
	* 1. Base Material

Type 1 Material (gravel / lateritic gravel)

1. The material shall consist of a natural or artificial mixture of hard durable particles and soil binder free from soft materials and excess clay and shall have the following particle size distribution.

|  |  |
| --- | --- |
|  | **Percentage passing by weight** |
| **BS sieve size** |  |
| **37.5 mm** | **100** |
| **20.0 mm** | **70-90** |
| **10.0 mm** | **45-75** |
| **5.0 mm** | **35-60** |
| **2.36 mm** | **25-45** |
| **0.425 mm** | **20-35** |
| **0.075 mm** | **15-25** |

1. The Fineness Index shall not exceed 300. In addition the Plasticity Index shall not exceed 12%.
2. The Liquid Limit shall not exceed 30%.
3. The CBR, obtained either unsoaked or after soaking for 96 hours as specified in the documents, of the material compacted to 98% of the maximum dry density at optimum moisture content as obtained in the BS (Heavy) Compaction Test shall be not be less than 80%. When appropriate a shorter soaking period than 96 hours may be used with the specific approval in writing of the Supervisor’s representative.

Type 2 Material (graded crushed stone):

1. The material shall consist of a natural or artificial mixture of hard durable particles and soil binder free from soft materials and excess clay and shall have the following particle size distribution.

|  |  |
| --- | --- |
|  | **Percentage passing by weight** |
|  | **Coarse aggregate** | **Medium aggregate** |
| **BS sieve size** |  |  |
| **53.0 mm** | **100** | **-** |
| **37.5 mm** | **-** | **100** |
| **25.0 mm** | **55-80** | **80-95** |
| **20.0 mm** | **50-80** | **65-85** |
| **12.5mm**  | **45-75** | **55-75** |
| **5.0 mm** | **30-60** | **35-55** |
| **2.36 mm** | **20-50** | **25-45** |
| **0.425 mm** | **10-25** | **15-25** |
| **0.075mm** | **2-10** | **5-15** |

1. The material passing the 0.425 mm sieve shall be non-plastic.
2. The Flakiness Index shall not exceed 35%.
3. The average loss determined after 5 cycles of the sodium sulphate soundness test shall not be greater than 12%.

4.04.6 Lime Improvement (fill and capping layers)

Definition

Capping layer: This is a layer of improved sub-grade material immediately below the sub-base layer

Material

Where lime improvement is indicated for clayey materials it shall be hydrated calcium lime complying with BS EN 459 – 1 and the following requirements :

 (a) Fineness

 Residue on 0.18mm sieve : maximum of 5%

 Residue on 0.075mm sieve : maximum of 15%

 (b) Chemical requirements

 Available lime content (as CaO) minimum of 50%

Lime content

The lime content shall be determined by a testing programme at the commencement of the works. It shall be deemed to be satisfactory if the improved material has a Plasticity Index not exceeding 20 and a CBR swell not exceeding 1%.

4.04.7 Cement improvement

Terminology

The term cement improvement is used when the cement content does not exceed 4% and the improved material retains most of its flexibility. When the cement content exceeds 4% the material becomes more rigid and the term cement stabilization applies.

Cement improved sub–base

Where cement improvement is indicated for sandy sub-bases the cement content shall not exceed 4% and the improved material shall have the following characteristics.

1. the CBR, after soaking for 96 hours, of the material compacted to 95% of the maximum dry density at optimum moisture content as obtained in the BS (Heavy) Compaction Test, shall not be less than 25%.
2. the Plasticity Index shall not exceed 20
3. the CBR swell of the material shall not be greater than 0.5%.

4.04.8 Laying and Compaction, general

The material shall be placed, spread, watered, mixed, shaped and compacted by methods which shall not disturb the previous layer, and such methods shall be to the approval of the Supervisor’s representative.

The material shall not be spread over the area on which it has been tipped but shall be spread away from that area. Spreading shall proceed from the centre to the sides of the pavement on normal crossfall and from the high side to the low side on superelevation.

Hauling of material shall not take place over uncompacted material.

The sub-base material shall be spread without segregation uniformly to the full width of the subgrade in one operation.

The base material shall be spread without segregation in lanes of uniform thickness. Where the material is to be laid in more than one layer the full width of base shall be completed before the second layer is commenced.

Storage or stockpiling of materials shall not take place on partially completed subgrades or pavement.

Specified thicknesses of 100mm to 200mm shall be laid in one layer and thicknesses exceeding 200mm shall be laid in two equal layers.

Sub-base material shall be compacted to a density not less tahn 95% of the maximum dry density of the material at optimum moistyre content as obtained in the BS (Heavy) Coampaction Test. Base material shall be compacted to 98% MDD.

In situ dry density tests shall be carried out by the contractor on each layer of compacted material at the rate of 3 per 2,000m3 or at such other intervals as directed by the Supervisor’s representative.

The surface of the finished sub-base and base shall be smooth and free from irregularities to the approval of the Supervisor’s representative.

Any weak spots in a layer which become apparant during compaction shall be cut out and repaired with sound material before the next layer commences.

4.04.9 Laying and Compaction of Type 1 Base Material (Gravel / Lateritic gravel)

The material shall be thoroughly mixed by windrowing from side to side so as to obtain a uniform mixture before it is finally spread and shaped.

4.04.10 Laying and Compaction of Type 2 Base Material (Graded crushed stone)

The appearance of the compacted base shall be a mosaic of interlocking stones held firmly in position by successively smaller stones wedged into the interstices so that no cavities are present.

4.05 Surfacing

* + 1. Materials for surface dressing
1. Prime Coats:
2. Prime coat for graded crushed stones ( Type 2 material)

The prime coat shall be a cut-back bitumen of MC 30 Grade having a kinematic viscosity of 40-60 centistokes at 400 C, in accordance with BS 3690.

1. Prime coat for gravel / lateritic gravel Type 1 material)

The prime coat shall be a cut-back bitumen of MC 70 Grade having a kinematic viscosity of 70-140 centistokes at 600 C in accordance with BS 3690.

1. Binder for stone seal:

The binder shall be a straight run bitumen having a penetration of 80/100 at 25oC in accordance with BS 3690

1. Aggregate for stone seal:

The material shall consist of approved single sized crushed gravel or rock graded in accordance with BS 63. The aggregate crushing value of the material shall not exceed 25%, and the Los Angeles Abrasion value shall not exceed 25.

4.05.2 Application of Prime Coat

Immediately before the application of the prime coat, the surface of the base shall be swept clean of all loose material with soft-haired brushes to the satisfaction of the Supervisor’s representative.

The surface of the material to be primed shall be in a damp condition and this shall be achieved by a light sprinkling of water as necessary.

The prime coat shall be uniformly applied over the surface area at the rate of 0.65 to 0.75 litres/m2 for MC 30 and 0.85to 1.10 litres/m2 for MC 70 or as otherwise directed by the Supervisor’s representative . The temperature of application shall be 350 C - 700 C for MC 30 and 550 C - 850 C for MC 70. Any areas not adequately covered shall immediately be resprayed by hand to the satisfaction of the Supervisor’s representative.

The prime coat shall be allowed to dry out thoroughly and for a minimum period of 24 hours.

Traffic shall not be permitted to use the primed surface unless the surface is adequately protected to the approval of the Supervisor’s representative .

4.05.3 Application of Surface Dressing, general

Before the application of further surfacing the primed surface shall be thoroughly examined and any weak or damaged areas shall be made good by cutting out the unsatisfactory material, replacing and re-priming to the approval of the Supervisor’s representative .

Such areas after repair shall be in conformity with the remainder of the primed surface.

Immediately before covering, the primed surface shall be brushed and thoroughly cleaned to the approval of the Supervisor’s representative.

The actual rate of application of bitumen as measured by the Road Tray Test shall be within ± 10% of the specified rate.

The Contractor shall ensure that joints between spraying strips are straight, that no bitumen is sprayed on adjacent completed surfacing and that no excess or deficiency of bitumen shall occur.

Any sections which show a deficiency in binder shall be re-sprayed and where sections show an excess of binder, the material shall be removed by burning off and the section re-sprayed, all to the approval of the Supervisor’s representative ..

Protection shall also be laid on the shoulders and kerbs to ensure that the surface dressing terminates at the edge of the carriageway and forms a neat line. Rolling shall commence at the edge of the carriageway and proceed in a longitudinal direction. Overlap on successive passes shall be at least half the width of the roller.

The completed surfacing layer shall be evenly textured, show no lean or fat areas and shall not have any areas which will allow the accumulation of water.

4.05.4 Stone Seal

Straight run 80/100 penetration bitumen shall be applied at a temperature between 165o C and 190oC. The rate of application at spraying temperature shall be as follows:

Rate of application

 Chipping Size of bitumen (l/m2)

 20 mm .. .. .. .. .. 1.15-1.50

 14 mm .. .. .. .. .. 1.05-1.35

 10 mm .. .. .. .. .. 0.90-1.20

The rate of application within the ranges given above shall be as directed by the Supervisor’s representative. Surface dressing shall not be carried out when the road temperature is below 250 C.

Immediately following the application of bitumen the surface shall be covered with approved stone chippings.

The rate of spread of chippings shall be such that the finished appearance shall be that of a close-knit mosaic of stone particles firmly adhering to the bitumen, with individual chippings in contact with those immediately surrounding them. The surfacing shall be rolled with an approved pneumatic tyred roller immediately after the application of the chippings.

All aggregate shall be dry and free from deleterious matter. Where chippings have become dusty in transit or in the stockpile these shall be cleaned to the Supervisor’s representative’s satisfaction.

At least one sieve analysis and one determination of flakiness index shall be carried out on chippings per working day. Samples for test shall normally be taken from the material on the Site where surfacing is in progress, but stock­piles of chippings shall be sampled and tested when the Supervisor’s representative so requires.

Where double or triple surface seals are specified at least one week shall elapse between the applications of each layer when the surfaces may be opened to traffic with the approval of the Supervisor’s representative. Before the second and third layers are applied the road surface shall be thoroughly brushed to remove all loose and deleterious material. When the road is opened to traffic the speed of the traffic shall be limited to 30 km/hour until the loose material has been removed by the Contractor. Suitable speed limit signs shall be erected and traffic signs warning the motorist of the possibility of loose flying stones shall be displayed.

The length of carriageway to be sprayed in one operation shall not exceed that which can be immediately covered by stone chippings. This length shall be to the Supervisor’s representative’s approval, and shall not normally exceed one half carriageway width by 500 m in length.

4.05.5 Premix surfacing (Asphalt concrete)

The aggregate shall be a crushed stone and shall have the following particle size distribution:

 Percentage passing

 BS sieve size by weight

 20 mm .. .. .. 100

 14 mm .. .. .. 95-100

 l0 mm .. .. .. .. 70-90

 6.3 mm .. .. .... 45-65

 3.35 mm .. .. .. .. 30-45

 1.18 mm .. .. .. .. 15-30

 0.075 mm .. .. .. .. 3-7-

For hot mx/Hot lay premix the binder shall be straight run bitumen having a penetration of 80/100 at 600C in accordance with BS 3690.

The filler material required to be added to the crushed stone to comply with the above grading shall be crushed stone dust, Ordinary Portland Cement or approved sand.

The Contractor before commencing the premixed surfacing shall design trial mixes by the Marshall Method of Design and subject the material to stability, flow and voids tests in accordance with ASTM D 1559-65 and ASTM D 1188-68.

The material shall comply with the following:

1. Stability shall exceed 7 kN.
2. Flow shall exceed 2 mm but not exceed 5 mm.
3. Voids shall exceed 3% but not exceed 5%.

The bitumen content of the mixed material which shall exceed 5% by weight but not exceed 8% shall be selected by the Supervisor’s representative from the results of these tests.

4.05.6 Transporting, Laying and Compacting of premixed Surfacing (Hot Lay Type)

The mixed materials shall be transported in clean vehicles and shall be covered over when in transit or awaiting tipping. The use of dust, coated dust, oil or water on the interior of the vehicles to facilitate discharge of the mixed materials is permissible but the amount shall be kept to a minimum, and any excess shall be removed by tipping or brushing.

Mixed material shall be spread, levelled and tamped by approved self-propelled pavers and shall as soon as possible after arrival at the Site be supplied con­tinuously to the paver and laid without delay. The rate of delivery of material to the paver shall be so regulated as to enable the paver to be operated continuously and it shall be so operated whenever practicable.

The rate of travel of the paver and its method of operation shall be adjusted to ensure an even and uniform flow of material across the full width of layer, freedom from dragging or tearing of the material and minimum segregation.

The material shall be laid in accordance with the laying recommendations in BS 594 subject also to the following overriding requirements.

Hand laying of any premixed material shall he permitted only in the following circumstances:

1. For laying regulating courses of irregular shape and varying thickness.
2. In confined spaces where it is impracticable for a paver to operate.
3. For footways.

The material shall be compacted as soon as rolling can be effected without causing undue displacement of the mixed material and while this has a rolling temperature of at least 1200 C. The material shall be uniformly compacted by an 8-10 tonnes smooth steel wheeled roller having a width of roll not less than 500 mm or by a multi-wheeled pneumatic tyred roller of equivalent weight. Final rolling shall be carried out by an approved smooth-wheeled roller.

The material shall be rolled in a longitudinal direction from the sides to the centre of the carriageway, overlapping on successive passes by at least half the width of the rear roller or in the case of a pneumatic tyred roller, at least the nominal width of one tyre.

Rollers shall not stand on newly laid material while there is a risk that it will be deformed thereby.

Hand-raking of premixed material which has been laid by a paver and the addition of such material by hand-spreading to the paved area for adjustment of level will be permitted only in the following circumstances;

1. At the edges of the layers of material and at gullies and manholes.
2. Where otherwise directed by the Supervisor’s representative.

Joints between layers both longitudinal and transverse shall be formed by cutting back the exposed joint to a vertical face along the road centre line or at right angles to it, discarding all loosened material and coating the vertical face completely with a suitable grade of bitumen before the adjacent layer is commenced.

4.06 Concrete Pavement

4.06.1 General

The Specification for Concrete Works associated with highway/concrete pavement areas shall be Section 3 of the `Civil &Structural Specification' supplemented by the clauses contained in this specification. Where any conflict arises between the specifications, this specification shall apply for all concrete works associated with pavement construction.

4.06.2 Waterproof Membrane

An underlay as specified on the drawings shall be used to provide a waterproof/slip membrane between the concrete slab and the base course. Where an overlap of underlay material is necessary this shall be at least 300 mm. Water shall not be allowed to pond on the membrane, which shall be completely waterproof when the concrete is laid.

4.06.3 Joints

a) General

* 1. Joints shall be formed in a straight line and shall cross each other at right angles. Joints running in one particular direction shall be parallel to each other.
	2. That part of the groove to be sealed whether wet formed or sawn after concreting shall be within a tolerance of + 5 mm. from a straight line along the length of the joint.
	3. Joints shall be in the positions as shown on the drawings.

b) Expansion Joints

1. Expansion joints shall comprise vertical pre-formed joint filler, dowel bars and supporting cradles or assemblies and a groove as specified in Clause 4.06.3 (g) which shall be located directly over the joint filler. Joint assemblies and filler boards shall be within a tolerance of + 5 mm. from the true line of the joint.
2. The joint filler shall comply with the requirements on Clause 4.06.19 and be of sufficient rigidity to enable it to be satisfactorily installed in the joint. It shall resist deformation during concreting and shall be installed with such accuracy that its upper surface lies within the width of the part of the groove to be sealed, and at such a depth below the surface as to allow the depth of seal as given in Table P/1. The joint filler together with the seal shall provide complete separation of adjacent slabs and any loose fitting holes around dowel bars and spaces between the sub-base and the filler material after assembly of the joint.
3. Dowel bars complying with Clause 4.06.17 shall be provided at mid-depth of the slab + 20 mm. When supported in assemblies or cradles and positioned prior to concreting, the bars shall be parallel to the finished surface of the slab and to the centre-line of the carriageway within the following tolerances:
4. All bars in a joint shall be within + 3 mm per 300 mm length of bar, except that one bar in 3.65 m may by outside this tolerance.
5. Two thirds of the bars shall be within + 2 mm. per 300 mm. length of bar.
6. No bar shall differ in alignment from an adjoining bar by more than 3 mm. per 300 mm. length of bar in any plane.

After concreting, the alignment of dowel bars shall remain within twice the above tolerances. Dowel bars shall be provided at one end with a closely fitting cap 100 mm long consisting of waterproofed cardboard or an approved synthetic material. An expansion space equal in thickness to that of the joint filler shall be formed at the end of the cap by inserting into it a disc of joint filler or pad of cotton waste. The cap shall be placed on the free half of each dowel which shall also be coated, within 14 days of concreting, with bond breaking compound complying with Clause 4.06.16.

1. The assembly of joint filler dowel bars and supporting cradles when fixed in position shall be rigidly fixed to the satisfaction of the Supervisor’s representative.

c) Contraction Joints

1. Contraction joints shall comprise a bottom crack inducer, dowel bars and supporting cradles and a groove as specified in Clause 4.06.3 (g). The bottom crack inducer shall be an approved timber or synthetic strip or filler securely fixed to the surface under lying the slab along the line of the joint within a tolerance of + 5 mm. and cast into the bottom of the slab. The dowel bars shall conform to Clause 4.06.3 (b) except that the caps shall be omitted. Cradles supporting dowels shall not be continuous across the centre line of the joint, and they must be fixed to the sub-base in such a way that the bars remain within tolerance after concreting.

The groove shall be located in the top of the slab vertically above the centre of the crack inducer to within a horizontal tolerance of + 13 mm. The Combined depth of the groove and the crack inducer shall be between one quarter and one third of the depth of the slab and the difference between the depth of the groove at the top and the height of the crack inducer at the bottom shall not be greater than 13 mm.

The crack inducer may be omitted if grooves, as specified in Clause 4.06.3 (g) are sawn. In these cases the depth of the groove shall be between one quarter and one third of the depth of the slab. The bars shall be at mid-depth + 20 mm., except where a deep groove between one quarter and one third of the depth of the slab is used, when the upper tolerance shall be only 10 mm.

As an alternative to positioning joint assemblies before concreting, dowel bars may be inserted into the plastic concrete by a method approved by the Supervisor’s representative which ensures re-compaction around the bars. The insertion of the bars shall be carried out before the passage of the final finishing beam or screed. When bars are inserted, they must lie parallel to the centre line of the carriageway and to the surface and with each other to within twice the tolerances given in Clause 4.06.3 (b). Inserted contraction joint dowel bars shall be equally positioned about the centre line of the joint within a tolerance of + 50 mm.

d) Longitudinal Joints

1. Longitudinal joints in concrete paved areas shall be positioned as shown on the drawing and shall have dowel bars fully or partly bonded as specified. On concrete roads longitudinal joints shall be provided at the edge of each traffic lane within the tolerances given in the Contract, except when:
2. At right angles to the line of each longitudinal joint, tie bars shall be placed or inserted and the joint sealed as specified in Clause 4.06.18. The bars as specified in Clause 4.06.17 shall be 12 mm diameter, 1.0 m long mild steel or 10 mm diameter, 750 mm long high yield deformed bars. They shall be placed parallel to surface profile within the middle third of the slab thickness.

e) Construction Joints (Emergency)

Emergency joints in reinforced concrete pavements shall only be installed in the event of mechanical breakdown or adverse weather and shall not be constructed less than 3 m away from any expansion or contraction joint. They shall be formed by means of drilled and split cross form in which tie bars 12 mm. diameter, 1.0 m. long at 600 mm. centres at mid-depth of the slab, shall be inserted and which shall permit the reinforcement to project through the joint for a distance of at least 600 mm. The next reinforcement shall completely overlap and be tied to the projecting reinforcement.

f) End-of-day Joints

End-of-day joints, other than emergency joints, shall be at contraction or expansion joints.

g) Grooves at Joints

1. Grooves in the surface of the concrete at joints may be formed in the plastic concrete. Alternatively they may be sawn after the concrete has set. The part of the groove to be sealed shall have truly vertical and parallel sides, except when special formers are used in the plastic concrete with the approval of the Supervisor’s representative in which case the centre line of the former shall be vertical. Grooves shall be sealed in accordance with Clause 4.06.3 (h).
2. If the grooves are to be sawn the Contractor shall initially saw slots as follows:
3. Contraction Joints

To the depth required by Clause 4.06.3 (c) and of any convenient width not greater than the width required for the seal specified in Clause 4.06.3(h).

1. Expansion Joints

a) To the full depth and width required for the seal specified in Clause 4.06.3 (h).

 or

b) Two slots one along each edge of the joint filler to the depth of the seal. The overall distance between the outside edges of the two slots shall be the required width of the seal.

The initial sawing shall be completed as soon as possible and within 8 hours after the final compaction of concrete laid before noon and within 18 hours after the final compaction of concrete laid after noon.

Expansion joint grooves shall be temporarily or permanently sealed before any traffic uses the carriageway.

Contraction joint grooves wider than 5 mm. shall be temporarily or permanently sealed. Narrower slots shall be sawn to the full width and depth required for the seal immediately prior to permanent sealing.

3. If the grooves are to be formed, the Contractor shall demonstrate to the Supervisor’s representative's satisfaction that a surface finish across the joint is obtainable within the appropriate tolerance permitted in Clause 4.06.21. The forming mechanism shall include a horizontal vibrating plate at least 300 mm. wide across the line of the joint, or similar device, to ensure that the concrete displaced to form the groove is fully re-compacted into place, followed by, or incorporating, a screed of sufficient width to ensure the surface finish is satisfactory. When the grooves to be formed are more than 13 mm. wide the method of forming adopted shall remove from the slab the volume of concrete displaced to form the groove.

4. If rough arises develop when grooves are made, they shall be ground to provide a radius of approximately 6 mm.

Where flexible material abuts concrete slabs longitudinally at road surface level, and no detail is provided in the contract drawings, with the approval of the Supervisor’s representative a groove 10 mm. wide, 20 -25 mm. deep shall be formed or sawn and sealed in accordance with Clause 4.06.3 (h) with a poured sealant compatible with both pavements.

h) Sealing of Grooves

1. Before any traffic is permitted to use the pavement in advance of permanent sealing, the grooves shall be cleaned of any dirt or loose material and be protected by inserting a temporary sealing strip of a material approved by the Supervisor’s representative. This condition shall not apply where narrow grooves are first sawn in accordance with Clause 4.06.3 (g) until the grooves are widened. Alternatively, in the case of formed joints where a temporary filler or former is used, this shall be left in position until the joints are prepared for permanent sealing.
2. Except where otherwise permitted by the Supervisor’s representative or when a permanent seal is used when the joint is formed, the permanent sealing of the joints shall be carried out not less than 28 days after laying the concrete.
3. Except where permanent seal is used when the joint is formed, the joint, immediately prior to permanent sealing, shall be cleaned, and any dirt or loose material or any temporary sealing, former or other filling material shall be removed. The sides of the part of the groove to be sealed shall be scoured by grinding, sawing or dry sand-blasting except where plastic formers are used. The groove shall be temporarily caulked prior to sandblasting. In addition, ~~of~~ for the removal of old sealing compound, high pressure water jetting or water-and-sand-blasting may be used. The surfaces of the groove shall be dry at the time of sealing. The dimensions of the seals shall be in accordance with Table P/1 but if the depth of the groove exceeds the depth of the seal the groove may be caulked to the required depth with a compressible caulking material of a type which does not affect and is not affected by the sealing compound to be used. A compressible filler shall be used in all grooves with polysulphide type sealant 20 such that the width/depth ratio of the seal shall be between 2 : 1 and 1 : 1. Any spalling at the edges of the grooves shall be made good to the satisfaction of the Supervisor’s representative, using an approved material compatible with the sealant, before the sealant is applied.
4. The prepared grooves shall then be sealed with poured compounds complying with Clause 4.06.18. Where recommended by the manufacturer of the sealing compound, an appropriate primer shall be used in accordance with the manufacturer's recommendations.
5. Two components cold poured sealant shall be thoroughly mixed in the correct proportions in accordance with the manufacturer's instructions using an automatic mixer-dispenser approved by the Supervisor’s representative, or for small quantities for hand application, using a power operated mixer for sufficient time to produce a homogeneous mix. As soon as possible after mixing, the material shall be poured into the joint or applied using a caulking gun, to a level between 3 mm and 6 mm below the concrete surface. The tack-free time shall be achieved within 3 hours for machine-applied material or 12 hours for hand-applied sealants.

|  |
| --- |
|  TABLE P/1 DIMENSIONS OF POURED JOINTS SEALS |
|  | Spacing of joints (m) |  Width of seal (mm) |  Depth of cold poured seal(mm) |
| ContractionExpansionSawnLongitudinal | Under 88-15 inclusiveAll spacing |  10 155 mm greater than thickness of the filler (Note a)  5 |  8 - 10 10 - 15 20 - 25 10 - 15 |
| (a) Expansion joint filler shall normally be 25 mm. thick. |

4.06.4 Treatment at Manholes and Gullies

Manhole covers, gullies and their frames shall be isolated from the main pavement slab and be housed in separate slabs. The slabs shall be larger than the exterior of the manhole shafts and any concrete surround if the top of the shaft is less than 150 mm below the bottom of the concrete pavement.

The positions of manholes, gullies and joints in the concrete pavement shall be adjusted relative to each other so that the manhole and gully slabs shall be adjacent to a joint or the edge of the slabs, or alternatively lie within the middle third of the slab. When this is not possible, reinforcement must be included around the gully or manhole recess.

Manholes and gully recesses shall be formed by casting the main slab against formwork boxes placed and fixed accurately and vertically. The formwork shall be removed where the concrete around the manhole or gully cover is to be placed, and preformed joint filler 20 mm. thick fixed to the slab edges so exposed. This shall be the full depth of the slab allowing for the depth of the groove required for sealing. Alternatively the recess may be sawn out after the concrete has hardened.

A groove for a seal shall be made directly above the preformed joint filler and sealed as specified in Clause 4.06.3 (h).

Reinforcement as described in the Contract shall be placed in the position shown and concrete placed by hand in the space between the main slab and the manhole frame. This concrete shall meet the strength requirements specified on the drawing and the mix shall be modified to permit full compaction by the methods adopted.

4.06.5 Delivery, Storage and Batching of Materials

Refer to Section 3 of the Civil & Structural Specification.

4.06.6 Concrete Mixes

Refer to Section 3 of the Civil & Structural Specification.

4.06.7 Mixing Concrete

Refer to Section 3 of the Civil & Structural Specification.

4.06.8 Transporting and Placing

Refer to Section 3 of the Civil & Structural Specification.

4.06.9 Compaction and Finishing with a Hand Guided Vibrating Beam

Concrete shall be evenly placed without pre-compaction or segregation and be compacted in the following manner.

Concrete to be compacted by a vibrating beam shall be struck off at such a level that the surface level after all entrapped air has been removed by compaction is above that of the side forms. The concrete shall be compacted by a steel-shod hardwood compacting beam not less than 75 mm wide, 225 mm deep with an energy input of not less than 250 W per metre width of slab, the beam being lifted and moved forward by increments not exceeding the beam width. Alternatively, a vibrating twin beam compactor of equivalent power may be used. After every 1.5 m length of slab has been compacted the vibrating beam shall be taken back 1.5 m and then drawn slowly forward whilst vibrating over the compacted surface to provide a smooth finish.

The surface shall then be regulated by at least two passes of a scraping straight-edge with blade length not less than 1.8 m. If the surface is torn extensively by the straight-edge owing to irregularities in the surface, a further pass of vibrating beam shall be made, followed by a further pass of the scraping straight-edge.

4.06.10 Surface Finish During Initial Construction of Concrete Pavements

After the completion of joints and the final pass of the finishing beam and before the application of the curing membrane, the surface of concrete pavements to be used as running surfaces shall be brushed in a direction at right angles to the centre line of the pavements.

Brushed finish shall be formed with a wire broom not less than 450 mm wide. The wire tufts of the broom used shall initially be 100 mm long of 32 gauge tape wire. The broom shall contain two rows of tufts, at 20 mm centres and tufts shall be at 10 mm centres and offset to the centre of the gap between tufts in the other row. The tufts shall average 14 wires each. Brooms shall be replaced when shortest tufts wear down to 90 mm long.

4.06.11 Curing

The exposed surfaces of concrete pavements shall be cured immediately after the surface treatment specified in Clause 4.06~~5~~.10 by treating with an approved aluminised curing compound as specified in Clause 4.06.14. It shall be mechanically sprayed on to the surface at the rate of 0.22 - 0.27 litres/m² using a fine spray. For the sides of slabs when the side forms are removed within 24 hours and for small areas where a mechanical distributor cannot be used, the compound shall be sprayed by hand lance at the rate of 0.27 to 0.36 litre/m². Any groove over a joint shall be protected from entry of curing compound.

The mechanical sprayer shall incorporate an efficient mechanical device for continuous agitation and mixing of the compound in its container during spraying.

4.06.12 Trial Bays

The Contractor shall, if required by the Supervisor’s representative, demonstrate the plant, equipment and method of construction by first laying two bays.

The Contractor shall submit to the Supervisor’s representative at least one month prior to the date proposed for the trial a description of the plant, equipment and method of construction. No development of the plant shall be permitted either during the trial length or when pavement concrete is being laid in the Permanent Works.

For the trial to be acceptable, the length of pavement shall conform, without remedial works, to the Specification.

Approval of the method of construction, plant and equipment will be given when the trial has been successful. The Contractor shall not continue with the laying of pavement concrete in the Permanent Works until approval to a trial has been given or permission has been given by the Supervisor’s representative to proceed with another trial.

4.06.13 Aggregates for Concrete

Refer to Section 3 of the Civil & Structural Specification.

4.06.14 Aluminised Curing Compound

Aluminised curing compound shall, when applied at the rate specified in Clause 4.06.11 by mechanical sprayer, become stable and impervious to evaporation of water from the concrete surface within 60 minutes after application.

Test certificates, prepared by an approved testing laboratory, shall be supplied by the Contractor to show that the compound has a curing efficiency of 90 per cent and to the approval of the Supervisor’s representative.

The curing compound shall contain sufficient flake aluminium in finely divided dispersion to produce a complete coverage of the sprayer surface with a metallic finish. The curing compound shall not react chemically with the concrete to be cured and shall not crack, peel or disintegrate within three weeks after application.

4.06.15 Bond Breaking Coating for Dowel Bars

Bond breaking compound shall consist of 66 per cent of 200 pen bitumen blended hot with 14 per cent light creosote oil and, when cold, brought to the consistency of paint by addition of 20 per cent conventional naphtha or other approved compound which shall not retard or in any other way affect the setting of concrete.

The average bond stress on bars coated with the compound for half their length, as described in the Contract, cast into concrete specimens and subjected to pull -out tests at 7 days shall not exceed 0.14 N/mm² and the total movement of the dowel bar relative to the concrete shall be not less than 0.25 mm. at that stress. The concrete specimens shall be 150 mm x 150 mm in section and 450 mm long and made with the same mix proportions as used in the Works.

4.06.16 Cement

Refer to Section 3 of the Civil & Structural Specification.

4.06.17 Dowel Bars and Tie Bars for Concrete Pavements

Dowel bars shall consist of mild steel and tie bars shall be of mild steel or deformed bars of high yield steel complying with the requirements of BS 4449 and they shall be free form oil, paint other than bond breaking compound, dirt, loose rust and scale.

Dowel bars for joints shall be straight, free from burred edges or other irregularities and shall have their sliding ends sawn or, if approved by the Supervisor’s representative, sheared.

4.06.18 Cold Poured Joint Sealants and Seals

Joint Sealants shall consist of cold poured compounds as described in the Contract and which comply with the following Clauses.

Cold-poured sealants for joints in pavements and foot-ways shall comply with the performance requirements of the Normal type of sealant given in BS5212: 1990

The sealant shall be composed of curing agent and a base resin, which shall be in such proportions as recommended by the manufacturer to provide a fast cure if the material is mixed and applied by special machines, or a retarded cure if mixed by hand. When a primer is recommended by the manufacturer it shall be applied within the temperature range of 20 deg. C and 40 deg. C. It shall cure within one hour and remain active for not less than 4 hours. The sealant shall be applied after the curing period of the primer and within the period that the primer remains active.

Material mixed and applied by hand shall be supplied in separate containers in the correct proportions and shall be mixed using a powered stirrer or mixer or any other method approved by the Supervisor’s representative.

The work life for machine mixed material shall be adjusted to suit the appliance.

Testing Poured Sealants

Unless a manufacturer's certificate is produced to state that the material has satisfactorily passed the BS Tests within 6 months prior to use, the Supervisor’s representative may require samples to be taken and tests to be carried out in accordance with the relevant BS. The Supervisor’s representative may at any time also require a sample to be taken and testing in accordance with the BS to determine the quality of the material as poured into the joint.

4.06.19 Pre-formed Joint Filler

Pre-formed joint filler shall be compressible filler board consisting of wood fibre impregnated with a bitumen emulsion to be approved by the Supervisor’s representative.

4.06.20 Steel Reinforcement

Refer to Section 3 of the Civil & Structural Specification.

4.06.21 Surface Levels and Regularity of Pavement Courses

a) Surface Levels

1. The levels of pavement courses shall be determined from the true finished road surface calculated from the vertical profile and crossfalls as shown on the Drawings. The vertical depth below the true pavement surface of any point on the constructed surface of the formation or pavement courses shall be within the appropriate tolerances stated in the table below.

 Tolerances in Surface Levels of Pavement Formation

Concrete Road + 6 mm

Road Base Material + 15 mm

Formation + 20 mm

1. The surface level of the pavement at any point shall not deviate vertically from the true finished road surface by more than + 6 mm. However , the combination of permitted tolerances in different pavement layers shall not result in a reduction of the overall depth of concrete slab by more than 5 mm from that specified nor a reduction in the thickness of the whole pavement by more than 15 mm from the specified thickness.
2. For checking compliance with these requirements, measurements of surface levels will be taken at points selected by the Supervisor’s representative at 10 m centres longitudinally and at 2 m centres transversely. In any length of pavement, compliance with these requirements shall be regarded as met when not more than one measurement in any consecutive ten longitudinally or one in any transverse line, exceeds the tolerances permitted in the Table, but this one measurement shall not exceed 5 mm more than the tolerance for the layer concerned.

b) Surface Regularity

The surface regularity shall be tested where necessary at points decided by the Supervisor’s representative, with a straight-edge 3 m long placed parallel with or at right angles to the centre line of the road. The maximum allowable deviation of the surface below the straight-edge shall be:

For road surface 3 mm.

For Road Base 10 mm.

c) Rectification

Where any tolerances in this Clause are exceeded the Contractor shall determine the full extent of the area which is out of tolerance and shall make good the surface of the pavement course or formation in the manner described below.

1. Formation Level

If the surface is too high it shall be re-trimmed and recompacted to Specification. If the surface is too low the deficiency shall be corrected by scarification and the addition of suitable material of the same classification and moisture content or other approved material laid and compacted to Specification.

1. Road Base

The top 75 mm. shall be scarified, re-shaped with material added or removed as necessary, and re-compacted all to Specification. The area treated shall be not less than 10 m. long and 2 m. wide or such area to be determined by the Supervisor’s representative as necessary to obtain compliance with the Specification.

1. Concrete slab
2. Areas out of tolerances shall be rectified as follows:
	1. the complete bay shall be removed and replaced or at the discretion of the Supervisor’s representative where the area out of tolerance is small, this may be rectified by:
	2. cutting out of the surface and replacing to a depth of not less than 20 mm with concrete to an approved mix design and an approved method of replacement. Texturing shall be by brushing in accordance with Clause 4.06.10.

4.07 Kerbs and Foot-ways

4.07.1 Pre-cast Concrete Kerbs

1. Pre-cast concrete kerbs shall comply with BS 7263 and shall be laid and bedded in a layer of cement mortar not less than 10 mm. and not more than 40 mm. thick, on a Class C20/20 concrete foundation. Kerbs shall be backed with Class C20/20 concrete.
2. For radii of 12 m or less, kerbs of appropriate radius shall be used.
3. Any kerb deviation more than 3 mm in 3 m from line and level shall be made good by lifting and relaying.

4.07.2 Concrete Work

All concrete for this Section to be in accordance with Section 3 - Concrete Work.

4.06.3 Cement Mortar

Cement mortar shall consist of Portland Cement and fine aggregate, as specified in Section 3 - Concrete work, in the following portions:

a) For rendering, fillets, grouting and margins

 1 part of cement to 2 parts of fine aggregate.

b) For brickwork, kerbs

 1 part of cement to 3 parts of fine aggregate.

4.08 Traffic Signs and Road Markings

4.08.1 Permanent Traffic Signs

a) Permanent traffic signs shall comply with the requirements of:

 i) BS 8442:2006 in respect of quality

 ii) The Traffic Signs Regulations of the relevant country

b) Where illumination is to be provided, this shall be by lamps complying with BS 873. Where reflectorisation is required the means shall be approved type as described on the drawings.

4.08.2 Road Markings

The markings shall be white or yellow continuous or intermittent lines, letters, figures, arrows or symbols laid to the dimensions and consisting of one of the following materials described on the drawings:

1. Thermoplastic Material

Thermoplastic material complying with the requirements of BS 3262 laid to the following thickness:

1. Sprayed markings other than yellow lines: 2 + 0.5 mm.
2. Sprayed yellow edge lines: 1 + 0.2 mm.

These thicknesses specified are exclusive of surface applied ballotini. The method of thickness measurement shall be in accordance with BS 3262.

The Contractor shall state the maximum safe heating temperature, the temperature range of apparatus and the method of laying to be used.

Thermoplastic markings where described on the drawings shall be screed or spray applied incorporating ballotini and also having a surface application of ballotini applied evenly at the rate of 400 - 500 g/m².

1. Road Marking Paints (suitable for concrete, asphalt, interlocking pavers and kerbs)

Paint shall be road marking paint by an approved manufacturer. It shall be suitable for applying by brush or mechanical means to give a chemically stable film of uniform thickness and shall be chlorinated rubber.

White paint shall contain not less than 6 per cent by mass of titanium dioxide as a pigment, conforming to type A (anatase) or type R (rutile) specified in BS EN ISO 591-1:2000.

Yellow paint shall be standard colour BS 381C, except where and alternative shade has been specified in the Contract, and contain not less than 6 per cent by mass of a suitable yellow pigment.

The paint shall be supplied fresh and ready for use in sealed containers and stored in accordance with the manufacturer's instructions. The paint shall be applied without the use of thinners and approved by the Supervisor’s representative.

Where markings are to be reflectorised with ballotini it shall be sprayed uniformly on to the wet paint film at the rate of 400 - 500 g/m². Ballotini shall comply with the requirements of BS 3262.

4.08.3 Pavement Finish to Receive Markings

1. Concrete

On concrete the transverse texturing shall be carried across the full width of the pavement under the marking which shall be freed by wire brushing or other approved means from all traces of curing compound. A tack coat compatible with the marking material shall be applied in accordance with the manufacturer’s instructions prior to the application of thermoplastic material.

1. Surface Dressing

On surface dressing, all loose chippings shall be removed from the surface before applying markings.

Road marking materials shall only be applied to surfaces which are clean and dry. Marking shall be free from raggedness at their edges and shall be uniform and free from streaks. Carriageway lane and edge lines shall be laid by approved mechanical means to a regular alignment.

**PARTICULAR SPECIFICATIONS**

**CIVIL AND STRUCTURAL**

**SECTION 5**

**REINFORCED CONCRETE IN WATER RETAINING CONSTRUCTION**

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# Reinforced Concrete in Water Retaining Construction

5.01 General

This section of the Specification is applicable to all water retaining structures constructed in reinforced concrete.

5.02 Definition

Water retaining construction shall prevent water from passing through the concrete from one side to the other. This will be considered to have been achieved if no running water, water droplets or damp staining occurs on one side of the concrete when the other side in subjected to water pressure up to designed head of water.

5.03 Designed Head of Water

The designed head of water is 3.0 metres.

5.04 Interpretation

The specification clauses listed hereunder are to be read in conjunction with and shall prevail over those of the Section in the Specification for Concrete Work. The paragraphs in this Section are numbered in the same sequence as for the Section on Concrete Work.

5.05 Materials

1. Cement. Cement shall comply with BS EN 197 for Ordinary Portland cement and BS 4027 for Sulphate Resisting Cement.

2. Aggregates. The aggregates shall be gravel and natural sand both in accordance with BS EN 12620 and having a low drying shrinkage and an absorption not greater than 3% measured in accordance with BS EN 932 – 6: 1999

 The grading curve for the sand shall be such as to produce a concrete which with the specified essential requirements will have a consistency suitable for the work in hand and will readily work into position without segregating and can be readily compacted into a dense impervious mass.

3. Waterstops.

 i) Water stops shall be made of rubber and as specified on the drawings. All junction pieces shall be prefabricated by the supplier.

 ii) The waterstops shall be stored, handled, jointed and temporarily fixed in the formwork in accordance with the suppliers` instructions or recommendations.

 iii) In no circumstances whatsoever shall the waterstop be pierced either through the end bulbs or anywhere in between. Any waterstop so pierced will be rejected. The Contractor is advised that such a rejection may involve the demolition of the work back to the next sound waterstop.

4. Joint fillers. The joint filler shall be a non-absorbent, non-rotting cork based material.

5. Joint sealants. All joint sealants where specified shall be two-part polysulphide sealants conforming to BS EN ISO 11600 "Specification for Two-Part Polysulphide-Based Sealants", and shall be designated as suitable for use in hot climates.

Concrete Mix Design and Control.

a) Designed Mixes-Essential Requirements.

Mix Reference C30/20

Characteristic Strength(N/mm²) 30

Type of Cement As specified on drawings

Min. Cement Content (kg/m3) 360

Max. Cement Content (kg/m3) 380

Max. Free Water/Cement Ratio .45

Max. Aggregate Size (mm) 20

Special Properties Dense, low shrinkage

b) Concrete Quality Control.

 i) Mixing - Pre-Mixed Concrete

 The cement and aggregates shall be properly mixed before being placed in the drum of the lorry. The water may be added before discharge into the drum or upon arrival on site depending upon the distance of the depot from the site and the anticipated journey time. All subject to the approval of the Supervisor’s representative.

 ii) Designed Mixes - Preliminary Details

 The method by which the proposed depots monitor the moisture content of the stored aggregates shall be provided by the Contractor.

 It is a requirement of this Specification for Water Retaining Construction that the depots supplying concrete shall have permanently installed and in regular use a reliable device for measuring the moisture content of the stored aggregates and that the operator is properly instructed in the additional water required.

iii) Accepted Mixes

 Sampling

Tank Floor A sample shall be taken from each of two batches selected randomly form each bay being cast.

Tank Walls & Roof Slab A sample shall be taken from one batch selected randomly form each bay being cast.

 iv) Slump Tests

 The Contractor’s attention is directed to the requirements of the Section of the Specification for Concrete Work.

5.07 Workmanship

1. Placing and compaction. Concrete shall be mechanically compacted using immersion vibrators of suitable size and in suitable numbers for the work in hand.

The concrete shall be properly compacted as described in the Section of the Specification for Concrete Work, special care being taken to ensure that:

a) the water stop is not moved from its proper position and is not bent over; where the water stop is horizontal it should be carefully lifted so that concrete is properly placed and compacted beneath the water stop;

b) the vibrator does not come into contact with the water stop.

2. Joints. Joints shall be formed at the locations shown on the drawings.

Before pouring any concrete the Contractor shall ensure that the water stop is clean and is properly fixed in position so that it is symmetrically disposed about the line of the joint. The method of fixing shall prevent the water stop from moving during the pouring and compaction of the concrete.

Any work in which the water stop is not disposed symmetrically about the joint line will be liable to rejection. The Contractor is advised that such rejection will involve demolition of the work back to the next sound joint.

The Contractor is advised that the joints must be positioned exactly according to the drawings so that the lines of the expansion joints in any special finishes are maintained over the joints in the concrete.

The surface of the concrete facing onto the joints shall be lef "as struck".

3. Curing. All concrete shall be maintained in a moist condition for a period of not less than 7 days from the time of casting. In hot direct sunlight horizontal surfaces shall be protected from excessive temperature rise by "ponding" or other suitable methods.

Curing shall be effected by the use of imperforate polythene sheeting of suitable thickness held in close contact with the concrete surface and securely fixed at the edges so that air cannot circulate between the concrete and the polythene. The contractor shall arrange his work so that the polythene sheeting is not removed, disturbed or damaged for the whole of the specified curing period.

Sprayed curing compounds will not be permitted.

1. Shutter Ties. Internal shutter ties shall remain embedded in the concrete and shall be of a type specifically intended by the supplier for use in concrete subject to hydrostatic pressure.

The ties shall be so constructed that no part of the permanently embedded portion is closer that 50mm to the concrete faces.

Any holes or depression resulting from the use of shutter ties shall be completely filled with 1:4 cement/sand mortar thoroughly compacted into the hole or depression.

5. Use of Joint fillers. The joint filler shall be fixed to the face of the concrete already cast with a waterproof adhesive.

Where polysulphide sealants are to be used to seal joints containing a filler the Contractor shall ensure that the joint filler in use is a suitable backing material for the sealant and will not invalidate the suppliers’ warranties.

6. Polysulphide Sealants. Polysulphide sealants shall be mixed and used strictly in accordance with the manufacturer`s instructions. The sealant shall in no circumstances be less than 12mm thick and for joints exceeding 25mm wide the minimum thickness shall be not less than half the width of the joint.

The faces of the concrete in contact with the sealant shall be primed according to the supplier`s recommendations. The concrete shall be clean and dry when the primer is applied. If necessary the concrete shall be dried locally using a hot air fan or gas torch taking care not the overheat the concrete. (The Contractor shall note that the aggregates in concrete are likely to explode if allowed to get too hot and protective clothing and goggles must be worn).

5.08 Inspection of Tank

1. Preliminary Inspection. After completion of the tank and before any finishes are applied the Contractor shall prepare the structure for inspection by the Supervisor’s representative so that a check can be made on the exclusion of any external groundwater which may be present. For the purposes of this inspection any collected water must be removed and all surfaces dried off. If the roof has not been constructed the Contractor shall allow for protecting the tanks from rainfall.

Any work which shows visible singns of water penetration or damp staining will be rejected. The Contractor shall obtain the consent of the Supervisor’s representative for the remedial methods which he proposes to use before making good any work so rejected.

When the tanks are shown to be excluding external water as described in the preceding paragraph the tanks shall be tested for watertightness when filled with water.

1. Filling and Stabilising Period. Filling with water shall be at uniform rate of not greater than 2m in 24hours, up to the designed head of water. This level should be maintained as necessary over a stabilising period of 21 days.
2. Tank Testing and Watertightness Condition of Acceptance. The tanks will be accepted as watertight provided that the level of the water does not drop by more than 5mm in a period of 7 days after the stabilising period, due allowance being made for evaporation.
3. Time of Testing. The Contractor shall obtain the agreement of the Supervisor’s representative to the time during the Contract Period at which the testing takes place. In no circumstances will testing be permitted before 28 days have elapsed from the time of placing the final concrete in the tank construction.
4. Obtaining and Disposing of Water. The Contractor shall be responsible for obtaining and disposing of the water used during the tests. He shall obtain the consent of the Supervisor’s representative and of the appropriate Water Authority prior to the test period.
5. Protection from Weather. For the duration of the stabilising and test periods the tanks shall be completely protected from the weather so that rain or drying winds and hot sunshine do not materially affect the tests.
6. Test Procedure.

1) All drains, inlets or other openings shall be made watertight and during the tests should be inspected where possible to check that water is not leaking through them.

2) The tanks shall be filled with water as described in (ii) above. The drop in level of the water shall be recorded daily before any topping up to the test level is carried out.

3) At the end of the stabilising period the test period shall commence unless the amount of topping up required indicates that the tank is leaking. During the test period no water shall be added to the tank and no material of any description shall be permitted to enter the tanks.

4) The level of the water shall be measured at the start of the first and each subsequent 24 hour period of the test and at the end of the last 24 hour period (8 measurements).

viii) Method of Measurement. A scale 300mm long and divided into millimetres shall be securely fixed at two points in its length to the inside of the tank so that approximately 3/4 of the scale is immersed in the water.

The scale shall be made of a material which will be unaffected by immersion in the water and shall remain legible throughout the test.

5.09 Material Approval Sheets

The Contractor shall supply details of all proposed structural materials on Material Approval Sheets of an approved format to the Supervisor’s representative for his approval. Material Approval Sheets should be submitted well in advance of the Contractor’s ordering deadlines. A minimum approval period by the Supervisor’s representative of 5 days should be allowed.

# Structural Steelwork

6.01 Specification for Structural Steelwork

6.01.1 Scope of Section

This section covers building frames and other similar steelwork including anchorages and foundation bolts.

6.02 Materials

Materials shall comply with the appropriate British standards listed below

BS 4-1 Structural steel sections – specification for Hot rolled sections

BS EN 10210 Hot rolled structural steel sections. Part 2 – structural hollow sections and BS EN 10056-1:1999 Equal and unequal angles

BS EN 10296 Specification for seamless and welded steel tubes for automobile, mechanical and general engineering purposes.

BS EN 10149-2 & 3 Steel plate, sheet and strip. Part 1 – carbon steel plate sheet and strip

BS 3692 ISO metric precision hexagon bolts, screws and nuts

BS 4190 ISO metric black hexagon bolts, screws and nuts

BS 4320 Metal washers for general engineering purposes

BS 7668 Weldable structural steels

BS 4933 ISO metric black cup and counter sunk head bolts and screws with hexagon nuts.

6.03 Design of Connections

The main dimensions of the structures and the sizes of members are shown on the drawings.

Bolts shall comply with BS 3692 or 4190 and shall be of strength and grade as shown on the drawings. Washers complying with BS 4320 used with such bolts shall be tapered or flat as appropriate to ensure full bearing for the units and the bolt heads.

All bolts in any one connection shall be of the same diameter and all bolts used on site shall be of the same strength grade unless otherwise specified or approved by the Supervisor’s representative.

6.04 Submissions to the Supervisor’s representative

6.04.01 Submissions Before fabrication

The contractor shall submit to the Supervisor’s representative two copies of each of the following:

1. details of orders for materials and fabricated steelwork;
2. details of proposed source of supply of steel and dates of rollings;
3. details of proposed programme, sequence and methods of fabrication;
4. details of proposed programme; sequence and method or erection with any supporting calculations and details of constructional plant;
5. if it is proposed to use high strength friction grip bolts with load indicating devices, details of the manufacturer’s recommendations regarding their use;
6. outline details of materials and methods of application proposed to meet the specified requirements for protective coatings both in the shop and, if required, on site in compliance with “Specifications for protective coatings”.
7. Description and samples of all proprietary products which the Contractor proposes to use in the Permanent works”

Contractor’s fabrication drawings (if applicable)

The contractor shall supply to the Supervisor’s representative four printed copies and one reproducible copy of the drawings approved by the Supervisor’s representative and four copies or the specifications and other information’s approved by the Supervisor’s representative.

Fabrication shall not be started until the Supervisor’s representative has approved the relevant shop drawings and once such approval has been given no alterations shall be made to the shop drawings without the further approval of the Supervisor’s representative.

6.05 Fabrication

6.05.01 Material

Steel shall be Grade 43A to BS 7668 unless otherwise indicated on the drawings. Crane rails shall comply with BS 11 normal steel grade.

6.05.02 Workmanship

Steelwork shall be fabricated to comply with BS 5950 – Part 2 and with the following further requirements:

1. All members shall be accurately cut square or to the required angle and neatly dressed.
2. Flanges shall be neatly cut away or notched where required. Notches shall be as small as possible with radii in the inner corners.
3. Sheared or cropped edges shall be dressed to a neat finish with sharp edges removed and shall be free from distortion.
4. Flame cut edges shall be dressed to give a smooth and uniform surface. All edges shall present a smooth surface.
5. All holes shall be drilled and de-burred.
6. Bearing stiffeners shall be ground to fit accurately and shall be in contact over 90% of the stiffener area unless welds are provided, designed to transmit the full reaction of the load between stiffener and flange.
7. Butt joints transmitting compressive stresses in bearing shall be in contact over an area not less than 75% of the abutting faces, the contact area being generally symmetrical about major and minor axes.

All surfaces for protective coatings shall be in accordance with the requirement of “specifications for protective coatings”.

6.05.03 Welding

Welding fabrication shall be carried out by metal arc welding. All welding procedures, weld testing and proficiency testing of welders shall comply with the appropriate British Standards listed below for the grades and thicknesses of steel and the types of weld specified:

BS EN 499 Covered electrodes for manual metal arc welding of mild steel and medium tensile steel

BS EN 1435 Methods of radiographic examination of fusion welded butt joints in steel

BS EN 1714 Methods for ultrasonic examination of welds Part 1 – Manual examination of fusion welds in ferritic steel

BS EN 756 BS EN 760 Electrode wires and fluxes for the submerged arc welding of mild steel and medium tensile steel

BS EN ISO 15614-1 + A1 Welding Specification and welding procedures for metallic materials procedure test

BS EN 287-1 Qualification test of welders – Fusion welding of steel

BS 4872-1 Specifications for approval of testing of welders when welding procedure approval is not required – Fusion welding of steel

BS EN 1011-1:1998, 2 Metal arc welding of carbon and carbon manganese steels

BS EN 970 Visual inspection of fusion welded joints.

Only certificated welders tested and certified by an Authority acceptable to the Supervisor’s representative shall be employed in fabricating the Permanent Works. The Contractor shall arrange for such certification and testing.

The sequence of welding operations shall be arranged to minimise distortions and residual stress during fabrication and in the structure after erection.

Welds and weld finishes shall be carried out by the contractor and such testing shall comply with the requirements of the appropriate British Standards where applicable.

Preheating of members before the welding shall be carried out in accordance with BS EN 1011-1.

6.05.04 Weld PreparationAll parts to be welded at an angle (fillet weld) must be approached up to where feasible and in no case, shall the separation of such parts be larger than 3mm.; if the separation is of 1.5mm. or larger, the weld size shall be increased in the millimetres which the separation measures.

The separation between surfaces to be welded, when the joint is by lapping, shall not be larger than 1.5 mm. The parts to be butt welded shall be carefully aligned.

As long as feasible, the element shall be placed in position for flat welding. Upon assembling and joining the parts of a structure or combined pieces, the procedure and sequence of welding shall be such as to minimize distortion and residual stresses.

6.05.05 Butt welding

All butt welds shall be continuous and of complete full penetration with cross‑section not less than the next area of the section joined.

When the thickness of elements to be joined is equal to or less than 6 mm. butt welding from a single side shall be allowed, without the need of edge preparation as long as an electrode is used which ensures complete penetration. The separation between edges in this case shall be less than half the thickness of the thinnest piece to be welded.

When the thickness of pieces to be joined is more than 8 mm., edges shall be prepared for Vee or double-Vee joint, depending on whether both sides are accessible or not. In any of the two cases, the separation between edges shall not exceed 3 mm.

In double-Vee joints, cleaning of the root shall be systematically carried out by mechanical or by arc-air procedures, before starting welding on the opposite side.

When the need is specified for using back-up ring or backing plate, the material used must be of the same nature as the base material and the weld variables shall be such as to ensure a perfect fusion of the three elements which appear in the connection. Special care shall be taken in order to avoid corrosion traps.

When for the fill of joints it is necessary to deposit several beads, each one of them must be cleaned of slag before proceeding to deposit the next one. This operation can be performed with mechanical grinder or welder's pick. When carrying out this operation, the best practices of the profession must be used. The last bead shall be sufficiently wide for the weld surface to be smooth.

6.05.06 Fillet welds

Fillet weld sizes shall be as indicated on the drawings.

If required, the welds of several layers may be hit with a mechanical chipper, of oblong shape and round peen. The hits shall be done after weld cooling at a warm temperature felt by hand. Care shall be taken that no weld nor base metal suffer inlaying, detachments or deformations as a consequence of the hammering.

6.05.07 Correction of distortion

Any distortion over the allowable tolerances specified in Clause 6.5.9and those pointed out by the Supervisor’s representative shall be corrected so as not to impair the quality of materials.

Preheating of members before the welding shall be carried out in accordance with BS EN 1011-1:1998; BS EN 1011-2:2001.

* + 1. Bolts

Bolt holes shall be accurately aligned so that bolts can be inserted without force. Bolts shall not be driven home and drift pins used to draw members into alignment shall not be used in a manner to distort or enlarge bolt holes.

Bolts shall be of sufficient length to show at least two clear threads beyond the nut when fully tightened. When bolts are used in bearing, members shall not bear on the threaded part. Where physically possible bolts shall be fitted “nuts downwards”.

Joint interfaces shall be clean and free from loose scale, loose rust, oil, grease, paint and all other deleterious matter before the joint is assembled.

6.05.09 Fabrication and Erection Tolerances

Members shall comply with the dimensions and shapes shown on the drawings within the tolerances set out below:

1. Length – plus or minus 2.0mm
2. Width and depth – plus or minus 3.0mm.
3. Straightness
	1. Compression Members – a compression member shall not deviate from straightness by more than 1/1000 of the axial length between the restraint points.
	2. Other members shall not deviate from straightness by more than 1/1000 of the axial length
4. No part of the machined bearing face of a column shall deviate from a plane at right angles to the axis of the column by more than 0.25mm per metre of column width and 90 percent of the bearing area shall have full contact, the contact area being substantially symmetrical about the major and minor axes.
5. End plates at rafter splices shall be square to the axes of the rafter and in full contact for at least 75% of the area of the plates after assembly, the contact area being a generally symmetrical about major and minor axes.
	1. Protective Coatings

The protective coatings to be applied prior to delivery and/or on site are stated in Clause 6.11. Those parts of the structure which are to be encased in concrete shall be left bare, unless otherwise indicated and shall be free of loose rust, loose scale, grease and any deleterious matter.

* 1. Marking of Steelwork

Before despatch from the workshop, all steelwork shall be clearly and indelibly marked to indicate its position and direction in the permanent works and the weight of each piece if this exceeds one tonne.

* 1. Delivery to Site

The contractor shall ensure that all steelwork is handled, packed, transported and stored to prevent damage to the steelwork and protective coatings.

Steelwork shall be stacked and stored at places of manufacture and on site to prevent distortion and damage. Suitable bearers shall be provided and measures taken to allow free drainage and ventilation and to prevent contamination.

The contractor shall provide bearers during transportation and storage and shall take particular care to stiffen free ends and to prevent distortion. All machined surfaces shall be adequately protected. All bolts, nuts, washers, screws, small plates and small articles generally shall be suitably packed in crates or containers. Larger plates and bars, where bundled, shall be securely fastened together. All ropes and slings shall be covered to prevent damage

* 1. Erection

Erection of steelwork shall be carried out in a manner which will prevent damage of any kind to the steelwork. The contractor shall be responsible for the stability of the structure at all stages during erection and shall provide and remove on completion any temporary bracings and guys required.

Columns shall be set in position on steel wedges and packings. Site connections shall not be fully tightened until sufficient of the structure has been levelled, aligned and plumbed to ensure completion of the remainder without any need to strain members into position.

Bolted connections shall be made in accordance with Clause 6.05.08.

On completion of erection, the structure shall be correct to line and level and shall not be out of plumb in any direction by more than 6.0 mm. Steel for frameworks for lift shafts shall be plumb to tolerances required by the lift manufacturer.

* 1. Foundations Bolts And Anchorages

Foundation bolts shall be complete with tubular steel sleeves, washer plates, anchor frames, washers and nuts. Templates shall be used for correct location of anchorages and foundation bolts.

After foundation bolts and anchorages have been cast into the concrete, the bolt ends shall be protected by greasing and wrapping with suitable protective material.

* 1. Specification for Protective Coatings
		1. Scope of Section

This section covers the surface preparation and the type of protective coating required for structural steelwork.

* + 1. Surface preparation, materials and application

Surface preparation, materials and application of the material shall comply with BS EN ISO 12944.

The surfaces shall be prepared as described in 6.11.3 or 6.11.4 below, as applicable.

* + 1. Materials : scheme 1

Scheme 1 applies to mild and moderate exposure conditions as stated in the relevant drawings.

After fabrication all steelwork is to be hand-cleaned thoroughly to remove loose mill scale and rust by chipping, scraping and wire brushing.

Any surface which will be inaccessible after fabrication must be hand cleaned and painted one coat red lead prior to assembly.

Immediately after cleaning, the steelwork must be painted with a red lead primer paint to BS7956, with a dry film thickness of 70 microns for both mild and moderate exposure conditions.

The primer coat shall be followed by a coating of paint pigmented with micaceous iron oxide with a dry film thickness of 40 microns for mild exposure conditions and 80 microns for moderate exposure conditions.

* + 1. Materials : scheme 2

Scheme 2 applies to severe exposure conditions as stated in the relevant drawings.

 All steelwork is to be blast cleaned as St 2, as defined in BS 7079.

After blast cleaning the steel must be brushed or cleaned by vacuum to remove all traces of dust or abrasive.

The steelwork must be covered with a protective coating of zinc within 4 hours of being blast cleaned.

If the steelwork is to be fabricated after the zinc coating has been applied the welded joints, cut edges, drilled holes, etc. must be prepared to remove all contaminants and a remedial coat of paint applied.

The application of the zinc coating to the steel must be in accordance with the requirements of BS EN 22063. The coating must have a nominal thickness of 100 microns and must not be thinner than 75 microns at any point.

* + 1. Application

All protective coatings are to be applied as stated in the manufacturer’s instructions.

* + 1. Final coat

A final coat (or coats of paint) is to be applied as stated in the Architectural drawings or Specifications.

* + 1. Repairs to Paintwork

Any paintwork damaged during transportation on erection must be repaired at site, after proper surface preparation, with one or more coats of zinc-rich paint which must be additional to the main painting scheme.

# Specification for Blockwork

This section covers the use of cement blocks, whether hollow or solid, in walls.

* 1. Cement

Cement shall be as specified in Concrete Works

* 1. Sand for Cement Blocks

Sand for cement blocks shall be fine aggregate complying with BS EN 12620.

* 1. Water

Water shall be as specified in Concrete Works

7.04 Cement Blocks

The dimensions of cement blocks shall be as described in the Particular Specifications – Architectural, Section 4 : Walling.

Cement blocks shall be true and square, with sharp arises, free from cracks and other imperfections.

Cement blocks may be solid or hollow, but in either case the blocks shall have a minimum average crushing strength, at 28 days after manufacture, for any 10 blocks of 5.0N/mm2 with a minimum crushing strength of 3.3N/mm2 for any individual block. In the case of hollow blocks the crushing strength shall be calculated on the gross area of the block.

The thickness between the outer edge and the cavity of a hollow block shall not be less than 50mm unless the block is manufactured in an approved vibrating, blockmaking machine, but in no case shall the net volume of the material in the block be less than half the gross volume.

Cement blocks shall be composed of cement and sand mixed in such proportion as to give a block complying with the crushing strength stated above. In no case, however, shall the mix be richer than one part cement to four parts of sand or weaker than one part of cement to ten parts of sand.

The cement and sand shall be measured in approved gauge boxes and mixed in an approved mixer, or by hand as described for mortar, with only sufficient water to give the driest possible working mixture. The mix shall not stand longer than 20 minutes before moulding.

Moulding shall be carried out in metal moulds. The mix may be hand tamped, machine pressed, or vibrated in the mould.

After removal from the mould, the blocks shall be stacked on a hard level platform, covered up and protected from the weather and kept constantly moist for a period of at least 7 days. Thereafter, the blocks shall be covered and protected from the weather for a further period of at least 21 days to allow them to dry out completely before being used. During the rainy season the Contractor shall erect a water-tight roof over the area upon which the blocks are made and stored.

* 1. Blockwork

All blocks shall be carefully stacked on delivery. No broken blocks shall be used in the structure. All blockwork shall be built true and perpendicular. Blocks shall not be wetted before laying and the tops of wall shall be protected from rain at all times during construction.

Blockwork below ground shall be constructed in solid blocks or hollow blocks filled with class C15/10 concrete, with all vertical and horizontal joints flushed up solid in mortar as the work proceeds.

Blockwork above ground shall be constructed in solid or hollow blocks with all vertical and horizontal joints “shell bedded” in mortar as the work proceeds (“shell bedding” consists of laying the mortar in strips not less than 40mm wide along the two outer edges of the block only, so that a gap is left between the strips to prevent the passage of moisture).

Blocks shall be properly bonded. Cut blocks shall not be allowed in fair face work.

* 1. Mortar

7.06.01 Sand for mortar

Sand shall be clean, sharp, uncoated grains of naturally occurring pit or fresh water sand; free from injurious amounts of dust, lumps, soft or flaking particles, shale, alkali, organic matter, loam or other deleterious substances, washed if necessary and shall pass 5000μm

(5mm) BS sieve and not more than 15% by weight shall pass a No.150μm (0.150mm) BS sieve.

7.06.02 Lime for mortar

Lime shall be non-hydraulic or semi-hydraulic well burnt quicklime from an approved source or hydrated lime complying with BS 6463.

Quicklime shall be thoroughly dry slaked (but not to saturation) for a period of from two to five days for lump lime and from one to three days for ground lime before mixing into wet mortar. Hydrated lime can be mixed into wet mortar without further slaking.

7.06.03 Mixing

Gauged mortar for all blockwork shall be composed of one part cement, one part lime and six parts sand by volume.

The proportions shall be measured in approved gauge boxes. The mortar shall be mixed in an approved mixer or by hand on a clean, close-jointed timber or metal mixing platform. If the mortar is mixed by hand, the materials shall be turned three times dry or until the mixture is of an even colour throughout and turned three times wet. All mortar shall be prepared in sufficient quantity for immediate use only. No mortar shall be re-tempered for re-use after it has taken initial set.

7.06.04 Testing

Before the commencement of blockwork the Contractor shall carry out preliminary testing of 6 No.100mm cubes to be made with mortar of a consistency corresponding to a 10mm penetration of the dropping ball, cured hydraulically and tested for compressive strength in accordance with BS 4551.

Three cubes should be tested at 7 days and three cubes tested at 28 days. The average cube strength should not be less than 2.4N/mm2 at 7 days, nor less than 3.6N/mm2 at 28 days. If the average value of the cube strength falls below these values the mortar mix and/or materials shall be adjusted and tests repeated until the required strength is achieved.

During construction site testing of mortar shall be undertaken. 6 No. 100mm cubes shall be made from randomly selected mortar samples for every 150m2 of wall.

# Specification for Precast Concrete Paving Blocks

8.1 Scope of section

This section covers the use of precast, unreinforced concrete paving blocks in external trafficked paved areas.

8.2 Definitions

For the purposes of these specifications the following definitions apply:

* Paving block : precast, unreinforced concrete unit used as a surfacing material.
* Complementary fitting : unit that is used to infill and enable an area to be completely surfaced (a complementary fitting can be a piece of a paving block).
* Upper face : surface intended to be seen when in use
* Bed face : surface generally parallel to the upper face and in contact with the bedding after laying
* Facing layer : layer of concrete providing the upper face of a paving block, of different material and/or properties to the main body or backing layer.
* Spacer nib : small protruding profile on a side face of a paving block
* Arris : part of a paving block where two faces meet; an arris can be bevelled, rounded, or chamfered.
* Chamfer : bevelled arris with horizontal or vertical dimensions exceeding 2mm.
* Work dimension : dimension of a paving block specified for its manufacture.
* Actual dimension : dimension of a paving block as measured
* Overall length : length of the longer side of the smallest rectangle that encloses the entire paving block, excluding any spacer nibs.
* Overall width : length of the shorter side of the smallest rectangle that encloses the entire paving block, excluding any spacer nibs.
* Thickness : distance between the upper face and the bed face of a paving block.
* Slip resistance : ability of a paving block to resist relative movement between a pedestrian foot and the trafficked paving block surface.
* Skid resistance : ability of a paving block to resist relative movement between a vehicle tyre and the trafficked paving block.
	1. Materials

The materials used for the manufacture of paving blocks shall be at the manufacturer’s discretion. Details of the materials used be declared in the manufacturer’s production control documentation in accordance with Annex A of BS 6717.

* 1. Requirements
		1. General

Paving blocks shall be produced with a single type of concrete throughout.

It shall be permissible for a “square” arris to be either bevelled or rounded. A “square” arris shall have horizontal and vertical dimensions not exceeding 2 mm. The dimensions of a chamfer shall be at the discretion of the manufacture. The dimensions shall be declared in the manufacturer’s production control documentation.

* + 1. Shape and dimensions
			1. General

All dimensions in this sub-clause are work dimensions.

Excluding complementary fittings, the overall length and the overall width of a paving block shall not exceed 250 mm.

The length of paving block divided by its thickness shall not exceed 5.

The width of a paving block shall be not less than 50 mm at a distance of 50 mm from any edge.

* + - 1. Work dimensions

The work dimensions of all paving blocks shall be at the discretion of the manufacturer. The work dimensions shall be declared in the manufacturer’s production control documentation.

* + - 1. Spacer nibs, chased and profiled side faces

If a paving block is produced with spacer nibs, a draw, or chased and profiled side faces, the work dimensions of these items shall be at the discretion of the manufacture. The work dimensions of these items shall be declared in the manufacturer’s production control documentation.

* + - 1. Tolerances

When the dimensions of a single paving block are measured in accordance with BS 6717 the tolerances shall be as specified in Table 1.

Table 1 – Tolerances for work dimensions

|  |  |  |
| --- | --- | --- |
| Block thickness | Tolerance |  |
| mm | Length and widthmm | Thicknessmm |
| <100 | +2 | +2 |
| >100 | +3 | +3 |

The maximum difference between any two measurements of the thickness of single paving block shall be no greater than 3 mm.

For the dimensions of non-rectangular paving blocks, the tolerances shall be at the discretion of the manufacturer. These tolerances shall be declared in the manufacture’s production control documentation.

For paving blocks with an upper face that is intended to be plane, the tolerances for flatness and bow shall be as specified in Table 2.

Table 2 – Tolerances for flatness and bow

|  |  |  |
| --- | --- | --- |
| Length of straight edgemm | Maximum convexmm | Maximum concavemm |
| Up to 300300400 | Not applicable1.52 | Not applicable11.5 |

* + 1. Physical and mechanical properties
			1. Complementary fittings

When complementary fittings cannot be tested according to BS 6717, they shall be deemed to conform to this British Standard, provided that they have at least the same concrete quality as paving blocks that conform.

* + - 1. Weathering resistance

When paving blocks are tested in accordance with BS 6717, classes shall be assigned to them according to the mean value of the test results as specified in Table 3. Families of paving blocks that have not been tested for weathering resistance shall be assigned class W1.

Table 3 – Weathering resistance classes

|  |  |
| --- | --- |
| class | Mass loss after weathering test Mean value (kg/m2) |
| W1 | No performance determined |
| W2 | 1.0, no individual value> 1.5 |
| W3 | Manufacturer’s declared value |
| NOTE  | The manufacturer’s declared value is usually applied to secondary processed products |

* + - 1. Tensile splitting strength

When paving blocks are tested in accordance with BS 6717, the mean tensile splitting strength shall be not less than 3.9 MPa and no individual result shall be less than 2.9 MPa.

Additionally, no individual result shall have a breaking load less than 250 N/mm of the length of the failure plane.

8.4.3.4 Abrasion resistance

When paving blocks are tested in accordance with BS 6717, the abrasion resistance shall be to class A2.

* + - 1. Slip/skid resistance

When paving blocks are tested in accordance with BS 6717, the slip/skid resistance shall be to class S3.

* + 1. Visual properties
			1. Appearance

When examined in accordance with BS 6717, the upper face of paving blocks shall not exhibit defects such as cracking or flaking.

* + - 1. Texture

If paving blocks are produced with a special surface texture, the texture shall be at the discretion of the manufacturer. The properties of the textured surface shall be declared in the manufacture’s production control documentation. Paving blocks with a special surface texture shall be deemed to conform to this Specification if, when examined in accordance with BS 6717, there are found to be no significant visible difference to any samples supplied by the manufacturer and approved by the purchaser.

8.4.4.3 Colour

The paving blocks shall be of natural concrete colour.

* 1. Marking

The following particulars relating to paving blocks shall be indicated clearly on any of the delivery note, invoices, packing, or supplier’s certificate or brochure supplied with the consignment of paving blocks.

1. identification of the manufacturer or the factory :
2. date of production:
3. class(es) where applicable (see Table 4)
4. the marking BS 6717 : 2001
5. identification of the product (i.e concrete paving blocks).

Table 4 – Classes and their identification

|  |  |
| --- | --- |
| Parameter | Class marking |
| Weathering resistance | W1, W2 or W3 |
| Abrasion resistance | A1 or A2 |
| Slip/skid resistance | S1, S2, S3 or S4 |

* 1. Construction
		1. Terms and definitions
* Paving unit : a concrete paving block.
* restraint : device that serves to prevent lateral movement of paving units and to prevent loss of the laying course material.
* edge restraint : restraint used at the edges of an area being paved
* intermediate restraint : restraint used at intervals along an area being paved
* NOTE Intermediate restraints are generally used when steeply sloped areas are being paved.
* temporary restraint : restraint used when a partially paved area is to be trafficked or when it is necessary to preserve the integrity of the laying face at the end of a working period.
* interlock : effect of frictional forces between paving units which prevents them moving in relation to each other.
* laying course : layer of material on which paving units are bedded.
* laying face : working edge of the surface course to which paving units are being placed.
* roadbase : one or more layers of material placed above the sub-base that constitutes a structural element of a flexible or composite pavement.
* sub-base : one or more layers of material placed immediately above the subgrade.
* capping layer : layer of granular or stabilized material at the top of the subgrade to provide a working surface and an improved foundation for the pavement.
* surface course : layer of interlocked paving units that acts as a wearing surface and forms part of the structure of the pavement.
* inboard cut : paving unit that that is cut to one quarter or more of its original length.
* laying pattern : arrangement of paving units either for structural requirements or for visual effects.
* jointing material : material applied to fill the joints between paving units.
* joint width : distance between adjacent paving units or units and restraint.
* void : gap between adjacent paving units , or units and restraint, formed by virtue of the shape of the units and how they fit together
* NOTE voids are incorporated into the design of a permeable pavement to facilitate drainage.
* conventional pavement : pavement consisting of a surface course of paving units laid with narrow joints and filled with jointing material that has a low permeability.
* Permeable pavement : pavement consisting of a surface of paving units laid wide joints, void or openings, that allow water to pass through into the pavement construction.

8.6.2 Subgrade, sub-base and roadbase

Preparation of the subgrade and the construction and type of the of the sub-base and roadbase (if present) should be as described in the Specification for Roadworks.

The subgrade, sub-base and roadbase should be presented such that :

1. the surface levels of the sub-base and roadbase are within the tolerances given in Table 5 below.

Table 5 – tolerance of surface levels

|  |  |
| --- | --- |
| Layers of pavement | Maximum permissible deviation from the design level |
| Sub-base | +5-10 |
| Roadbase | +5-10 |
| Laying course | +10-5 |
| Surface course | +6-6 |

1. the longitudinal falls and the cross falls of the completed pavement are introduced into the pavement at the subgrade level and allow the water to run off, thus avoiding ponding:
2. the surface of the sub-base and roadbase is tight and dense enough to prevent laying course material being lost into it during construction and use;
3. the extent of the site preparation includes enough room to provide adequate foundations and backing for any edge restraint.

8.6.3 Restraint

8.6.3.1 Edge restraint

Edge restraints consisting of kerbs or channels or other approved edge strips, as scheduled or given on the drawings, shall be constructed on the sub-base or other specified formation before any units are laid.

8.6.3.2 Temporary restraint

For areas of pavement that cannot be completed for some time and that might be subjected to trafficking near the edge of the pavement, the Contractor shall construct temporary restraints to prevent the movement of the laid paving units.

During full compaction of the pavement, temporary restraints should be constructed to resist lateral movement of the pavement.

* + 1. Laying course
			1. Material

The laying course should contain no material which acts as a binder and could detract from the flexible nature of the pavement, e.g. cement or lime.

The laying course material for conventional pavements should be naturally occurring sand from the quaternary geological series or sea-dredged sands. It should conform to Table 6 below.

Table 6 – Grading for laying course material for conventional pavements

|  |  |
| --- | --- |
| Sieve sizemm | Percentage by mass passing% |
| 8 | 100 |
| 6.3 | 95 – 100 |
| 4 | 85 – 99 |
| 0.5 | 30 – 70 |
| 0.063 (fines content) | 1.5 |

* + - 1. Moisture content

When preparing the laying course, the material should be moist without being saturated. It should show no free water and should bind together when the material is squeezed in the hand and the pressure released.

If the prepared laying course becomes saturated prior to laying the paving units, it may be removed and replaced, or allowed to dry to an acceptable moisture content. To control the moisture content of a stockpile, covers may be used.

* + - 1. Preparation of laying course

The laying course should be laid on the roadbase or, if there is no roadbase, the sub-base. The laying course material should not be used as a regulating course or to achieve falls.

The thickness of the laying course after final compaction of the surface course should be 30 mm, with a surface level tolerance conforming to Table 5.

One of the following methods of screeding the laying course should be used for concrete block paving.

1. Compaction of laying course : Spread the material in one layer and compact this layer using a plate compactor. In order to achieve the target laying course thickness, make allowances for the reduction in thickness achieved during compaction. Level the surface by screeding.
2. Uncompacted laying course : Spread the material loose in a uniform layer. Screed it to a thickness that, after the paving blocks have been laid and compacted into place, will give the final target laying course thickness.
	* 1. Type of units and laying pattern

8.6.5.1 Rectangular paving units shall be used and the laying pattern shall be 900 herring bone Pattern

* + - 1. Laying paving units

General

Paving units should be placed, either mechanically or by hand, on the prepared laying course in the nominated pattern. Any minor adjustments necessary to maintain the laying pattern should then be made. A string line may be used to check the alignment of the paving units.

The paving units should be laid in such a way that, after final compaction, the surface course will conform to the surface level tolerances given in 8.6.2 (a) and the surface regularity given in Table 7 below.

Table 7 – Surface regularity of the surface course

|  |  |
| --- | --- |
| Measure of surface regularity | Conventional pavements |
| Flatness of pavement | 10 mm under 3 m straight edge |
| Difference in level at the joint of adjacent paving units | 2 mm |

An order of laying which maintains an open laying face should be followed. The first row of paving units should be aligned against a straight section of the edge restraint, intermediate or temporary restraint or by using a straight edge or string line. The alignment of paving units should be checked periodically for all laying patterns, e.g by using string lines, and adjustments made where necessary.

Joints

Paving units should be laid with a joint width typically within the range of 2 mm to 5 mm.

* + - 1. Cutting and trimming

General

The paved area should only incorporate cut units at the perimeter of the pavement, at an intermediate restraint, around obstacles and to accommodate motifs and pattern changes.

Where paving units need to be trimmed, sizes smaller than a quarter of the original plan size of the unit should be avoided.

To avoid cutting paving units to smaller than a quarter of their original size, complimentary fittings and inboard cutting as recommended in BS 7533-3 should be used to complete the surface course.

To achieve a straight cut face, concrete paving blocks should be cut using a hydraulic or mechanical splitter.

The accuracy of cutting the unit should be such that joint between the cut unit and the full unit or the edge restraint should be not more than 5 mm.

Trimming and laying around obstructions

The paving units should be trimmed to fit after laying full paving units around any obstruction. The joints between the obstruction and the paving units should not exceed 5 mm. Mortar should not be used to infill small gaps.

Where it is necessary to use infill around an obstruction, class C25/10 concrete should be used for the full depth of the paving unit.

8.6.5.4 Jointing and void filling material

The jointing material for conventional pavements should conform to Table 8 below.

Table 8 – Grading for jointing material for conventional pavements

|  |  |
| --- | --- |
| Sieve sizemm | Percentage by mass passing% |
| 2 | 100 |
| 1 |  85-99 |
| 0.5 |  55-100 |
| 0.063 (fines content) |  0-2 |

Material that might stain the pavement surface should not be used.

* + - 1. Compaction of paving units into the laying course

Prior to compaction, the surface should be free of debris.

A vibrating plate compactor should be used to fully bed the blocks into the laying course

material.

If there is a tendency during the compaction operation for individual blocks to move or

misalign, then a small amount of jointing material conforming to 8.6.5.4 may be applied to

assist in maintaining blocks in their correct position.

The surface course should be compacted using a plate compactor, making two or more

passes.

For concrete paving blocks with a small or no chamfer, prior to compaction, jointing

material conforming to 8.6.5.4 should be brushed over the surface and into the joints until

the joints are full. Surplus jointing material should be removed.

**Completion of compaction**

The compaction should preferably be carried out as soon as possible after the laying of the paving units.

Compaction should not occur within 1 m of any laying face.

All areas of paving, other than an area within 1 m of a laying face, should not be left uncompacted at the completion of the day’s work.

* + - 1. Joint filling after compaction of paving units into the laying course

It is essential that the joints between paving units are filled.

Prior to applying any jointing material, the surface should be free of debris.

Prior to joint filling the paving surface should be checked so that :

1. the surface level tolerance conforms to 8.6.2 (a), Table 5;
2. the flatness of the pavement conforms to 8.6.5.2, Table 7;
3. the difference in level at the joint of adjacent paving units conforms to 8.6.5.2, Table 7;
4. joint width is consistent;
5. joints are correctly aligned;
6. there are no damaged or broken blocks.

Any necessary corrective action should be taken to ensure that the pavements conform to item a) to f).Joints between concrete block pavers might have been partially filled during the compaction referred to 8.6.5.5. However, after the compaction the joints should be completely filled with material conforming 8.6.5.4.

* + - 1. Final compaction of the surface course

Following the completion of joint filling in accordance with 8.6.5.6 the surface course should undergo a final compaction using a plate compactor to ensure complete filling of the unit-to-unit joints by the surface-applied jointing material. Where necessary, further jointing material conforming to 8.6.5.4 should be added and the paving compacted once more.

This process of joint or void topping up should be repeated, when necessary, by brushing in further joint filling material until the integrity of the pavement is established. This is particularly relevant during the initial period of the pavement life.

This final compaction should be completed as soon as practicable after laying.

After final compaction the pavement should once again be checked in accordance with 8.6.5.6, with any necessary action taken to rectify the pavement.

* + 1. Construction in adverse weather conditions (conventional pavements)

In adverse weather conditions, units should not be laid on saturated laying course material. The filling of joints is not possible in damp conditions. In such conditions, the joints should be topped up at the earliest opportunity.

8.6.7 Additional work after early trafficking

The surface course should be inspected soon after completion and at regular intervals thereafter. Additional jointing materials should be brushed in where necessary.

Vacuum sweepers should not be used on the surface course for at least three months after laying in order to reduce the risk of jointing material being lost.

Whenever vacuum sweepers are used, they should be adjusted to avoid removal of jointing material.

# Specification for Storm Water Drainage

9.01 Handling Pipes

All pipes are to be carefully handled and stacked. Any pipes which exhibit signs of damage shall be rejected by the Supervisor’s representative and must be removed from the site immediately.

9.02 Excavation for Pipelines

Trenches for pipelines shall be excavated in any material to a sufficient depth and width to enable the pipe and any specified or agreed joint, bedding, haunch and surround to be accommodated. The width of the trench shall not exceed the external diameter of the pipe plus 500mm.

The sides of trenches and other excavations shall be adequately supported at all times. Where shown on the drawings, or as directed by the Supervisor’s representative, the supports shall be left in.

Material arising from the excavation of pipelines shall be classified as suitable or unsuitable in accordance with “Earthworks for Drainage Structures”. Unsuitable material shall be disposed of to spoil.

* 1. Laying of pipes

Immediately before pipelaying commences the excavation shall be thoroughly cleaned of all stones, soil or other debris which may have fallen therein.

Pipes must be laid true to line and level. Each pipe shall mate concentrically with the next to preserve a true and uniform invert. Pipes shall be uniformly bedded and must not be allowed to rest on the joints or on stones or hard objects in the bottom of the trench.

* 1. Jointing of Concrete Pipes

For ogee jointed pipes, the joints shall be thoroughly cleaned before laying, and cement mortar 1 to 2 shall be applied evenly to the ends for jointing so as to completely fill the joint. The pipes shall then be properly drawn together and the outside the joint shall be neatly pointed with a bank of cement mortar approximately 125mm wide and 25mm thick.

The inside of each joint shall also be pointed up as the work proceeds.

Special care shall be taken to ensure that excess of cement mortar is neatly cleaned off while each joint is being made and any earth, cement or other material thoroughly cleaned out of the pipes by drawing a tight fitting wad through them as the work proceeds, or by other approved means.

* 1. Bedding, Surrounding or Haunching of Pipes

Bedding, surrounding and haunching of pipes shall be carried out sing concrete of class C15/20 or as specified. In carrying out his work the contractor shall take care to pack the concrete under and around the pipes to ensure even bedding and solidity in the concrete, and the concrete shall not be thrown directly on to the pipes. The upper surface of the concrete shall be struck off with a wooded screed or template and neatly finished off.

No concrete surround or haunching shall be placed until the pipework concerned has been inspected and approved by the Supervisor’s representative. Concrete surround shall be constructed at least to the minimum dimensions shown on the drawings. The cost of any formwork shall be included in the rates for concrete surround.

Payment will be made only for the concrete beddings, surrounds and haunches shown on the Drawings, and any additional concrete to completely fill trenches, etc, shall be deemed to be included in the rates for concrete bedding, surrounds and haunches.

* 1. Backfilling

Trenches shall be backfilled with selected approved material but not before the permanent work therein has been approved by the Supervisor’s representative and measurements taken and agreed.

For pipes which are not surrounded with concrete, filling material for a depth of 300mm above the pipe shall be wholly free from stones and shall not be thrown direct onto the pipes, but shall be placed and packed with care under and around them. All filling shall be deposited and compacted in layers not exceeding 150mm compacted thickness to 90% of the maximum dry density. The moisture content of the material shall be adjusted to ±2 percent of optimum.

* 1. Measurement of Pipes

The nett length laid shall be measured. The rates entered in the Bills of Quantities shall include for supplying, laying and jointing, all in accordance with the requirements of the Specification.

* 1. Measurement of Earthworks for Pipes

Items for excavation shall be deemed to include backfilling with approval selected material as specified and the disposal of surplus to spoil or fill areas as directed.

The depth of excavation shall be taken as the vertical distance from ground level, or from lowest bulk excavated level if this is lower, to the underside of the pipe or the underside of the concrete surround as applicable. The width of the excavations for pipes shall be taken as the nominal diameter of the pipe plus 500mm or the pipe specified plus the width of the concrete surround. The lengths of excavations for culverts shall be taken as the horizontal distance between the faces of the headwall excavations

The rates stated in the Bills of Quantities shall include for all trimming and cleaning operations, any additional excavation for working space or caused by overbreak, dealing with water, supporting the sides of excavations, backfilling and all other costs and expenses incurred by the requirements of this section of the Specification.

* 1. Inlet and Outlet Structures

Inlet and outlet structures shall be as shown on the Drawings, or as instructed by the Supervisor’s representative. Foundation slabs shall consist of concrete of the class specified. The walls shall be built of blockwork or reinforced concrete and shall be either fair face or rendered all as specified on the drawings.

* 1. Lined Drainage Channels

Drainage channels shall be lined with solid concrete blocks where indicated on the drawings, or where instructed by the Supervisor’s representative. The cross-section shall be as shown on the drawings and the excavations shall be neatly trimmed to correct lines and levels before lining is constructed. Blockwork shall be 75mm thick, stretcher bonded with staggered joints, and shall be true to line and lever and vertical joints shall be raked if the Supervisor’s representative so directs.

Any irregularities in the surface of the excavation on which the blockwork is to be laid shall be made up with mortar. Blockwork shall be cured and spaces between the edge of blockwork and surrounding ground filled with suitable material tamped to the highest state of compaction compatible with not causing damage to the blockwork.

* 1. Materials

The materials to used for the construction of the inlet and outlet structures and the lined drains shall be as specified in the relevant sections in “Concrete Works” and “Blockwork”.

* 1. Grouted Pitching

The stones used for grouted pitching shall be approved hard angular rocks, roughly cubical in shape of dimensions such that they can be laid with a minimum thickness equal to that shown on the Drawings.

The stones shall be laid by hand on a bed of fresh 1 : 3 cement sand mortar, interlocked and rammed. The interstices may be choked with large rock spalls. A grout of 1 :3 cement sand mortar shall be thoroughly rammed into all interstices and smoothed off flush with the pitched face.

* 1. Gabions

Gabion protection shall be located as indicated on the Drawings, or as directed by the Supervisor’s representative and in accordance with the specifications laid down in section 4-Roadworks.

* 1. Oil Separators

9.14.1 Applicable standards

Oil separators shall comply with the current editions of the following British Standards:

 BS EN 858 Separator systems for light liquids (e.g. oil and petrol)

 - Part 1: Principles of product design, performance and testing, marking and quality control

 - Part 2: Selection of nominal size, installation, operation and maintenance

9.14.2 Departure from standards

BS EN 858 requires that separators up to Nominal Size 125 be made in a factory; however the separators for this project are specified with in-situ reinforced concrete housing for economic reasons.

9.14.3 Type of separators

The separators shall be Type I, with separate by-pass devices and integral sludge traps.

9.14.4 Materials and workmanship

In addition to the requirements of the relevant British Standards, Section 7 of the Particular Specifications – Civil and Structural Works, namely, Reinforced Concrete in Water-Retaining Construction, shall apply to the in-situ concrete housing for oil separators in respect of materials, workmanship, water-tightness etc.

Coalescence units shall satisfy the requirements of Type 1 separators.

9.14.5 Construction

Construction of the housing shall be separate from that of the cover. After completion of the housing it shall be cleaned prior to the installation of the inlet and outlet and inner components, followed by the installation of the cover

9.14.6 Commissioning

The separator shall be checked for final cleanliness before testing and commissioning which shall be carried in conjunction with the supplier of the coalescence units and associated parts.

9.14.7 Maintenance Manual

The Contractor, in conjunction with his specialist supplier, shall prepare a maintenance manual giving, inter alia, details of the type and frequency of inspection, cleaning and maintenance necessary for the continued safe and efficient operation of the oil separators and their components.

# Specification for Foul Drainage

10.1 PVC Pipes and Fittings

PVC Pipes and fittings for soil waste and ventilation shall comply with BS 4660 and shall be a minimum of class 4.

10.2 Excavation and Backfilling

Excavation for pipe trenches shall include for levelling and ramming bottoms or grading to required depths, planking and strutting to sides and executing all other items listed in the Excavation Specifications, backfilling in accordance with the pipe manufacturer’s instructions, making good any depressions in surface levels after the ground has settled and spreading and levelling surplus excavated material. Generally, the initial backfilling shall be executed with the finest of the excavated material, free from stones or other materials liable to puncture or fracture the pipes, sufficient to provide 150mm minimum cover and the remainder shall be backfilled with selected material rammed in 150mm (consolidated) layers. Care shall be taken not to disturb the pipework whilst backfilling.

10.3 Manhole Construction

Unless otherwise shown on the drawings manholes are to be constructed in solid blockwork in 1:3 mortar and have a minimum internal dimension of 900mm square. The base is to be 150mm thick class C20/20 concrete, and the cover slab to be 100mm thick class C20/20 concrete reinforced with A142 mesh reinforcement. Sides are to be plastered with 1:3 cement plasters with a steel trowel finish. Manholes deeper than 1:2 m are to be constructed with step irons. Manholes deeper than 2m shall be 1100mm square internally.

10.4 Manhole Spacing

Unless shown otherwise on the drawings, manholes shall generally not be spaced more than 30m apart.

10.5 Laying

Pipes must be laid perfectly straight and to a constant gradient between manholes. Joint must remain watertight under a pressure head of 1.5m.

10.6 Minimum Gradients

The minimum gradient for 100mm and 150mm diameter sewers are 1:80 and 1:150 respectively.

10.7 Maximum Gradients

The maximum gradient for 100 mm and 150mm dia sewers is 1:40. Gradients as steep as 1:30 may be permitted with the express permission of the Supervisor’s representative. Drop manholes must be used to avoid steeper gradients.

10.8 Gulley Traps

Where specified, gulley traps are to be constructed as follow:

Gulley traps are to be in stoneware or similar approved having 150mm diameter or 150mm x 150mm square inlets and 100 mm diameter trapped outlets. Gratings are to be cast iron, galvanised or coated. Gullies are to be bedded in and surrounded with class C20/20 concrete not less than 150mm thick. Brick or concrete kerbs are to be provided to four sides of gullies 80mm wide and 120mm high built in cement mortar and rendered all round in cement and sand (1:3) including forming all arises.

10.9 Concrete Embedding

PVC foul sewers passing under roadway or parking areas, or in situations where there is less than 300mm of cover to the pipe crown, are to be surrounded with 150mm of class 20/20 concrete on all sides.

10.10 Pipe Jointing

Joints shall be formed using proprietary runner “o” rings or by solvent welding. Pipe socketing by heating over an open fire shall not be permitted.

10.11 Bends

All pipes shall be laid straight. The bending of pipes by heating over an open fire shall not be permitted.

10.12 Sewer to be left clean

During construction, temporary open ends of pipes shall be closed off to prevent the ingress of vermin or soil, etc. before that works are handed over, all sewers are to be rodded to ensure that no obstruction have been left within them.

# SHIRE VALLEY TRANSFORMATION PROGRAMME 1 CHIKWAWA HOUSES- PARTICULAR SPECIFICATIONS

**ELECTRICAL**

## SECTION

1.- GENERAL REQUIREMENTS

2.- TESTING AND COMMISSIONING

3.- STANDARDS

4.- LOW VOLTAGE SWITCHBOARDS

5.- CABLES

6.- CABLE CONDUITS AND SUPPORT SYSTEM

7.- LIGHTING AND ACCESSORIES

8.- SMALL POWER INSTALLATION

9.- EARTHING AND LIGHTNING PROTECTION SYSTEM

10.- STAND-BY GENERATOR

11.- RADIO INSTALLATION

12.- TELEPHONE PABX AND WIRING INSTALLATION SYSTEM

**PARTICULAR SPECIFICATIONS**

**ELECTRICAL**

**SECTION 1**

**GENERAL REQUIREMENTS**

**1.0**

These specifications relate to Electrical work involves:-

* Cable site reticulation
* Electrical street lighting
* Electrical Security lighting
* Electrical Installation in buildings
* Telephone and Data Installation, Security Cameras, Smoke Detectors and other related works

**1.1. SCOPE OF SPECIFICATION**

This specification relates to the manufacture, supply, delivery, erection and testing of the following services all as indicated on the drawings and specified herein.

 Low Voltage Distribution Switchgear

 Lighting & Power Installation

 Small Power Installation

 External Lighting

 Earthing & Lightning Protection

 Standby Generation

 EPABX and Telephone Wiring

The standards of equipment and work required are defined within the Specification.

**1.2. RELATED DOCUMENTS**

This specification shall be read in conjunction with the schedules of equipment and the Design Production Drawings issued with it.

**1.3. EXTENT OF WORK**

The work shall comprise the whole of the labour and all the materials to form a complete working facility including tests and commissioning, as detailed in this specification and on the drawings.

The Sub-Contractor shall be responsible for ensuring that all sections of the work and all materials are compatible with one another. The Sub-Contractor shall check and ensure that all of the equipment and work offered by will fit into the space provided in the buildings, including the limited entry through doorways and into ducts.

**1.4. COMPLIANCE WITH REGULATIONS**The work shall comply with all relevant statutory instruments and regulations at the date of construction and in particular with the following:

IEE

The IEE Regulations for the Electrical Equipment of Buildings.

The Sub-Contractor shall be held fully responsible for strict compliance with the above.

**1.5. COMPLIANCE WITH BRITISH STANDARDS**

The equipment and/or installations shall comply with the appropriate specifications or Codes of Practice issued by the British Standards Institution or a higher standard where specified.

**1.6. DESIGN DRAWINGS**

The services as at present envisaged are indicated on the related Drawings.

The drawings together with any supplementary drawings and/or written instructions issued during the currency of the Sub-Contract.

**1.7. INSTALLATION DRAWINGS**

The Electrical drawings issued together with any further details/drawings added by the Sub-Contractor shall form the installation drawings plus any additional drawings issued by the Sub-Contractor.

The Sub-Contractor shall obtain from the suppliers general arrangement drawings, detailed working drawings and wiring diagrams for all items of plant and equipment

All wiring diagrams shall clearly indicate that wiring which forms part of is connected to the equipment delivered and shall include the following minimum information:

1) Maximum electrical loading for each power cable type and size.

2) Cable termination facilities.

3) Cable identification and all terminal numbers.

The Engineer’s approval of the drawings issued by the Sub-Contractor shall in no way relieve the Sub-Contractor of responsibility for any error subsequently discovered in these drawings.

Approved drawings shall not be departed from except with the written approval of the Engineer.

The Sub-Contractor shall be responsible for correcting any discrepancies, errors or omissions in the drawings and other particulars supplied by him, whether or not such drawings and particulars have been approved by the Engineer.

Information contained in any of the drawings supplied by Engineer shall not be utilised for any purpose other than for the Sub-Contractor Works and any such information shall not be communicated to other parties for other purposes without the specific approval of the Engineer.

The Sub-Contractor shall maintain on site a full set of installation drawing marked up to date in a neat and tidy manner to indicate the "as installed" layouts.

These drawings shall be available for inspection by the Engineer and other nominated interested parties during the period of the contract.

**1.8. BUILDERS WORK**

The expression 'Builder's Work' shall mean that work which will be carried out by other tradesmen outside this Sub-Contract in connection with, or consequent on the Sub-Contract Work defined in this specification. and will include:

All the builders work details such as plant bases and plinths not forming part of the structure shall be provided to the Main Contractor by the Sub-Contractor.

**1.9. ACCESS FOR MAINTENANCE**The Sub-Contractor shall ensure that all plant and equipment is easily accessible by maintenance staff and adequate space allowed for maintenance and replacement of plant.

**1.10. FOUNDATION BOLTS AND ALIGNMENT**

The Sub-Contractor shall supply to approved dimensions all necessary foundation bolts, nuts, plates and frames for the equipment covered by this Specification.

The Sub-Contractor shall be responsible for aligning and levelling up each item of equipment supplied under this Sub-Contract using steel shims as necessary, and for placing the holding down bolts in the correct position. The grouting in of the bolts and the shims shall be in accordance with the setting out.

**1.11. DISSIMILAR METALS**

The Sub-Contractor shall take every precaution to ensure that no chemical or electrolytic action takes place where dissimilar metals and/or materials are used together. This is of particular importance where aluminium and aluminium alloys are one of the surfaces.

**1.12. RADIO AND TELEVISION SUPPRESSION ON ELECTRICAL EQUIPMENT**

All electrical equipment supplied under this Sub-Contract such as motors and all thermostats, shall be provided with radio and television suppressers, complying with the requirements of the Local Telecommunications Regulations.

**1.13. PROTECTION OF PLANT, EQUIPMENT, ETC.**The Sub-Contractor shall be responsible for providing and maintaining adequate protection for his work during execution, such protection being to the following minimum standards:

**1.13.1. Primer Finished Plant, Pipe-work, Fittings, etc**

The plant shall be provided with adequate protection by suitable storage conditions or enclosures. Ferrous parts shall be protected against rust.

**1.14. PAINTINGS, PROTECTION, PREPARATION FOR PAINTING AND CLEANING ON COMPLETION**

All ungalvanised ferrous materials not plated shall be supplied free from rust and scale, and be dipped or otherwise coated with a protective priming paint of a type suitable for receiving the finishing protective or decorative paint.

All ungalvanised steel parts fabricated by the Sub-Contractor, e.g. cable tray brackets and supports, suspension supports, electrical conduits, trunking and trays, screwed joints, steelwork, etc, shall be thoroughly cleaned removing all rust, grease, oil dirt and surface corrosion using wire brush, emery paper and degreasing media as required after fabrication. It shall then be painted one coat of either zinc phosphate, zinc chromate or calcium plumbate with a further coat after erection.

Where the protective paint coating has been damaged or the surfaces show signs of rust the affected areas shall be cleaned as above prior to repainting.

**1.15. LIST OF SPARES**

Six months prior to the completion of the Sub-Contract, the Sub-Contractor shall supply to the Client via the Architect, a full list of recommended spares for each item of equipment. This list of spares shall be completed with details of ordering procedures, delivery periods and prices ruling at the date of submission

**1.16. SUPPLY OF OIL AND GREASE**

The Sub-Contractor shall supply sufficient oil and grease necessary for the initial filling of starters, oil-wells, bearings, etc, and shall top up as necessary before hand-over.

The maintenance and operating manual shall include a schedule of all lubrication oils and greases to be used on the moving equipment, together with recommended of oiling and greasing.

**1.17. MAINTENANCE KIT**

A fully comprehensive set of tools shall be provided for all plant etc as recommended by the supplier including any special tools/instruments required for testing or dismantling items of equipment.

The tools shall be contained in a sheet steel cabinet in a position as agreed, with lock and contents list with all tools NEW at the completion of the Contract (ie. not having been used during construction).

**1.18. ELECTRIC SHOCK NOTICES**

Safety posters together with instructions for the treatment of persons suffering from electric shock shall exhibited in the following rooms:

 All sub-station LV rooms

 Generator room

 All floor distribution cupboards

 Adjacent to floor distribution cubicles located in risers

 All plant-rooms

The safety posters shall be in English and France when installed in main switch rooms, generator room and plant-rooms they shall be mounted in an approved glazed hardwood frame. Posters in distribution cupboards shall be fixed on the cupboard door.

The posters shall be printed on substantial cardboard and shall be varnished to preserve legibility.

**1.19. LABELS AND MANUALS**

All equipment and switch panels shall be provided with approved identification and designation labels in English and French.

Equipment manuals supplied for approval, commissioning and hand-over to the client shall be in English and French.

**1.20. DRAWINGS FOR APPROVAL**

The successful tenderer shall submit the following drawings for approval within a time scale suitable for the program of the contract period, this to be agreed with the Engineer or as specified elsewhere:

1) Arrangement drawings of all switchboards showing the layout of equipment and principal dimensions.

2) Section drawings of all switchboards showing bus-bars arrangements with clearance distances, separation between circuits, equipment locations and cabling access and builders work requirements.

3) Complete electrical scheme diagrams for:

The Contractor shall be responsible for obtaining approval from the Local/National Authorities for all of the above.

**1.21. MANUFACTURER AND PLACE OF MANUFACTURE**

EQUIPMENT NAME OF PLACE OF

 MANUFACTURER MANUFACTURER

Air Conditioners

Air Circuit Breakers

Static Protection Relays

Light fittings

Switched Fuses and Switches

Socket Outlets

Contactors

**PARTICULAR SPECIFICATIONELECTRICAL**

**SECTION 2**

**TESTING AND COMMISSIONING**

**2.1. GENERALLY**

Testing shall be carried out in the presence of the Architect on all sections of the electrical services installation and signed copies of the results of the tests, together with copies of the Completion and Inspection Certificate as required by the Fifteenth Edition of the Regulations for the Electrical Equipment of Buildings.

Site testing of all systems and components comprising the Contract works shall be carried out in the presence of and to the complete satisfaction of the Architect. After the Contractor has first satisfied himself that the systems are operating correctly.

All certified instruments, equipment, plant, labour and materials necessary for conducting specified site tests shall be provided. The Contractor shall be responsible for and prepared to demonstrate the accuracy of all test instruments supplied by him.

Observations shall be made of the operation and performance of the installations and subsequent readjustments made as necessary.

Accurate records of all commissioning and testing shall be kept and results comprehensive reported to the Architect when the installed system(s) are functioning correctly.

The Contractor shall ensure that all equipment and plant under his supply shall be tested at the makers works before despatch and copies of test certificates in respect of each test shall be forwarded to the Architect and included in the Maintenance Manual.

All works tests shall comply with the relevant British Standard Specification, IEC Standard Specification and shall be sufficient to show that equipment will function correctly when installed as part of the Contract works.

Each item of electrical plant or equipment so tested shall be fitted with a plate giving:

Date of Test.

Individual equipment serial number.

Test voltage.

Operating voltage (if different from the test voltage).

Test current.

Full load current (if different from test current).

The following test results shall be submitted:

(a) Continuity of ring final circuit conductors.

(b) Continuity of protective conductors, including main and supplementary equipotential bonding.

(d) Insulation resistance.

(e) Insulation of site-built assemblies.

(f) Protection of electrical separation.

(g) Protection by barriers or enclosures providing during erection.

(h) Insulation of non-conducting floors and walls.

(i) Polarity.

(j) Earth fault loop impedance.

(k) Operation of residual current devices and fault voltage operated protective devices.

(l) Each circuit breaker shall be operated manually or electrically many times to the satisfaction of the Architect.

**2.2. TESTS AT MANUFACTURER'S WORKS**

The following tests shall be performed at the Manufacturer's Works unless an alternative place is specified or approved to determine whether the materials and apparatus comply with the Specification.

As many tests as in the opinion of the Architect are possible shall be arranged together.

Six copies of the records of all tests shall be furnished to the Architect.

All instruments shall be approved by the Architect and if required shall be calibrated by an approved laboratory or other such body as may be approved, as part of the Contract.

Tests shall be arranged to represent the working conditions as closely as possible.

Routine tests, in general, shall be carried out as summarised below, in accordance with this Specification and the relevant standards/Specification to which the equipment has been made.

a) Components

 Circuit-breakers

 Current transformers Routine

 Indicating instruments & meters tests

 Voltage transformers at place

 Control switches of

 Protection relays manufacture

 Fuse switches, switches & isolator)

 Fuse switches, switches & isolators)

b) Complete Switchboards

 High voltage power frequency tests on main and auxiliary circuits.

 Insulation resistance tests.

Electrical operation of circuit-breakers control circuits at the appropriate voltage limits.

Mechanical operations tests and tests to certify correct functioning of interlocks.

 Primary injection test.

 Secondary injection tests.

**PARTICULAR SPECIFICATIONS**

**ELECTRICAL**

**SECTION 3STANDARDS**

**3.1. SCOPE**

This specification covers the supply, installation and testing of all necessary equipment required for the complete Electrical Engineering Services as described in the attached Contract Documents and incorporates standard descriptions for equipment and the installation to be provided under this Contract. The clauses shall be read in conjunction with the accompanying General Conditions of Contract, Specification Sections, Schedules and Drawings.

Where, for special reasons, requirements differ from those included in the standard Specification and are specified in the particular detail Specification or on the associated drawings, then such special requirements shall supersede the requirements of this standard Specification Section.

The words 'as indicated', 'where indicated', 'unless otherwise indicated', refer to requirements identified elsewhere in the documents issued in connection with the Contract, e.g. on a drawing, in a supplementary detail specification or in a schedule.

The whole of the work and materials to be supplied shall be in accordance with the following publications as relevant, current at the date of Tender, unless otherwise stated:

- 15th Edition of the Wiring Regulations issued by the Institution of Electrical Engineers.

- British Standards issued by the British Standards Institution.

- British Standard Code of Practice issued by the British Standards Institution.

* Requirements of the Chartered institution of Building Services Design Guides and Recommendations.
* Requirements of Local Environmental Regulations.
* Requirements of the Local Electricity Authority.

The extent of work shall comprise of the whole of the labour and materials required to form a complete installation, together with such tests, adjustments and commissioning as prescribed in subsequent clauses and/or detail Specification Sections and otherwise as may be required, in order to provide an effective working installation to the satisfaction of the Engineer. The following standards shall apply:

DESCRIPTION BRITISH STARNDARDS

Cable Trunking B.S. 476 part 5 and 6

PVC Conduits B.S. 6099 and B.S. 4607

Light Switches B.S. 3676

Luminaires B.S. 4533 and B.S.6702

Lamp Holders B.S. 6702

Socket Outlets B.S. 1363

3Phase Outlets B.S. 4343

Earthing B.S. CP 1013

Standby Generator B.S. 5514

Low Voltage Switch Boards B.S. 89, 3871,Part 1,142 and 5486, B.S.159

PVC Insulated cables B.S. 6231

Current Transformers B.S. 3938

**PARTICULAR SPECIFICATIONS**

**ELECTRICAL**

**SECTION 4**

**LOW VOLTAGE SWITCHBOARDS**

**4.1. SCOPE**

This specification details the requirements for 400V/230V switchgear, control gear and ancillary equipment for systems not exceeding 1000 V.

**4.2. EQUIPMENT RATINGS**All ratings referred to in this Specification are site ratings, that is for the environment in which the equipment is to be installed. Ratings shall be consistent with those required by the total system.

**4.3. STANDARDS**

In addition to meeting the particular requirements of this Specification, all equipment shall be designed and constructed in accordance with the most recent and relevant issue of the following British Standards and others where applicable except where modified by this Specification and in particular the Local/National regulations.

BS 89 Direct acting electrical indicating instruments.

BS 3871 Miniature and moulded case circuit-breakers.

Part 1 Miniature air-break circuit-breakers for a.c. circuits.

BS 142 Electrical Protective Relays.

BS 5486 Factory Built Assemblies of Switchgear and control-gear for voltages up to and including 1000 V a.c. and 1200 V d.c.Part 1 General requirements.

Part 1 Contactors.

BS 6231 PVC insulated cables for switchgear and control-gear wiring.

BS 3938 Current transformers.

BS 4752 Switchgear and control-gear for voltages up to and including 1000 V a.c. and 1200 V d.c.

Part 1 Circuit-breakers.

BS 4941 Motor starters for voltages up to and including 1000 V a.c. and 1200 V d.c.

**4.4. LOW VOLTAGE SWITCHBOARDS**Low voltage (L.V) switchboards shall be of the "unit" type, and be constructed by a specialist switchgear manufacturer, in accordance with BS.5486.Each switchboard shall incorporate the isolators, fuse switches, circuit breakers, meters, instruments, protection relays as detailed in the following Specification Sections and/or drawings.

Equipment sizes indicated are the minimum acceptable to the Architect. Approved manufacturer's standard units may be offered however the units shall not be of a lower rating than the sizes specified.

Each switchboard shall be manufactured so that no operating handle exceeds the height of 2.10 m from the finished floor level.

Circuit breakers shall be of the air insulated type (A.C.B.) in accordance with BS.4752 having enclosure protection in accordance with IP31 as detailed in BS.5420 unless otherwise stated. Each unit shall have a nominal voltage rating of 400 volts and a minimum short time rated current of 50 kA for 1 second with appropriate short circuit breaking and making currents calculated in accordance with the requirements of BS.4752, as detailed in drawings.

Each circuit breaker shall be totally enclosed in sheet steel and be provided with a 3 phase isolating device suitably interlocked to prevent isolation except when the circuit breaker is open. It shall not be possible to withdraw the breaker or remove the front cover until it is in the 'isolated' position, and provision shall be made for locking the isolator in this position. When isolated, the bus bar and C.T. chamber orifices shall be guarded by automatic covers.

Each A.C.B. shall be complete with an approved power assisted closing device mounted at a convenient height and the breaker shall be opened by means of a separate hand trip device. The operating mechanism shall be accessible for inspection without withdrawing the breaker.

The A.C.B. shall be of the horizontal withdrawable load making and breaking type with the contacts being of the double break pattern, operated by a vertical motion. The main arcing contacts shall be of the high pressure butt type with wipe and roll action on opening and closing. The main contacts shall be silver alloy faced with the arcing contacts copper alloy faced. Removable arc shutters shall be fitted, together with a hand operated circuit breaker and isolating mechanism, complete with a mechanical ON/OFF position indicator.

All switched neutral contacts shall be arranged to close the circuit prior to the phase contacts and break the circuit after the phase contacts.

All A.C.B. switch or isolator handles shall be arranged to operate in a vertical plane.

Meters and instruments shall be of the flush mounting type of the sizes as detailed in the following Specification Sections. The meters and instruments shall be mounted in such a manner that they are easily readable from the front of the switchboard. In no instance shall meters be mounted at a height in excess of 2.30m from the finished floor level. Selector switches associated with the meters and instruments shall be mounted at a height not exceeding 2.10m from the finished floor level.

Each switchboard shall be complete with necessary sealing chambers or terminations. No connecting cables shall be taken through bus-bar chambers.

Each switchboard shall be complete with a main high conductivity copper bar or tape mounted horizontally in the cable termination section at the rear of the switchboard. Adequate cross-section earth tape shall bond each item of equipment and the cable terminations.

Interlocks shall be provided where specified and facilities shall be provided to enable cylinder type locks to be fitted to each A.C.B. fuse switch or isolator.

All bus-bars and connections shall be in accordance with BS.158 and 159.

**4.5. MANUFACTURERS**

All low voltage main and sub-main switchboards shall be supplied by the same manufacturer.

All floor distribution cubicles, purpose-made distribution panels, distribution boards, MCCB, MCB, switches and isolators shall be supplied by one manufacturer, but not necessarily the same manufacturer as mentioned above, and shall be IP42, form 3.

All types of equipment shall have been in general use for at least 3 years prior to the commencement of the Contract and spares availability shall be guaranteed for a minimum of five years following the completion of the Contract.

**4.6. DISTRIBUTION BOARDS**

Each unit shall be of the 600 volt pattern as a minimum requirement and be complete with a pressed or fabricated steel case manufactured from sheet steel having a minimum thickness of 1.7 mm.

Hinged doors shall be provided and shall be complete with a catch and key operated lock.

All live terminals or parts shall be shrouded by insulating material to ensure that it is impossible for any live metal to be touched whilst withdrawing or replacing the MCB units or fuses.

The moulded case circuit breakers (MCCB), miniature circuit breakers (MCB) or HRC fuses shall be arranged in banks which shall be easily removable to facilitate wiring and connection. Adequate non-ferrous bus-bars shall be fitted to the banks and shall be complete with suitable cast brass cable terminals for the termination of the cables. The diameter of each terminal pinching screw shall be not less than 75% of the diameter of the cable entry hole.

Each distribution board shall be complete with an internal circuit chart clearly detailing the circuit numbers, area served and the respective circuit breaker or HRC sizes. The charts shall be typewritten, glued to stiff cardboard, covered with clear perspex and fixed to the inside face of the door by means of screws and nuts.

In addition, each circuit chart shall contain full details of the size and type of cable feeding the distribution board, etc., together with the size, type and location of the major switch or section board serving the board.

Circuit and phase colour identification bands shall be fitted to all phase, neutral and control circuit cables.

**4.7. MINIATURE AIR BREAK CIRCUIT BREAKERS (MCB)**All sizes of MCB units shall be checked with the Architect before any orders are placed. Each MCB unit unless otherwise stated, shall be of the hermetically sealed, Thermal/Magnetic having a short circuit duty rating of at least 9 KA at 415 volts a.c.

MCB units used for the final means of protection and isolation to items of fixed or removable equipment, e.g. small ventilation fans, etc., shall be complete with malleable iron or pressed steel box and with front plate arranged as over-lapping for flush mounted units.

Assemblies shall be arranged for flush or surface mounting and the associated front plates shall be finished to match the general lighting switches.

Earth leakage protection will be provided for the final sub-circuits as specified in drawings, 100mA for lighting, and 30mA for small power and small appliances.

**4.8 INTERNAL WIRING**The main current carrying conductors of each main circuit from the incoming terminals to the outgoing terminals shall be capable of carrying, for one second without distress, the fault current.

The removal of insulation shall be carried out by the hot wire stripping methods.

All power wiring cables shall be PVC insulated cables be coloured in accordance with IEE Regulations to indicate differing phases.

All power wiring shall be kept physically segregated from all other wiring and the working voltage shall be indicated on the fixed portion of the associated terminal boards.

**4.9. LABELLING**

Each outgoing and incoming circuit shall be clearly labelled to indicate the circuit controlled, and the size or settings of the protective device.

Labels shall include white lettering, minimum height 5mm on a black background.

All labels shall be screwed, not glued or fixed by the use of rivets.

All labels both inside and outside the switchboard shall be manufactured in ivorine, with the base having bevelled edges. Approval to all wording shall be obtained before manufacture commences.

 **PARTICULAR SPECIFICATIONS**

**ELECTRICAL**

**SECTION 5**

**CABLES**

**5.1. CABLES IN CONDUIT AND TRUNKING**

Cables to be drawn into conduits or trunking shall be selected in relation to working temperature as indicated below:

---------------------------------------------------------------------------

Working Temperature Cable

---------------------------------------------------------------------------

Not exceeding 65 Deg.C 450/750 V grade PVC to BS 6004

Not exceeding 80 Deg.C 450/750 C grade or Butyl rubber insulated to BS 6007

Not exceeding 85 Deg.C 450/750 V grade E.P. rubber insulated to BS 6007

Not exceeding 145 Deg.C Silicon rubber insulated and braided to BS 6007

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**5.2. POLYVINYL CHLORIDE (P.V.C.) INSULATED CABLES AND FLEXIBLE CORDS**

All P.V.C. cables shall be manufactured by a member of the Cable Manufacturers Association and shall be 450/750 volt grade and shall conform to size, covering and resistance as set out in BS 6004 "P.V.C. insulated cables (non armoured) for electrical power and lighting".

Every flexible cable and flexible cord for use at "low voltage" shall comply with the British Standards listed below:

BS 6500 Insulated Flexible Cords

BS 6007 Rubber Insulated Flexible Cables

BS 6004 PVC Insulated Flexible Cables (non armoured)

BS 6977 Rubber Insulated Flexible Travelling Cables for Lifts

In no case shall cables less than 1.5 sq mm be used the loading in Amperes is not to exceed that permitted by IEE and Local/National Regulations Whichever is the lesser. Identification of cables and flexible cords shall comply with requirements 524-3, 524-4, 524-5 and tables 52A and 52B of the IEE Regulations. The whole of the wiring shall be carried out in the looping-in-system. Junction boxes and joints in cables shall not be permitted.

All cables shall be copper conductor unless otherwise specified. Conductors shall not be wrapped round stud terminals. Crimped lugs applied with a tool specifically designed to prevent inadequate crimping shall be used to connect cables to stud terminals. The cable insulation shall not be trimmed back beyond the lug.

P.V.C. cables shall not be brought direct into luminaires but terminated in a connector block or plug in ceiling roses in false ceiling areas, and will be terminated to a connector block in suitable boxes in other areas.

**5.3. P.V.C. INSULATED S.W.A./P.V.C. SHEATHED CABLES**

PVC insulated armoured cables shall comply with BS 6346 "PVC insulated cables for electricity supply" with shaped cores and the neutral of the same cross section as the phase cores unless otherwise specified.

PVC insulated single wire armoured PVC sheathed cables shall be 600/1000 volt grade cable and shall be terminated in approved glands supplied by the cable manufactures which shall not leave any armouring exposed. The glands shall then be covered with PVC shrouds. All cables shall be copper conductors and will comply with I.E.E. Regulations Appendix 9.

**5.4. CABLE IDENTIFICATION**Each end of each cable shall be provided with an identification label. Labels shall be permanently attached to the cables in an approved manner. Loose tags will not be accepted.

The materials of the labels and fastenings shall be such as to avoid corrosion due to incompatibility of materials, and to ensure permanent legibility.

**5.5. FINAL CIRCUIT CABLE SIZES**

Irrespective of type of cables used, the minimum conductor size for final sub circuits shall be 1.5 mm2.

for lighting and 2.5mm2 for power.

All cables shall be sized in accordance with Appendix 9 of the with Edition of the IEE Regulations for Electrical Installations and Local/National Regulations if a larger cable size would result. Suitable de-rating factors for method of installation, ambient temperature and the like shall be applied when choosing a suitable cable size.

**5.6. CABLE TERMINATION**

All cable terminations or joints other than sub-circuit wiring shall be carried out using compression type conductors or glands the size and type suitable, for each particular situation.

The correct crimping tools shall be used for each particular application and the manufacturer' recommendations strictly adhered to, especially in maintaining the recommended crimping tool pressure.

**5.7. SEGREGATION OF CIRCUITS**

Where an installation comprises extra low, low or medium voltage, telecommunication or fire alarm circuits in proximity to each other as precautions shall be taken in accordance with the following to prevent both electrical and physical contact between the cables of the various types of circuits.

 Circuits (other than fire alarm circuits) operating at medium voltage and supplied directly from

 a main supply system.

All low and extra low voltage circuits.

Fire alarm circuits.

All telecommunication circuits e.g. radio, telephone, sound distribution, burglar alarm, bell and call circuits which are not supplied directly from a mains supply system.

**PARTICULAR SPECIFICATIONS**

**ELECTRICAL**

**SECTION 6**

**CABLE CONDUITS & SUPPORT SYSTEMS**

**6.1. CONDUITS6.1.1. General**Conduit, unless otherwise specified shall be of screwed heavy gauge welded steel, not less than 20 mm external diameter and its finish shall be determined as follows:

i) Galvanised Steel Conduit be used if it is:

a) On the surface in kitchens, plant rooms, tank rooms, sub-stations, out-buildings of any place which is likely to be damp.

 b) Exposed to outside ambient temperature.

ii) Non-metallic conduit shall be used in areas not covered in (i) above.

iii) PVC conduit may be used where concealed installation is required unless elsewhere specified and then in accordance with section 3.8.6 on PVC conduit.

**6.1.2. Steel Conduit**

All conduit used throughout the Electrical Installation shall be manufactured in accordance with the BS 4568 Part 1 Screwed Conduit, except where the installation is required to be flameproof. In this instance the conduit shall be of heavy gauge screwed steel solid drawn from the billet.

All conduit shall be rigid high impact heavy gauge galvanised Class 4 by the hot dip process both inside and out. Care should be taken to make watertight all screwed joints by means of a suitable metallic paint.

All conduit shall be run in an approved manner and arranged with adequate ventilation and drainage where necessary as directed by the Architect.

Where a conduit is exposed to different air temperatures at any particular time the section of the conduit at the higher temperature shall be isolated from the section at the lower temperature by means of a conduit box filled with approved plastic compound. Such a condition would arise if a conduit passes from an area which is air-conditioned to an area that is not.

The radius of any bend shall not be less than that given in BS 4568, Part 1 and where conduits are concealed the radius shall be increased to facilitate the drawing in of cables. The conduit shall be of sufficient capacity to allow all cables to be easily drawn in or withdrawn. The capacity of conduits to be installed shall generally comply with the recommendations detailed in Appendix 12 cable capacities of conduit and trunking of the Institution of Electrical Engineers ( IEE ) Wiring Regulations.

No conduit smaller than 20 mm diameter shall be installed except where specifically called for with the written consent of the Architect.

Where runners or similar items are essential for steel conduits and at any other position at the discretion of the Architect, circular lock nuts with knurled edges shall be fitted and fully tightened.

The ends of fittings, sockets, etc. in such cases shall be machine finished to permit a perfect mechanical contact alignment. In all cases conduit shall be screwed firmly into all fittings, full use being made of the total length of threads in accordance with the requirements of BS 4568.

Steel conduits shall be threaded by means of efficient sharp dies and in no circumstances will torn or loose threads be accepted. Where practical all threads shall be half the length of the appropriate standard coupling and no threads shall be exposed except at "running couplings".

Where such exposed threads occur, they shall be given a coat of paint immediately after erection.

All conduit threads shall be clean and free from paint, enamel, dirt etc., when being installed.

The whole of the conduit system in any particular section shall be completed and swabbed through to remove any dirt or loose matter before cables are drawn in.

Where metallic conduits connect to bus-bar chambers, distribution boards, switchgear, switchboxes, junction boxes special draw-in boxes etc. the conduits shall each have a machine faced socket screwed onto the end which when tightened is flush with the outside of the above-mentioned apparatus. The conduit shall then be secured to the apparatus by means of a hexagon male smooth bore brass bush and brass compression washer, screwed from the inside of the apparatus into the conduit socket to make a sound and tight mechanical joint. In the case of bus-bar chambers, distribution boards, switchgear and adaptable boxes the machine faced sockets shall be of the flanged type and shall be used in conjunction with brass compression washers.

Where surface type distribution boards are used in conjunction with conduit work the conduits shall terminate at each distribution board position in a suitable flush steel adaptable box and cables shall enter the distribution board via a rectangular hole in the back of the distribution board. Each distribution board shall be effectively bonded to the conduit system and any space between the adaptable box and the distribution board shall be filled by a rectangular metalplate of suitable thickness, this plate being fixed by means of four metal thread screws passing through holes drilled in the box. The edges of the rectangular holes in the distribution board shall be radiused and finished smooth to prevent cable abrasion.

Where in any particular instance this method cannot be adopted, an alternative method of terminating the conduit shall be agreed with the Architect before the conduit and distribution board are installed.

All exposed threads, vice marks, etc. shall be painted immediately the conduit is erected.

Particular attention shall be paid to the continuity of all conduit etc., and the conduit installation shall comply in all respects with the requirements of regulations 543-91, -10, -11 and -13 of the IEE Wiring Regulations, the Regulations for Electrical Installations latest Edition. The impedance between any point in the installation and the earth terminal on the main switchboard shall not exceed 0.5 ohm. Tests shall be carried out during the erection of the conduits to check this impedance as described in Part 6 of the IEE Wiring Regulations, the Regulations for Electrical Installations. Full particulars of these tests shall be recorded and submitted to the Architect with the weekly report. Tests shall be carried out using earth loop testing equipment.

All precautionary measures shall be taken to safeguard all conduits, boxes, etc. from damage during the progress of the Contract.

Special precautions shall be taken to prevent the ingress of moisture, silt, brick chippings, etc. into the conduit after they are installed. Swabs shall be drawn through the conduits to remove condensation before wiring, when this has occurred. The inside of all conduits shall be free from burrs and similar.

Conduits and bushes shall butt firmly at couplings and at terminations.

Damage from mechanical causes and from the weather during storage on the site shall be avoided.

All concealed conduit work shall be installed where practicable in the "loop-in" system. Any alternative method, should the "loop-in" system prove to be impracticable for a particular application, shall be approved by the Architect prior to adoption.

All proposed conduit runs shall be submitted to the Architect for his approval before installation.

**6.1.3. Steel Conduit Fittings**

All conduit fittings of malleable iron shall conform to BS 4568 Part 1:1970.

All fittings shall be of the screwed circle box type and no solid or inspection elbows, tees or bends shall be installed without instructions in writing from the Architect. Generally conduit fittings shall be black enamel or galvanised inside and out to match the conduit system specified; such fittings shall be of Class B pattern.

All adaptable boxes shall be constructed of best quality heavy gauge mild steel or cast iron, where specifically called for.

Such boxes shall be of a suitable size to avoid undue packing of cables and a minimum space of 1.5 mm shall be left between all conduit holes. The boxes shall be painted or heavily galvanised to prevent rust as required. Boxes having "Knock-out" entries will not be permitted unless otherwise specified.

All ceiling point boxes except in the case of surface conduit or unless otherwise stated shall finish flush with the underside of the ceiling, extension rings being used where necessary.

Every flush ceiling point box to which a lighting fitting is attached to shall unless otherwise specified be fitted with an approved type break joint ring.

Where surface conduit is used in conjunction with distance saddles, special distance pieces shall be used behind all boxes etc. to obviate the setting of conduit when entering or leaving the boxes. Each distance piece shall be cut to the exact size of the box behind which it is to be fixed.

"Special" raised back boxes may be used instead of distance pieces at the discretion of the Architect.

All conduit boxes including boxes in which fittings, switches and socket outlets are mounted shall be securely fixed to the walls and ceilings by means of not less than two countersunk screws, correctly spaced and the fixing holes shall be countersunk so that screw heads do not project into the box.

At expansion joints cast in concrete the conduits shall terminate flush at one side of the joint in a screw to slip solid coupler. From the other side of the joint the conduit shall bridge the expansion gap to engage the slip section of the coupler to allow not less than 12.5 mm movement of the conduit without separation.

A P.V.C. covered copper flexible earth continuity conductor of size not less than 4 mm2 shall be installed within the conduit between the boxes which are on either side of the expansion joint and shall be secured to a brass earthing terminal screw fixed to the box.

Conduit fittings shall be of the same material as the conduit to which they are attached.

**6.2. DRAW-IN BOXES**

Draw-in boxes or through boxes shall be provided to give access to all conduits for the drawing in or out of any cable after the installation is complete. The draw-in boxes shall be of ample size to enable the cables to be neatly diverted from one conduit to another without undue cramping. No joints will be allowed in draw-in boxes under any circumstances.

All draw-in boxes shall be complete with suitable rust proofed iron covers, securely fixed in position with round head brass screws and where flush boxes are installed the covers shall be of the overlapping rust proofed pattern.

Generally, where conduit is to be installed from one point to another point in a straight run with no bends, draw-in boxes shall be provided at every 10 metres of conduit run but where conduits are run from point to points with not more than two right angle bends e.g. from ceiling point to ceiling point, boxes shall be installed not more than 7.5 m apart.

Ceiling draw-in boxes (where permitted), except in the case of surface conduit shall finish flush with the underside of the ceilings, extension rings being used where necessary. Other draw-in boxes shall be installed in the walls and no in floors.

Circular boxes shall not be used in flush systems solely for the purpose of "drawing-in", rectangular boxes shall be used.

Where multiple conduit runs occur, rectangular adaptable boxes shall be used by arrangement with the Architect to avoid the use of an excessive number of individual draw-in boxes with suitable barriers being installed where necessary.

**6.3.1. CONDUIT INSTALLATION - GENERAL**

Conduits shall not be installed in contact with plumbing and mechanical services with a minimum distance of 150 mm being maintained wherever practicable.

Prior to erection all burrs and sharp edges shall be removed from the conduit together with any dirt, oil or paint which may be present.

Corners shall be turned by means of hand made bends or where this is impracticable by means of conduit boxes. Factory made bends, tees and elbows and inspection tees and elbows shall not be used without approval.

Not more than two right-angled bends will be permitted between draw-in boxes.

All conduits, boxes and accessories comprising a circuit shall be erected before any wires in that circuit are drawn in. Ends of conduits left open during building operations shall be effectively plugged and the thread of metal conduit coated with petroleum jelly. Any blockages occurring in conduits shall be cleared. Conduits shall be swabbed through before commencing wiring.

Saddles and distances pieces shall have the same finish as the conduit for which they are to be used, by single way or multi-way as required and be fixed by means of screws in metal or other approved plugs. Wood or fibre plugs shall not be used. Saddles shall be fixed on either side of all bends, draw-in boxes or sets.

Conduits shall be so arranged that it is impossible for water from condensation or other sources to lodge at any point. When this is not practicable drain holes 3 mm diameter shall be drilled at the lowest points in the conduit runs or boxes and at any other points required by the Architect.

i) Surface Conduit

Surface conduits shall be made to harmonise as far as practicable with the architectural features of the building. They shall be run only in vertical and horizontal directions except where it is desirable to follow the line of a constructional feature in which case approval shall be obtained. Wherever possible, they shall be located in secondary rooms and stores and not in the main areas.

Surface conduits shall be securely fixed to the building fabric by means of distance saddles to give not less than 6 mm clearance between the conduit and the walls. In ceiling spaces where conduits are fixed to wood the distance pieces may be omitted.

In multiple runs crossing of conduits will not be permitted. Where a surface conduit turns through a wall a back outlet box shall be provided.

 Where distribution boards are connected to trunking by conduits the capacity of the conduits shall be sufficient to carry as many sub-circuit cables as there are ways in the distribution board. The supply cables shall be run in separate conduit.

ii) Concealed Conduit

Before any conduits are concealed earth continuity tests shall be carried out.

Conduits running from ceiling or roof positions to positions on walls shall be connected by a solid coupling 300 mm below ceiling level.

Extension rings shall be fitted to sunk conduit boxes to which lighting fittings or pull switches are to be attached if the distance between the conduit box and the finished ceiling or wall surface exceeds 10 mm.

**6.3.2. Cast in Concrete**

Conduit laid in concrete poured 'in situ' shall be fastened to the reinforcement before concreting. All conduit boxes shall be securely fixed to shuttering to prevent displacement and all open ends securely capped to prevent ingress of slurry or water.

Before any conduits are concealed, earth continuity tests shall be carried out.

Attendance during pouring shall be provided to ensure that conduits and accessories are not displaced.

**6.3.3. Conduit in Floor Screeds**

Conduits shall be installed in floor screeds only when it is particularly specified.

Conduits shall be galvanised and care taken to ensure that runs do not foul the position of any door spring boxes.

Before any screed is laid the conduit shall be checked for rigidity and mechanical damage and earth continuity tests carried out.

The cable capacities of conduit shall be taken as those determined by the factors in Appendix 12 of the IEE Regulations, latest Edition.

**6.4. PVC CONDUIT**

This section shall be used to supplement preceding installation practices where PVC conduit is permitted.

**6.4.1. Standards**

All conduits shall comply with BS 4607 or with BS 6099.

Light gauge conduit may be used for protected cast concrete work or for protected surface work e.g. in false ceilings only with specified, prior written approval by the Architect otherwise heavy gauge conduit shall be used in all locations.

**6.4.2. Joints**

Conduits shall be jointed and terminated utilising the appropriate components as supplied by the conduit manufacturers:

i) Permanent adhesive

A solvent cement shall be used to produce a rigid watertight joint when used with standard couplers and accessories.

ii) Flexible adhesive

A non-hardening adhesive shall be used where expansion facilities are required in long conduit runs in conjunction with expansion couplers.

**6.4.3 Bends**

Conduits up to 25 mm diameter may be bent cold with the use of the appropriate bending spring obtained from the conduit manufacturers, as specified in Section 16.

**6.4.4. Temperatures**PVC conduits may only be used in situations where continuous ambient or localised temperatures do not exceed 60 ºC or 70 ºC for intermittent periods.

**6.4.5. Expansion**

Adequate allowance shall be made for linear expansion and contraction of conduits under normal working temperature variations as follows:

**6.4.6. Support**

Conduit shall be supported at intervals of 1.5 metres in isolated positions or 1 metre in accessible situations. Where working temperatures tend to be high, this spacing should be reduced accordingly: See table 11C of the IEE Regulations.

**6.4.7. Conduit Accessories**

Wherever possible, conduit junction boxes shall be of the BS circular pattern with appropriate spout entries. Tangential entry circular boxes shall be used where appropriate.

Multiple conduits may necessitate the use of large PVC adaptable boxes for junctions.

**6.4.8. Support of Lighting Fittings**

Care must be taken in the support of totally enclosed lighting fittings. Where excessive temperatures are likely to occur, special insulated boxes shall be used i.e. of a pattern specifically designed to improve weight-loading characteristics at high temperatures.

**6.5. TRUNKING**

Horizontal trunking shall be either suspended by hanger fittings and conduit or mild steel rod or supported by mild steel or angle iron brackets. Suspensions and supports which will be visible shall be painted to match the trunking.

Where trunking passes through walls and partitions the cover shall terminate at either side of the wall at a point 80 mm from the wall. Between the removable covers a fixed section of cover shall be installed through the wall.

**6.5.1. Trunking - Plastic**

Plastic skirting and architrave trunking will be manufactured to a Standard equivalent to BS 4607 Part 1 and have an ignitability characteristic 'P' as specified in BS 476 Part 5 & 6. The trunking shall be fixed at intervals not exceeding 500 mm using 25 mm roundheaded screws and washers.

All fitting, including connectors, cable retainers, internal and external corners, left and right handed end caps and adapters for mounting switch socket outlets shall be manufactured from material of the same specification.

Vertical and horizontal fire block facilities shall be used when the trunking passes through the ceilings. Mounting assembly plates shall be used fixing socket outlets, telephone outlets boxes etc. to the skirting trunking.

**6.5.2. METAL CABLE TRAY**

Cable trays shall be:

i) perforated with not less than 1.5 mm thick having a depth of not less than 15.2 mm and have a galvanised finish unless otherwise detailed.

ii) galvanised or have approved rust resistant finish except where installed in corrosive atmospheres when the tray and any associated components shall be PVC coated.

iii) of adequate size to support the cables without undue bunching.

iv) supported at intervals by suitable brackets necessary to provide a rigid fixing.

v) installed using factory formed bends and when cut sections are used for sets they shall be free from sharp edges and welded. Bends shall be of the same material thickness and finish as the cable tray.

vi) Painted including any hand fabricated accessories with zinc rich paint where cuts have been made.

**PARTICULAR SPECIFICATIONSELECTRICAL**

**SECTION 7**

**LIGHTING AND ACCESSORIES**

**7.1. LIGHT SWITCHES**

**7.1.1. General**

Light switches shall comply with BS 3676. All switches shall be suitable for use on either inductive or resistive loads. They shall be of the type and rating shown in the Schedule or on the Drawings.

All light switches shall be rated in accordance with the protection afforded unless otherwise specified.

The mounting height to the bottom of the switch plate shall be 1150 mm unless otherwise specified. Where the structure and furnishings permit, the distance from the edge of the architrave to the near edge of the switch shall be 150 mm.

Where several switches on one phase are shown mounted adjacent they shall be grouped in a single enclosure (multi-gang box) and share a common switch plate. Different phases shall not be ganged in one box unless each phase is segregated in a separate compartment which is covered by a separate internal warning plate.

Where switches are shown mounted adjacent to each other but are fed from different distribution boards, each switch shall be mounted in a separate enclosure.

Where possible the arrangement of switches in multi-gang boxes shall be similar in plan to the lighting points which they control. Switches not so arranged shall be labelled in a suitable manner to indicate the circuits controlled.

The swing of all doors shall be checked on site before marking out any chases for switch positions.

The position and loading of all points shall be taken from the drawings for tender purposes, but the exact setting out and runs of conduit and cables shall be agreed with the Architect before the work is carried out. Particular attention shall be given to the position of switches with reference to the hanging of doors.

The Engineer's attention shall be drawn to locations where switch positions are at variance with drawings, consistent with the following conditions:

Single doors: Switches shall be located adjacent to closing style.

Unequal two leaf doors: Switches shall be located adjacent to hanging stile of narrower portion of doors.

Equal two leaf doors: Switches shall be located adjacent to the left hand side of the doors on entering.

**7.1.2. Surface Light Switches**

Surface mounted light switches shall be fitted to either malleable cast iron or pressed steel boxes of minimum depth 37 mm.

Weather-proof light switches shall be mounted in cast alloy or iron boxes unless otherwise specified.

Cord operated light switches shall be fixed to circular conduit boxes using extension rings. The switches shall be white or ivory coloured. They shall be fitted with an operating cord of suitable length.

**7.2. LIGHTING POINTS**

**7.2.1. General**

Lighting points shall not be used as cable junction boxes for the through connection of switch-wires. Not more than three connectors shall be permitted at any lighting point.

Strap wires for two-way or intermediate switching shall be connected directly between switches and not through lighting points.

From each multi-gang light switch position, cables to lighting points shall be limited to single and twin core cables or a multi-core cable shall be taken to a separate junction box from which separate cables shall be run to a point in each switch group of lights. Such a junction box shall be used in a concealed but accessible position unless otherwise specified.

The junction box used for this purpose shall be complete with lid and insulated multiple connector blocks with sufficient ways to suit the number of connections necessary. The connector block shall be fixed to the base of the box. All terminals in this connector shall be adequately marked for identification.

**7.2.2. Discharge Lighting Points**

The Conduit to each discharge lamp type luminaire shall be terminated at the control gear unit, in a conduit coupler and bushed, where the control gear is integral with the luminaire. When the gear is remote, the conduit shall terminate direct on to the luminaire. Remote control gear shall be housed in purpose built enclosures.

Where ceiling mounted discharge type luminaires are specified, the control gear for each luminaire shall be enclosed within a sheet metal casing of the type specified. The control gear shall be located adjacent to the luminaire fixed to the soffit in the void formed by the false ceiling or supported as detailed. The flexible tail provided as an integral part of the luminaire shall be terminated in the control gear unit via a vulcanised rubber gasket and secured with a suitable cable clamp. Connection between the control gear unit and the circuit wiring shall be carried out using a high temperature lighting flexible cord of the type specified. Connections shall be carried out in an adjacent conduit box local to each control gear unit using twin screw insulated shrouded connectors.

**7.2.3. Fluorescent Lighting Points**

Circuit wiring to fluorescent luminaires shall be so arranged to eliminate the use of the luminaires as an enclosure for through wiring.

Where fluorescent luminaires are mounted on thermally insulated ceilings adequate ventilation shall be provided by lugs or spacers to maintain a suitable air gap between the rear of the fitting and the ceiling.

Adequate ventilation of the fitting shall be provided for. Where necessary with fibre type ceilings, suitable spacers shall be provided to ensure that minimum gap of 6 mm exists between the rear of the fitting and the finished ceiling.

For suspended type fluorescent luminaires, these fittings shall be mounted on conduit drops to the mounting height detailed. These conduit drops shall be fixed to conduit box cover plates of the ball and socket type, fitted to 50 mm fixing centre circular conduit boxes at the fixing centresrequired for the specified luminaires. For fittings mounted on lighting trunking, suspension at the fixing centres is required for the specified luminaire.

Recessed fluorescent luminaires shall be connected via 'plug-in' type ceiling rose and three core heat-resisting flexible cable installed in the ceiling void unless where otherwise specified.

**7.2.4. Plant Room Lighting**

The final lighting installation in Plant Rooms shall not be carried out until services plant, pipework, ducting and equipment have been finally placed in position.

**7.2.5. Suspended Ceilings**

Ceilings layout plans will dictate the final positions of lighting points and these must be used for setting out purposes.

On no account is the suspended ceiling construction to carry the weight of any light track or luminaire.

**7.3. LUMINAIRES**

**7.3.1. Luminaires**

All luminaires called up on drawings shall be supplied and installed in accordance with the following clauses.

All luminaires shall be supplied and installed complete with lamps and tubes.

Fluorescent luminaire shall comply with BS 4533 'luminaires' and BS 6702:1986 Part 4 'Built in lamp holders and starter holders for tubular fluorescent lamp'.

Lamp holders for use with tubular fluorescent lamps shall be bi-pin complying with BS 6702:1986 and BS 5101 Parts 1 & 3:1975.

**7.4. WIRING**

**7.4.1. General**

The minimum size of cable for lighting circuits shall be 2.5 sq mm.

 Sweated lugs of the appropriate sizes for the cable used.

 Compression type lugs.

Pinch screw type terminations of the type that do not spread the conductors.

 Clamp type conductors.

**7.4.2. Cable Identification**

Cables shall be coloured as in the latest edition of the I.E.E. Regulations, i.e. respective phase conductors shall be coloured red, yellow, blue up to the final single pole and neutral distribution boards and throughout all three phase circuits. Final single phase sub-circuits shall have phase wires coloured red. Under all circumstances the neutral wire shall be black.

The cord of all-flexible cords and cables shall be coloured brown for the phase conductor, blue for the neutral conductor and green/yellow stripe for earth conductor.

**7.5. EXTERNAL LIGHTING INSTALLATION**

The Contract shall include to supply and install all necessary materials and equipment, to provide a complete road, pathway and car park lighting installation with all lighting standards and bollards, positioned as detailed on the attached drawings and/or Specification Sections.

The details of the standards and bollards are included in the attached 'Schedule of Luminaires and Lamps' and each unit, unless otherwise stated, shall be complete with column, bracket, spigot, doors, wooden backboards, column root, earthing terminal, cable entry slots, luminaires, control gear and H.R.C. fused cur-out.

All excavations, together sith the backfilling of trenches, after the cable tiles have been laid, will be carried out by the Building Contractor, unless otherwise stated. The Contract shall include for the necessary liaison with the Building Contractor in the instruction for this work. Before excavations are backfilled the Architect shall be notified in writing that the cable installation is complete, in order that an inspection may be made of the cable installation.

Lighting standards shall be set at a minimum depth of 750 mm in the ground set on a hardcore or concrete plinth approximately 450 mm square by 150 mm deep with 300 mm deep concrete poured in-situ around the base of the column.

**PARTICULAR SPECIFICATIONSELECTRICAL**

**SECTION 8SMALL POWER INSTALLATION**

**8.1. SOCKET OUTLETS**

**8.1.1. General Purpose Socket Outlets**

13 Amp socket outlets and plugs shall comply with BS 1363 '13A plugs, switched and unswitched socket outlets and boxes'. The plugs shall contain the correct rated cartridge fuse link complying with BS 1362 'General Purpose Fuse links for domestic and similar purposes (primarily, the use the plugs)' to protect the apparatus or appliances connected to the outlet.

Socket outlets shall be mounted in suitable sheet steel or insulated boxes with conduit entries. Where flush mounted socket outlets are required the outlet box shall be fitted with adjustable fixing lugs.

Where socket outlets with integral pilot lights are required, these lights shall be of the low current consumption type and incorporated in the outlet plate behind a red coloured plastic lens.

The outlets shall be of the type as detailed on the drawings.

Socket outlets located in exterior locations shall be of the weatherproof type to prevent the ingress on water and corrosion.

**8.1.2. Plugs**

One high impact plug for each socket outlet shall be provided unless otherwise specified. Each 13 amp plug will be fitted with the appropriate cartridge fuse. The plugs shall be handed over at the completion of the works and a receipt received.

**8.1.3. Three Phase Outlets**

Socket outlets shall be of the five pin type, arranged as a phase, neutral and earth industrial type socket and plug conforming to BS 4343 and I.E.E. CEE 17 requirement. The sockets and plugs shall be manufactured from tough plastic, suitable for onerous working conditions. Sockets shall be fitted with spring loaded flaps which retain the plug in position and which close automatically to protect socket when plug is withdrawn. All sockets and plugs shall be colour coded in accordance with CEE 17.

It is essential that the current key-way in respect of the earth contact is used for the voltage rating. All sockets and plugs shall be splash-proof IP 44 and suitable for surface mounting, unless otherwise specified.

**8.2. FUSED CONNECTION UNITS**

Fused connection units shall be mounted in suitable sheet steel or insulated boxes with conduit entries. Where units are required flush the outlet box shall be fitted with adjustable fixing lugs.

Where fused connections units are detailed with integral pilot lights these be of the low current consumption type and incorporated in the outlet plate behind a red coloured plastic lens.

Where detailed on the drawings these units shall be provided with cable entry facility with provision for changing the cable.

All fuses shall be of the cartridge type.

**8.3. DOUBLE POLE SWITCHES**All double pole switches shall be manufactured in accordance with BS 3676.Double pole switches shall be mounted in suitable sheet steel or iron-clad boxes with conduit entries. Where units are required flush the outlet box shall be fitted with adjustable fixing lugs.

Where double pole switches are required with integral pilot lights, these lights shall be of the low current consumption type and incorporated in the outlet plate behind a red coloured plastic lens.

Where required these units shall be provided with cable entry facility with provision for changing the cable.

**8.4. LOCAL ISOLATORS**

All local isolators shall be of the 500 volt duty type.

Enclosures for isolators shall be fabricated from rust-protected sheet steel in stove paint finish with gasketed doors and fitted with chromium plated front mounted operating handles with "on/off" indication and provision for internal fixing unless otherwise specified.

The isolator shall be suitable for padlocking in the off position.

Interiors shall comprise porcelain bases fitted with non-ferrous (brass) conducting components. Switches shall be of the quick make quick-break type suitable for use on either a.c. or d.c. Shields shall fitted over both fixed and removable contacts.

Where isolators are to be weatherproof they shall generally be as described above and in addition shall be provided with cast iron enclosures fully gasketed to prevent the ingress of water and suitably finished to prevent the effects of corrosion.

Stay put stop buttons operating on the control circuit of the motor starter shall not be used as the sole means of isolation of a motor and each starter shall be provided with an isolator. Where stay put stop buttons are specified a warning notice shall be mounted adjacent to the button to read as follows "Emergency Stop - isolate and lock off at starter isolator" in English and Chichewa.

Where stop buttons are provided for meters with assisted start type starters it shall only be possible to re-start the motor in the normal sequence.

**8.5. FINAL CONNECTIONS TO EQUIPMENT AND PLANT**

Final connections to plant subject to vibration shall be carried out using either flexible cord or flexible cable in flexible conduit (heat resisting where necessary) as appropriate to the installation.

**PARTICULAR SPECIFICATIONS**

**ELECTRICAL**

**SECTION 9**

**EARTHING AND LIGHTNING PROTECTION SYSTEM**

**9.1. STANDARDS**

All earthing and bonding installation and equipment shall comply with the requirements of the IEE Wiring Regulations and BS. CP. 1013. 'Earthing'. Descriptions of earth conductors or electrode locations are intended to define the minimum standards to which the installation shall conform. Reference to the cross-sectional area of conductors in this Specification and the Specification drawings relates to the minimum size of conductors that will be accepted.

**9.2. EARTH ELECTRODES**

Earth electrodes shall be supplied and installed as required to achieve the specified resistance to earth electrode and shall consist of: an earth rod of minimum length 1200 mm and all necessary clamping and linking metalwork. The earth electrode pits shall be provided with a purpose made concrete surround and inspection cover with a permanent label engraved "Safety Electrical Connections do not remove" in English and Chichewa.

Earth rods shall be copper-bonded steel

Copper Thickness - the copper jacket shall not be less than 0.25 mm thick at any point.

Connections between building earth terminals and earth electrodes shall be by made of either:

a) P.V.C. covered 70 mm2 stranded copper conductor OR

b) P.V.C. covered 25 mm x 3 mm solid copper tape

Earthing systems for sub-stations shall be in accordance with BS CP 1013 and supplementary details where detailed in the particular specification.

**9.3. EQUIPOTENTIAL BONDING**All conduit, trunking, metal enclosures, metallic cable sheaths, the cases and enclosure of all electrical switchgear, fuse-gear, plant and equipment in each building and the like shall be so bonded as to be directly connected to the main earthing bar at the incomer position.

In situations such as bathrooms, kitchens, laundries or any situation where there is exposed metal and socket outlets or fixed appliances are installed, all metal work including hot and cold water pipes, waste pipes, metal draining boards, the casing of electrical appliances shall be effectively bonded to the earth continuity conductor so as to ensure that no difference in electrical potential can arise between these items.

Bending connections to gas and water incoming services as required by the Regulations shall be made as near as practicable to the point of entry. These connections shall be made with solid copper conductors of minimum cross section in accordance with IEE Regulations. These bonds shall be installed as inconspicuously and neatly as possible. The connections shall be visible after installation.

Bonding Conductors shall comply with IEE Regulations (15th Edition) 547-2 to 547-7 inclusive.

**9.4. LIGHTNING PROTECTIVE SYSTEM INSTALLATION**

The Contract shall include for the supply and installation of all necessary components to provide a complete lightning protective system in each of the buildings specifically detailed in the following Specification Sections in order that the building(s) may be protected against the effects of a lightning discharge in accordance with the British Standard Code of Practice No. CP.326.

Each installation shall comprise air networks connected to roof and down conductors and finally terminated in earth electrodes, via suitable test points in accordance with the details included on the attached drawings or in the following Specification Section.

From the roof network, down tapes shall be routed down to the earth pits. The down conductors shall be secured to the roof as described above for the roof conductors and where fitted on exterior wall, the down conductors shall be secured by suitable 'distance' type saddles.

Copper earthing tape laid in the ground shall be tinned and buried to a depth of 600 mm and covered with interlocking cable tiles.

No joints in either the down conductor or roof conductors, shall be allowed other than at air terminal, earth electrodes and terminal or test block positions.

The Contract shall include to ensure that at the completion of the installation the resistance to earth from each testing point does not exceed 10 ohms. The tests being carried out in accordance with Section 4 of B.S. Code of Practice No. CP 1013. The Contract shall include for the performance of these tests.

Where it found that the resistance to earth at any test point is in excess of 10 ohms, the length and number of earth electrodes shall be increased to the instructions of the Architect, in order to comply with the requirements of the above Code. The resistance of each metallic conducting path.

**PARTICULAR SPECIFICATIONS**

**ELECTRICAL**

**SECTION 10**

**STAND-BY GENERATOR**

**10.1. EXTENT OF WORK**

This Specification Section covers supply, delivery and erection, connection and testing of all materials and equipment to provide complete alternator set installation fully in accordance with BS. 5514, 1977.

The Contractor shall include for a specialist contractor to supply an alternator set and shall include in his tender the total cost for a standby diesel alternator installation. The Contractor shall include for the supply, delivery, erection, testing and handing over of alternator set detailed in the attached schedule.

The supply, installation, and connection of all necessary cables which shall be carried out by the Contractor.

**10.2. NATURE OF SUPPLY**

The normal mains supply will be at 400/230 volts, 3 phase, 4 wire, 50Hz. The output supply from the alternator set shall be identical to the normal mains supply.

**10.3. DIESEL ENGINE**

The diesel engine shall be of the water cooled type 4 stroke direct injection, water cooled Vee Formation, multicylinder, turbocharged and after-cooled, 4 cycle diesel engine. Speed governor equipment shall be to BS 5514, class A1. Two cycle engines will not be acceptable.

**10.4. ENGINE FAILURE SAFE GUARDS**

Adequate automatic fuel isolation safeguards shall be provided to protect the diesel engine in event of high cooling water temperature, high oil temperature and low oil pressure, whilst the machine is running.

In addition visual warning indication shall be incorporated in the control panel to indicate that the cooling water, oil pressure or engine speed are reaching critical conditions, the engine shall be shutdown, with the above alarm and indication still being energised. The audible alarm shall be cancelled by an operating alarm/mute switch.

A servicing switch shall be provided to select set for start locally for test running. (No plant protection in this mode).

**10.5. STARTING**

Electrical starting shall be employed for the diesel engine, the equipment comprising of a 24 volt DC starter motor.

The starter batteries shall be of the lead acid type having adequate capacity with an output of 24 volts DC, 250 Amp/Hr.

Starting shall be either automatically on the application of a signal from a sensing unit referred to later in this specification, or manually via a power switch locally on the control panel.

The set will incorporate an automatic timing device to give 3 attempts to start in 3 pulses of 40 seconds starting, and 10 seconds rest. If the engine fails to start after 3 such attempts, the starter will be isolated from the batteries and a set failure indication illuminated on the control panel.

The 'failure to start' audible alarm shall be cancelled by the alarm/mute switch.

**10.6. ENGINE INSTRUMENTATION**

The following instruments shall be incorporated in the engine mounted control panel:

Oil pressure gauge.

Oil temperature gauge.

Cooling water temperature gauge.

Hours run recorder.

**10.7. EXHAUST SYSTEM**

The Contractor shall include for the supply and erection of an efficient exhaust system for the alternator set. The system shall incorporate a primary silencer and necessary mild steel pipe, all connected to the diesel engine via a flexible length of exhaust pipe.The Contractor shall ensure that the noise levels will be maximum level 60dB NR to be achieved as listed below.

**10.8. FUEL SUPPLY**

The generator will have its own daily service fuel tank connected to a 25,000 l. fuel storage tank.

All tanks shall be provided with a fuel tank stand except bulk storage tank which is buried below ground.

Means shall be provided so that the oil supply to the diesel engine may be manually isolated for maintenance and automatically isolated when the engine is not running or when the automatic discharge system operates.

In the event of fire being detected within the generator room the fuel supply to the daily service tanks shall be automatically shut down.

**10.9. COOLING**

Diesel engine shall be of the water-cooled type, having a close circuit tropical type radiator with water circulating pump and engine driven fan.

**10.10. INMERSION HEATERS**

An immersion heater suitable for a 230 volt single phase AC supply thermostatically controlled shall be provided in the engine jacket water circuit system for operation whilst the set is not running.

**10.11.1. AUTOMATIC VOLTAGE REGULATOR**

Mounted on one side within the alternator terminal box, solid state transistorised automatic voltage regulator operating on low voltage supplied from stator winding shall be provided. Quadrature droop control circuit shall be fitted in the A.V.R. system.

A lockable voltage trim potentiometer shall be mounted on the front of terminal box.

Voltage drift shall be negligible. Voltage regulation for 100% unbalanced load shall = + 6% over full range of load, temperature and BS5514 engine speed variations.

**10.11.2 Control Items**

Individual visual indications by light emitting diodes with audible alarm and automatic shutdown for:

Low oil pressure.

High engine temperature.

Overload.

Overspeed.

**10.12. CHANGEOVER CONTACTOR PANELS**

Changeover contactor panels (C.O.C.P.) shall be provided to automatically transfer the emergency circuits throughout the various buildings to supplies provided by the standby alternator set. Contactors shall accord to the requirements of BS.775, Part 1 as far as applicable for voltages up to any including 1000 volts AC.

- Mechanically and electrically interlock the main and emergency contactors so that the two supplies cannot be paralleled.

- Prevent the emergency supply from being connected to circuits which are still healthy, although the diesel alternator has been started due to a mains failure elsewhere.

 The Generator contract shall include the supply and installation of earthing components for the Generator set which will include an earth electrode, 70mm2 single core earth cable and earth bar. Connections to the bars shall be by means of compression joints or soldered cable lugs, complete with2 x hole fixings and 2x10mm cadnimium plated set screws and nuts, spring washers and brash washers.

**10.13. EARTHING**

The Contract shall include for the supply and installation of all necessary components to provide an effective means of earthing to the generator set, with an earth bar which shall be connected to the site earthing system by means of a single core PVC cable complete with continuous green coloured PVC sheath. Unless otherwise stated, earth bars shall be in the form of 50 mm x 6 mm thick copper mounted on adequate porcelain 'egg' type insulators and rawbolts. All connections shall be spaced at minimum centres of 75 mm and each earth bar shall have 50% spare length for the connection of future conductors.

Connections to the earth bars shall be made by means of compression or soldered cable lugs complete with 2 hole fixings, and 2 x 10 mm cadmium plated set screws and nuts, spring washers and brass washers.

Where joints are necessary in strip conductors, each shall be soldered and riveted in order to ensure an electrically and mechanically continuous joint.

Earth conductors installed outside the buildings shall be in the form of copper tapes or cables in accordance with the attached drawings and/or Specification Sections and be adequately protected against corrosion.

Solid copper strip or cable earth continuity conductors installed on the surface of walls shall be fixed by means of brass or copper two hole fixing saddles. All strip or stranded cable coloured conductors shall be complete with continuous green PVC sheath unless otherwise indicated.

Where earth electrodes pass through, or are set into structural concrete rafts, the hole so formed shall be adequately sealed to prevent the ingress of moisture.

**10.14. TESTING**

The following tests shall be executed under the Contract in the presence of the Architect as detailed in the I.E.E. Regulations:

 Insulation to earth and between phases.

 Polarity.

 Earth conductor continuity.

 Earth bonding.

 Line - earth loop impedance.

 Earth electrode resistance.

Full load test (1 hour). During this test, voltage and current readings at the final sub-circuit, sub-main and main intake positions shall be taken.

**PARTICULAR SPECIFICATIONS**

**ELECTRICAL**

**SECTION 11**

**RADIO INSTALLATION**

**11.1. PRIVATE RADIO COMMUNICATION SYSTEM**

(i) A Private radio communication system consisting of a Base Radio, various mobile radios and ancillary equipment shall be installed at each Border Post.

Each UHF and VHF aerial shall be provided with mast-head signal amplifiers located within 5 metres (maximum) of the mast head. From these amplifiers, non-deteriorating low loss co-axial cable shall be routed to the outlets via main amplifiers (located in the control room level 1 adjacent to the main entrance/telephone room).

Down stream localised signal booster amplifiers shall be provided as necessary to the distribution, these shall amplify the incoming signal to a suitable level to ensure the correct signal level at each television outlet.

The cables shall be run in trunking and conduit and they shall be screened suitable for sharing the trunking compartment with other extra low voltage services such as radio, clocks.

(ii) Radio Distribution

From the roof mounted FM and AM aerials, co-axial cable shall be routed to the main radio console located with the main TV amplifiers. From the radio console output, double star quand (100 volt) shall be routed to bedhead units and independent loudspeakers via matching transformers (4 to 7 volts) and loud-speaker control units respectively.

The radio and sound cables shall be routed in trunking and conduit similar to the TV cabling.

The background music speakers shall be provided with either combined or independent volume control as indicated on the drawings.

2 No. microphones complete with speech override switches shall be provided (one per Reception desk) for public announcements in the Main Entrance Waiting areas.

The microphones shall be arranged to override the General background music via a change-over relay mounted on the back of each Waiting Area Loudspeaker.

**11.2. PROTECTION AGAINST LIGHTNING**

The TV and radio antenna shall be equipped with a surge arrestor to ensure lightning strike is diverted to earth via lightning conductor system and not the co-axial cable.

**PARTICULAR SPECIFICATIONS**

**SECTION 12**

**ELECTRICAL**

**TELEPHONE PABX AND WIRING INSTALLATION**

**12.1. STANDARDS**

The PABX equipment shall be adaptable (with minimum modifications) for the changes anticipated in the Telecom Organisation ( GTO's ) national network, (EWSD exchanges) with the possibility of incorporating CCITT Nº 7 signalling.

**12.2. SPARES**

As detailed list of spares to be provided shall be submitted to the Architect for approval.

**12.3. GUARANTEE**

The Contractor shall guarantee the PABX and associated equipment to the satisfaction of the Architect and the Telecom Organisation for a minimum of one year after completion of the installation. In addition to the above the supplier shall guarantee the supply of spares for a period pf 10 years.

**12.4. TRAINING**

The Contractor shall provide training for the Client..

This shall include for both classroom and on site practical training for maintenance and running of all equipment plus the general use/operation of the system.

The Contractor shall be responsible for organising and inviting the user client and the GTO to the training sessions.

**12.5. COMMISSIONING**

The Contractor shall be responsible for commissioning the telephone system in the presence of the Architect.

**12.6. TRAFFIC**

The Contractor shall state the equipment traffic carrying capacity per line.

**12.7. COMPATIBILITY WITH PUBLIC EXCHANGE**

The equipment offered must be suitable for connecting to the Public network.

The equipment offered will incorporate a computer interface and a paging system interface.

**12.8. APPROVAL**

The exchange equipment shall be approved by the State Telephone Authority for connection to the Public Network and for handing over after installation. If the approval is conditional pending operational experience, this must be clearly stated in the suppliers offer.

**12.9. SIZE OF EXCHANGE**

Extensions

Circuitry shall be provided for 600 extensions.

**12.10. OPERATORS' CONSOLES (**COMPUTER BASED)

1 Operator console shall be provided. The Contractor shall satisfy himself that the distance between console positions and exchange position is well within the capabilities of the system.

**12.11. TELETYPEWRITER**

A management control teletypewriter shall be provided.

**13.12. POWER SUPPLY**

A suitable power supply to operate the exchange will be provided, but a standby Generator Supply sufficient to provide power for 6 hours shall will be available.

**12.13. PHYSYCAL SIZE**

The Contractor shall include floor loading requirements for the equipment room, room layouts and equipment heat dissipation in his tender. (Refer to drawing).

**12.14. TRAFFIC HANDLING**The system shall be engineered to the requirements of the State Telephone Authority.

Total erlang capacity average figure to be used.

The exchange shall be capable of extension to a capacity of 600 extensions with the same quality of service as above.

**12.15. SIGNALLING**

**12.15.1. PABX/Extension Signalling**

The PABX shall be able to operate in the following modes:

1. Multi-frequency signalling to CCITT recommendations for push button telephone units.

2. Signalling for data transmission terminals attached to extensions.

 Initially, all extensions shall be push button.

**12.15.2. PABX/Public Exchange Signalling**

The PABX shall be loop disconnect DC signalling.

**12.15.3. Call Control**

Control shall be used with a centralised mini-computer or distributed microprocessor.

**12.15.4. Other Modes Required by the Engineer**

PARTICULAR SPECIFICATIONS

MECHANICAL

SECTION

1.- STANDARDS AND METHODS OF FIXING

2.- PIPEWORK INSTALLATION

3.- AIR CONDITIONING AND VENTILATION

4.- INSPECTION, TESTING, COMMISSIONING

5.- DOMESTIC WATER SERVICES

6.- SOIL, WASTE, VENT AND RAINWATER PIPES

7.- LABORATORY WASTE INSTALLATION

8.- SANITARY APPLIANCES

9.- BOREHOLE SITING AND DRILLING

10.- SOLAR SERVICES GENERAL

11.- FIRE SAFETY AND PROTECTION

PARTICULAR SPECIFICATIONS

**MECHANICAL**

**SECTION 1**

**STANDARDS & METHODS OF FIXING**

**1.1 GENERALLY**

Materials and products shall comply with the following:

(a) This Specification;

(b) Government Rules;

(c) Municipality Bylaws and Regulations;

(d) Water Supply Authority's requirements;

(e) Any other Special Licensing Authority's requirements;

(f) Appropriate British Standard Specification and Codes of Practice;

Revisions or alterations to the above standards and regulations that are published during the installation of the work shall be brought to the attention of the approval authority. The appropriate instruction may then be issued.

All costs associated with charges made by any authority approving any part of the Contract Works shall be included.

**1.2. SUITABILITY OF MATERIALS AND PRODUCTS**

Materials and products shall be supplied to suit the temperatures and other conditions normally expected to apply during transit, storage and installation periods and after the installation is completed, and also to withstand any test specified herein or in any document referred to herein.

Materials and products shall not support bacterial life and be proof against attack by insects and vermin. Animal hair must not be used in acoustic or sound deadening materials.

**1.3. STANDARDISATION**

Equipment shall be standardised throughout the installation where possible.

**1.4. LABELS**

All identification labels, duty labels, instruction and safety labels for electrical equipment and cables shall be in English or French.

**1.5. METHODS OF FIXING**

**1.5.1. General**

The size of bolt or screw used must be the largest permitted by the diameter of the hole in the equipment to be fixed.

All screws and bolts shall be standardised.

For fixing in block and concrete, holes of correct size for screws or bolts shall be neatly drilled with tungsten carbide tipped twist drills to a depth (excluding plaster thickness) equal to the length of plug to be used. The plug length must be correct for the screw. Fixings shall not be made between joints in blockwork.

Unless otherwise specified all fixing screws in blockwork and concrete shall be 38 mm long.

Conduit boxes shall be fixed by two roundhead screws.

Countersunk screws shall only be used where countersunk holes are provided, otherwise the wood screws shall be roundhead and set screws shall be cheesehead. Where holes have to be drilled for fixing No. 10 wood screws shall be the minimum size used.

**1.5.2. Lightweight and Heavyweight**

Dependent upon size of fixing holes provided in the equipment, all fixings in blockwork and concrete shall be by woodscrews and suitable plugs or mild steel bolts of the grouted type or by one of the various type of expanding rawbolts. Fixing to timber shall be by means of wood-screws or coach screws.

**1.5.3. Fixing to Metalwork**

Fixing to light gauge metal inaccessible at the back shall be by means of shakeproof self-tapping screws or rawlplug spring or gravity toggles.

Fixings to supporting metalwork shall be made where possible, by means of setscrews or bolts and nuts of appropriate size for the equipment, holes being drilled of correct size. Each bolt and setscrew shall be fitted with a plain washer and a shakeproof washer under the nut. Where it is not possible to fit a nut, a tapped hole shall be provided, the plain and shakeproof washers being fitted under the bolt head.

No fixings shall be made to structural steelwork without approval.

All brackets for supporting trunking or bus-bar trunking shall be made from mild steel, and unless otherwise specified, the brackets shall be fabricated from 38mm x 6mm minimum flat bar. All brackets shall be cleaned and painted before erection.

**PARTICULAR SPECIFICATIONS**

**MECHANICAL**

**SECTION 2**

**PIPEWORK INSTALLATION**

**2.1. GENERAL**

This section of the Specification shall apply to all pipework installations serving the various systems.

Materials and workmanship generally shall be of the highest standard and the Specification shall be closely adhered to.

No substitution of specified materials or equipment will be permitted without approval. Such approval will only be given if it can be demonstrated that the delivery of the specified equipment is such that it would affect the general progress of the works or if other special circumstances arise.

Where materials or equipment are not described in detail they shall be of the best quality available and shall comply with the appropriate BS. The Sub-Contractor shall, if required, submit drawings or samples of such materials or equipment to the Supervisor’s Representative for his approval before use on the Sub-Contract works.

**2.2. MILD** **STEEL PIPEWORK AND FITTINGS** **GENERALLY**

All tubes shall be of uniform thickness within the manufacturing tolerances as stated in the appropriate British Standard and shall have a concentric bore throughout.

All pipework shall be free from rust and without any signs of scaling, pitting or weathering to the satisfaction of the Supervisor’s Representative.

All pipework shall be supplied with varnished finish and each length must have at least one coloured identification band when delivered.

All tubes shall be supplied in straight lengths of not less than 5.50m long.

When screwed pipes are required they shall be supplied with at least one socket for each length fitted and threads not fitted with sockets shall be fitted with protectors during transit.

Where welded pipes are required they shall have ends bevelled for welding and fitted with protectors during transit.

All cuts from standard lengths of pipe shall have burrs and swarf removed and ends trimmed square.

Where pipes are held in vices, as when screwing, care shall be taken to ensure that the pipe surface is not damaged. Any pipework so damaged shall not be fitted.

Where the tube is galvanised, care shall be taken to ensure that threads are carefully cut so that the number of exposed threads is minimised. Steel exposed shall be painted with suitable galvanising paint immediately upon fabrication.

Screwed pipework joints shall be made using an approved jointing compound and cleaned off when joint has been made and shall comply with the provisions of BS 21: 1985.

Welded steel fittings shall be to BS EN 102531 : 1999. Screwed fittings shall be best quality malleable iron beaded and easy sweep pattern no BS 143 & 1256 : 2000. Where fittings are connected to light or medium weight pipework they shall be "medium" quality and where connected to heavy weight pipework they shall be "heavy" quality.

Long sweep bends and sweep tees to BS EN 102531:1999. and BS 1640 1:1962 shall be used throughout, except on drain points or air venting points, where square tees shall be used. Long screw connectors and bushes shall not be used under any circumstances. Elbows shall be used only with prior written approval of the architect.

The use of fire or cold pulled sets or bends shall be employed wherever possible on 65mm pipes nominal bore and over up to a bend of 45 degrees from the straight. Above this angle welding fittings or purpose made factory sets shall be used.

On tubes 50mm nominal bore and below the maximum use of bending shall be made.

In all cases, bends shall be carefully formed so that there is no distortion of the tube, no undue thinning of the tube wall or ovality, and no damage to the structure of the steel.

All branches off mains shall be of the easy sweep type, where the size of the branch off the main is outside the range of branch bends available, the branch shall be formed from piping carefully formed to an easy sweep.

Where mild steel pipework is specified to have welded joints, then branch welding will be permitted as detailed in the table below. On all other combinations of mains and branch sizes made fittings only shall be used.

 Main Size Branch Size

 25 mm or above Up to 15 mm permitted

 32 mm or above Up to 20 mm permitted

 40 mm or above Up to 25 mm permitted

 50 mm or above Up to 32 mm permitted

 65 mm or above Up to 40 mm permitted

 80 mm or above Up to 50 mm permitted

 00 mm or above Up to 65 mm permitted

 125 mm or above Up to 80 mm permitted

 150 mm or above Up to 100 mm permitted

Holes cut into the main for these branches shall be carefully shaped so that there is no restriction to the flow of the water in the main or branch.

Welding shall be carried out in accordance with BS 2640 : 1982 or BS 2971 : 1991 as appropriate to the pipework material - see "Welded Pipework" clause elsewhere in this section of the Specification.

Reducing pieces shall be of the concentric or eccentric type on vertical pipes, but shall be of the eccentric type only on all horizontal pipes and shall be arranged for draining and/or venting as applicable.

Concentric and eccentric reducing pieces shall be seamless steel butt welding fittings or malleable iron fittings for the appropriate grade of pipework.

Unions shall consist of two screwed halves with ground spherical faces joints between the faces. These shall be fitted where necessary to facilitate maintenance in addition to those required for erection purposes.

Flanges shall be provided at or near to all components, plant or equipment, articulated expansion joints, where required for cold draw and to facilitate maintenance and erection.

**2.3. COPPER PIPEWORK AND FITTINGS GENERALLY**

All copper pipework supplied for site for use on this project shall be stamped with the BS kite mark. Copper tube not carrying the BS kite mark shall not be used.

All copper tubes shall be of uniform thickness within the manufacturing tolerance and shall have concentric bore throughout.

All tubes shall be supplied in straight lengths of not less than 5.5m long.

All cuts from standard lengths of pipe shall have burrs and swarf removed and the ends trimmed square.

Where pipes are held in vices care shall be taken to ensure that the pipe surface is not damaged. Any pipework so damaged shall not be fitted.

Where pipework is specified to have welded joints then branch welding will be permitted as detailed in the below. On all other combinations of mains and branch sizes factory made fittings only shall be used.

 Main Size Branch Size

 42 mm or above Up to 15 mm permitted

 54 mm or above Up to 22 mm permitted

 67 mm or above Up to 28 mm permitted

 76 mm or above Up to 35 mm permitted

 108 mm or above Up to 42 mm permitted

 133 mm or above Up to 54 mm permitted

 159 mm or above Up to 67 mm permitted

All reducing sockets shall be eccentric and arranged for drainage and/or venting as applicable.

Where pipework is specified as having bronze welded joints, approved welding rod alloys conforming to BS EN 1044 :1999 and weldable fittings suitable for BS EN 12451 : 1999 copper tube shall be used.

Where silver brazing is specified, brazing alloys shall be used in accordance with BS 1845.

Where pipework is specified as having capillary joints capillary type fittings with integral silver solder rings to BS EN 1254 2:1998 Part 2 shall be used.

Where pipework is specified as having compression joints compression fittings to BS EN 1254 2:1998 Part 2 shall be used.

Long sweep bends, twin elbows, sweep tees shall be used throughout, except on drain points or air venting points where square tees shall be used. Sets and bends shall be, wherever practicable, formed by means of bending machines but care shall be taken with fabrication to ensure the full circular bore of the pipe is maintained and that no thinning of the metal takes place on the outside wall or creasing on the inside wall of the pipe. Where a connection is made between a copper tube and a ferrous appliance, the connection shall be made by means of a special purpose made connection or an insulated joint with a rubber or vulcanite ferrule and washer or a similar type of connector.

**2.4. LABORATORY WASTE**

Pipework shall be installed in polypropylene with mechanical joints.

**2.5. UNPLASTICISED PVC PIPES**

UPVC pipes used in the installation shall be obtained from one manufacturer and not mixed with those of other manufacturers. The pipes shall conform to BS EN 1452 1 :2001 Class E for pipes up to and including 25mm nominal bore and Class D for pipes over 25mm nominal bore.

**2.6. UNPLASTICISED PVC PIPES: JOINTS**

Solvent welded joints to pipes and fittings shall be made in accordance with the printed instructions of the fitting manufacturer. Joints shall be cleaned of all surplus solvent immediately after setting.

The threaded ends of UPVC fittings shall be jointed with PTFE fittings only.

UPVC socket unions shall incorporate rubber 'O' rings.

Flanges for use with UPVC pipes shall be stub type with galvanised steel backing flange. Joints between the stub flanges and the UPVC pipe shall be solvent welded.

Adequate time shall be allowed to elapse after completion of the last joint and before filling with water.

**2.7. DRAINS, OVERFLOWS AND WARNING PIPES**

Drains pipework shall be provided from:

a) Pump glands and drip trays comprising a short length of pipe cut with a splay end and turned over a tundish with a 25 mm pipe connection carried to the nearest gully.

b) Cooling coil condenser connections comprising a suitably deep "U" trap with pipe connections to the nearest gully.

Overflows and warning pipes shall be provided from all cold water storage tanks as indicated on the drawings.

All drains overflows and warning pipework shall be copper to BS EN 12451 : 1999. All pipework shall be welded and have plugged crosses at any change of direction for cleaning purposes.

All pipework shall be adequately supported and free from vibration and electrolytic action.

Tundishes shall be manufactured from light gauge copper with welded joints and fitted with hinged lids. The outlets shall be of adequate diameter to pass the maximum flow of water.

**2.8. SCREWED PIPE JOINTING**

Screwed jointing on pipework shall be made in accordance with the provisions of BS 21:1985. Where tube is galvanised care shall be taken to ensure that threads are carefully cut so that the number of exposed threads is minimised.

All joints shall be clean threaded, pulled up tightly and made with approved jointing compound and/or PTFE tape.

After joints have been formed all surplus hemp shall be cut away and joints wiped clean.

**2.9. WELDED PIPEWORK**

The Sub-Contractor shall issue three copies of the current welding certificates for each of the welding operatives to the Supervisor’s Representative. Under no circumstances will uncertified welders be employed on the project. The operatives shall be fully experienced in the class or work to be undertaken.

Steel piping of 50 mm bore and below shall be oxyacetylene welded.

Steel piping of 65 mm bore and over shall be electric arc welded.

Oxyacetylene welding shall conform to BS 2640 : 1982, Class II, Oxyacetylene Welding of Steel Pipelines and Pipe Assemblies for Carrying Fluids.

Electric arc welding shall conform to BS 2971 : 1991, Class II Metal Arc welding of Steel Pipelines and Pipe Assemblies for Carrying Fluids'.

If requested by the Supervisor’s Representative samples of the filler rod or electrodes to be used shall be submitted for approval before any work is commenced on site. The Sub-Contractor shall make arrangements for the dry storage of filler rods and electrodes to prevent deterioration.

Where tack welds are used to secure alignment there shall be four equally spaced around the circumference to the pipe. Each tack weld shall be of the same quality as the final weld. With full penetration at the throat or vee or fillet and of a length equal to twice the pipe thickness. Tack welds shall be examined visually for defects by the welder and if found defective, they shall be removed completely.

Copper pipe welds shall be made by qualified welders using a bronze welding or silver brazing technique. Joints may be performed by swaging and a neat join made, or by using welding fittings of approved pattern. All traces of flux shall be removed after the weld is formed. Bronze welding shall conform to the requirements of BS 1724 : 1990.

**2.10. WELDERS QUALIFICATION TESTS**

These tests shall be completed to the satisfaction of the Supervisor’s Representative by all welders employed on all services.

The purpose of the welder's qualification test is to determine the ability of welders to make sound and acceptable welds. Before any site welding on the Sub-Contract is performed each welder shall carry out the tests required.

A welder shall qualify for welding by performing a test on two full diameter pipes covering the range of diameters required in the Sub-Contract. Each test shall be completed in a reasonable time in relation to the process used.

Before starting the qualification tests the welder shall be allowed reasonable time to adjust the welding equipment used in the test.

Under no circumstances shall the Sub-Contractor employ a welder on the Sub-Contract wither on or off site welding operations other than those for which he is qualified.

Copies and records of all test reports shall be promptly given to the Supervisor’s Representative.

**2.11. STEEL PIPES**

Each test shall be carried out to comply with the requirements of BS 4872, Part I, 1982, or alternatively the test procedures laid down in BS 2640 and BS 2971 for steel pipes.

Each test piece shall also be examined to check that proper penetration of the weld through the thickness of the tube has been obtained. No serious excess penetration should be present resulting in obstructions to the bore of the pipe. The alignment of the tubes at the specimen weld junction should be accurate and the pipe ends must be set up with an equal gap, suited to the welding process and correctly aligned.

Both of the re-tests must be successful for the welder to be granted a welder's qualification for the work required in this Section of the Specification.

**2.12. COPPER PIPES**

The tests on bronze welded joints shall be to BS 1724, 1990, and shall consist of visual examination and micro examination of polished sections.

The test specimen shall be made with a weldable fitting to a pipe having length twice the weldable fitting, but not less than 100 mm long. The test specimen shall be cut through the joint and suitably prepared and polished.

The test specimen shall show satisfactory penetration, adhesion and freedom from porosity. If found to be unsatisfactory two additional welds made by the same welder shall be selected and retested.

Both of the retests must be successful for the welder to be granted a welders qualification for the work described in this Section of the Specification.

**2.13. DESTRUCTIVE TESTING OF WELDS (FOR LOW PRESSURE STEEL PIPEWORK)**

On all steel water pipelines subjected to low pressure only (not exceeding 6.2 bar gauge and 120ºC.) destructive tests shall be made.

Destructive testing shall consist of the removal of up to 2% of all sizes of completed welds, the sectioning of them into specimens and the examination of the specimens. The specimens shall be prepared to meet the requirements of welder’s qualification by destructive testing as previously described. The Supervisor’s Representative shall have the right to accept or reject any weld not meeting the requirements of the method by which they are inspected. The welder who makes a weld that fails to comply with the requirements may be disqualified from further work on this contract. All destructive weld tests shall be carried out under site conditions in the presence of the Supervisor’s Representative. A minimum of two welds per welder shall be selected at random for destructive testing by the Supervisor’s Representative.

**2.14. RECORDS OF INSPECTION AND TESTING**

Full records shall be kept, and a copy sent promptly to the Supervisor’s Representative showing details of each inspection, with the radiographic and ultrasonic recordings and the name of the welder.

The results of all tests on the Sub-Contract welding work shall be given to the Supervisor’s Representative on the site not more than 24 hours after each test is carried out.

The inspector shall clearly state all the faults found in each test specimen. Where the Inspector finds the faults exceed the requirements of this Specification he shall reject the weld as a whole or only part of the weld, where he considers repair may be affected. Where such repairs are called for the Inspector shall identify the part of the weld that shall be removed and replaced on each individual joint.

Each area inspected by radiographic or other means shall have a serial number and a means of location identification permanently stamped on. The stamping shall be as light as possible. These symbols shall be reproduced on the corresponding radiographs on recordings placed to coincide with the permanent markings.

The position and quantity of such marking shall be sufficient to identify the position of every defect which may appear on the radiographs or ultrasonic recordings.

**2.15. ERECTION OF PIPEWORK**

Pipework shall be graded to ensure adequate draining and venting. Draining and venting facilities as detailed in this Specification shall be fitted at all low and high points respectively and wherever else necessary to ensure that all sections and subsidiary sections can be drained and no air locks can form.

The gradients shall be appropriate to the service as follows unless otherwise stated on the drawings.

Service Gradient

Cold Water, Chilled Water and Fire Mains 25 mm in 12 m

For detailed specification of draining and venting, see the Specification Section for the Service concerned.

All piping shall be erected to present a neat and orderly appearance, arranged parallel to or at right angles to structural members of the building and to give maximum headroom and fitting in with the work of other Sub-Contractors. All pipe drops shall be plumb. No joints shall be formed in the thickness of walls, floors or ceilings. It shall be the responsibility of the Sub-Contractor to ascertain the thickness of plaster and other wall finishes, skirting heights, sill heights and floor finishes. Pipework shall generally be set around all piers and columns and shall follow the contours of the building whether so indicated or not.

All pipework valves, fittings and equipment forming the piping installation shall be erected so that it can be dismantled and is accessible for repair and replacement.

Unions or flanges shall be provided at valves and equipment so that they can be dismantled. Flanges or unions shall be provided at not greater than 30 m intervals.

Bends, springs and off-sets shall be formed by use of an efficient bending machine or fire sets. Fire sets shall not be employed on galvanised tube. Copper tube may have its bends, springs and off-sets formed with springs.

The use of fire or cold pulled bends is permitted providing that there is no distortion, undue thinning of the pipe well, ovality or any damage to the metallic structure of the metal.

All terminal and branch connections to equipment shall be arranged with dirt pockets and drain cocks at low points.

Reducing fittings of horizontal pipe runs shall be eccentric type to suit air venting and draining.

A clearance of 150 mm shall be maintained between gas pipes and electric cables conduits etc.

Where it is specified that pipework, fittings or equipment shall be insulated, the Sub-Contractor shall ensure that the setting out makes due allowance for insulation as specified in the Thermal Insulation Section of the Specification.

**2.16. PIPE AND SERVICES SUPPORTS**

All pipework shall be supported by means of clips, hangers etc., or in the manner and positions indicated at intervals not exceeding the following:

 Steel Copper

 Nominal interval Nominal Interval

 Bore (Metre) Bore (Metre)

 Vert. Horiz. Vert. Horiz.

 15 mm 2.5 2.0 15 mm 2.0 1.2

 20 mm 2.5 2.0 22 mm 2.5 1.5

 25 mm 3.0 3.0 28 mm 2.5 2.0

 32 mm 3.0 3.0 35 mm 3.0 2.5

 40 mm 3.0 3.0 42 mm 3.0 2.5

 50 mm 4.0 3.5 54 mm 3.0 2.5

 65 mm 5.0 3.5 67 mm 3.5 3.0

 80 mm 5.0 4.5 76 mm 3.5 3.0

 100 mm 5.0 4.5 108 mm 4.0 3.0

 125 mm 5.0 4.5 133 mm 4.5 3.5

 and over 6.0 6.0 and over 5.0 4.5

Ductile iron pipework shall be supported at the recommended manufacturer’s interval.

In the event of two or more pipes being carried by a single support the spacing shall be for the short the intervals. No more than two pipes may be supported from a single drop rod support. Double hanging of pipes with unequal expansion movement due to different service temperatures shall not be permitted.

All supports for mild steel pipes and fittings shall be ferrous as indicated and/or specified herein.

All supports for copper pipes shall be either of brass construction or nylon coated steel. Where brass supports are used, these shall be polished where exposed and rough finish elsewhere. It shall be the responsibility of the Sub-Contractor to ensure that all supports are adequate, firmly and truly fixed, and that they do not transmit vibration.

The Sub-Contractor shall provide and install all fixings to the structure or cast in support channels where provided, to carry the brackets, clips, hangers, etc, etc., for the various services.

All pipework shall be supported by substantial brackets, hangers, or clips of approved type. The layout of piping shall take into account expansion and contraction, particularly at ends of runs where changes of direction occur. Main walls or partition walls etc., where pipes pass through sleeves shall not be considered as pipe supports.

Care shall be taken to ensure that the axis of the pipe is parallel with the axis of the pipe ring or hanger. No structural steel shall be drilled unless the Supervisor’s Representative approval has first been obtained.

Pipes shall have sufficient clearance for the proper application of the insulating material where necessary. The finished surface of any covering shall be at least 25 mm from walls etc., and bare pipes shall be at least 75 mm clear from walls etc. Clearance between adjacent insulated pipes shall be at least 25 mm.

Ferrous pipes where hung supported shall be provided with purpose made mild steel brackets consisting of mild steel drop rod screwed at one end with a hemispherical washer and double hexagon nut. The other end shall be formed into a close welded eye to receive the bolts of a band clip around the pipe. Sufficient clearance shall be allowed on the band clip to allow it to be bolted tightly to the pipe and yet be free moving at the eye of the rod.

Drop rods shall be of adequate strength for the load imposed and a minimum diameter of 10 mm. For vertical pipework munsen rings (10 - 50 mm) or block 'U' bolts (65 - 100 mm) shall be used in lieu of band clips. Above 100 mm purpose made slide guides and spring supports shall be provided. In service subways, trenches and where indicated the Sub-Contractor shall supply and install all supports, bearers, PTFE pads and supporting steel frames.

Supports for copper pipes shall generally be as steel but with pipe clips of either brass construction or nylon coated steel.

The Sub-Contractor shall include for all necessary steelwork required to span between beams to provide intermediate hanger supports for piping. Where fixing are made to any structural steelwork galvanised girder clamps shall be used.

Supports for insulated pipes on chilled water lines shall be arranged so that there is no penetration by metal of the pipe insulation. In addition precautions must be taken to preserve an un-fractured vapour proof skin at these joints. Two half sections of high density phenolic foam (120 Kg/m3) to fit the pipes and of correct thickness to suit the insulation shall be used at all support positions. The joints between the high density phenolic foam and the insulation shall be chamfered and trowelled in with a mastic compound.

In false ceilings and concealed areas the vapour barrier shall be maintained under band clips by ensuring the outside surface of the high density phenolic foam is vapour seal treated and an adequate overlap minimum 40 mm provided on either side of the band clip to allow for sealing and continuing the vapour barrier.

In exposed areas and where metal clad pipework insulation finish is provided the vapour barrier shall be over the band clip to ensure a concealed and straight line finish appearance.

Where insulation is penetrated by heat conducting materials then the insulation shall be carried far enough over such material to avoid condensation.

Spring supports for thermal movement shall be fitted where indicated and/or wherever a pipe turns to the horizontal plane after a vertical rise. The spring supports shall be of such number and type so as to completely support the pipework during its full movement. They shall be approved by the Supervisor’s Representative.

All valve trains shall be installed at low level, except where indicated and the Sub-Contractor shall provide suitable ladder type Supporting framework.

Bases for air handling units, boiler, calorifers etc. shall be suitably extended to allow adequate fixing of valve train framework. Where no suitable base is available for extension separate bases shall be provided.

**2.17. PIPE SLEEVES**

Where pipes pass through walls, floors, footings and waterproof membranes, the Sub-Contractor shall provide sleeves and Supervisor’s attendance and instruction at the building in of such sleeves to ensure the sleeve is correctly positions and concentric with the pipe diameter.

Where sleeves penetrate structural floors, cavity barriers and fire compartment walls the gap between the pipe and the sleeve shall be firmly caulked by the Sub-Contractor with caulking rope or any other approved material.

The inside diameter of sleeves shall not be less than 15 mm larger than the outside diameter of the pipe except where pipes pass through bearing walls or footings where sleeves shall be sized to allow for structural movement and 15 mm clearance from the outside diameter of the pipe.

The diameter of the sleeves for chilled water pipework shall be such that adequate clearance between the pipe and the sleeve will enable the insulation to be carried through the sleeve.

Sleeves in bearing walls or footings shall be cast iron pipe. Sleeves in walls, floors, ceilings and partitions shall be of the same metal as the pipe.

Sleeves shall protrude not less than 2 mm and not more than 4 mm proud of the finished surface.

Flashing sleeves shall be provided where pipes pass through waterproofing membranes. Flashing sleeves shall be provided with an integral flange to which a flashing shield can be clamped or welded. The shields shall be in zinc and shall extend no less than 200 mm from the sleeve in all directions.

The Sub-Contractor shall make the shield into the membrane and shall fill the space between the sleeve and pipe with flexible water-proof material and mastic compound.

**2.18. FLUSHING OF PIPEWORK SYSTEMS**

Prior to the chemical cleaning or treatment of any pipework system the entire system, sectionally or as a whole, shall be subjected to a fullbore rapid flush to ensure the complete removal of any loose foreign material. This shall also apply to pipework systems where chemical cleaning is not called for. Flushing shall be carried out without circulating water through any filter, pump, coil, heat exchanger etc., and the Sub-Contractor shall be responsible for providing temporary by-pass connections where necessary to enable this to be achieved. The Sub-Contractor shall also be responsible for providing temporary fill and drain points on each system and for making whatever temporary arrangements that may be necessary to have adequate raw water available at the fill points and for the removal of flushing water from the drain points.

Temporary drain points for flushing shall not be less than 65 mm diameter in pipework, of 65 mm nominal bore or larger and pipeline size in pipework of less than 65 mm nominal bore.

If flushing of a system is carried out on Sectional basis, it shall be done in such a manner that foreign material cannot be introduced into a section of pipework already flushed.

The entire flushing operation of a system shall be carried out to the satisfaction of the Supervisor’s Representative.

**2.19. CHEMICAL TREATMENT**

Chlorination

The Sub-Contractor shall allow for all new mains and tank cold water pipework storage cisterns/tanks and any existing supplies where affected by the works, to be sterilised before being put into operation by the water undertaking, or alternatively by an approved specialist who shall be informed of all conditions relating to the Sub-Contract and whose works shall be co-ordinated with the remainder of the Sub-Contract, to ensure a complete working installation.

Mains water supplies shall be sterilised first, followed by cisterns and/or tanks and finally tank water distributions. Prior to sterilisation the systems shall be flushed out to remove dirty water, debris etc.

Storage cisterns/tanks and distributing pipes shall first be filled with water and be thoroughly flushed out. With all draw-off taps closed, the cistern/tank shall be refilled with water, and sufficient sterilising chemical shall be added during filling to ensure that when full the cistern/tank contains water having a concentration of 50mg/litre of chlorine in the solution. The sterilising chemical shall be prepared in accordance with the manufacturer's instructions. The supply to the cistern/tank shall then be stopped and all the draw-off taps on the distributing pipes shall be opened progressively, working away from the cistern/tank. Each tap shall be closed when the water begins to smell of chlorine. The cistern/tank shall then be topped up with water and sufficient sterilising chemical to give a concentration of 50 mg/litre chlorine. The cistern/tank and pipes shall then remain charged for 24 hours, where upon the systems shall be thoroughly flushed out and refilled and a test made for bacterium and residual chlorine. If satisfactory a repeat test will be arranged by the Supervisor’s Representative and if this test proves unsatisfactory the Contractor shall re-sterilise the system at his own expense.

All works involved in sterilisation, including water undertaking charges, are to form part of the subcontract Works.

**2.20. PREVENTION OF DIRT ENTERING PIPES, VALVES, ETC.**

The Sub-Contractor shall guarantee that all pipes, valves, fittings, etc., are free from corrosion and internal obstruction. Pipework showing signs of corrosion shall not be fitted.

Special care shall be taken to prevent dirt and rubbish entering the open ends of pipes during erection. Wrought iron screwed caps or plugs, or plastic covers only shall be used. Wood, rag or paper plus shall not be used. Failure to comply with this instruction shall mean that the Supervisor’s Representative shall have the right to order the pipework to be dismantled for as far as considered necessary and the pipework to be cleaned internally. Such work shall be carried out by the Sub-Contractor and all cost shall be borne by the Sub-Contractor.

The Sub-Contractor is reminded that a valve fitted to the open end of a disconnected pipe is not considered satisfactory to prevent the entry of rubbish. The open end shall be capped, or plugged or crimped.

**2.21. VALVES AND COCKS**

All valves and cocks shall be generally as described and of first class quality and be of the types hereafter specified. They shall comply with the requirements of the appropriate Water Authority.

All castings shall be clean close-grained metal free from rough projections. Unless otherwise specified valves of 50 mm nominal bore and under shall have ends screwed to BS 21 : 1985 female threads and valves 65 mm nominal bore and over shall have flanged ends.

Screwed valves shall have heavy hexagon reinforcements at openings, threads of ample length and heavy shoulders to prevent over entry to pipes. Flanged valves shall have the flanges flat faced and of thickness conforming to the appropriate specifications and drilled.

All valves must have the maker's name or trade-mark cast or heavily stamped or rolled on. Valves not bearing these distinguishing marks will be rejected.

Each valve must be made easy to operate before being installed. Regulating and isolating valves shall be fitted where indicated and all incoming mains into plant-rooms and at all other points throughout the installation necessary to permit proper isolation and regulation of plant and primary and secondary mains.

All valves shall be suitable for the temperatures and test and working pressure of the system in which they are installed.

**2.22. DOMESTIC, COLD WATER DOWN SERVICE AND COLD WATER RISING MAIN VALVES**

a) Stopcocks

Shall be of the screw down pattern gunmetal construction in accordance with BS 1010 2 : 1973 with pinned jumper and gunmetal or brass spindle with crutch head and union connection up to 54 mm and flange connection above 54 mm.

b) Ball Float Valves

Unless otherwise specified ball valves shall be of bronze or gunmetal construction with flanged connections manufactured in accordance with BS 1212 1 :1990 Part 1 and having a bronze or gunmetal seat, lever and plastic float conforming to BS 2456 :1990.

Where required ball valves of the delayed action type shall be provided generally as above and complete with hydraulic delay subsidiary tank and bottom float. Galvanised mild steel supports shall be provided to the valve manufacturer’s recommendations.

The ball valves shall be suitable for the particular pressure requirements at the point of discharge.

c) General Valves

The type of valves shall be as dictated by the position in which the valve is to be located, and the service requirements.

Full way gate pattern valves 54 mm diameter and below shall be bronze or gunmetal construction in accordance with BS 5154 :1991 solid wedge disc, non-rising stem, and having either integral solder ring capillary ring union ends, or compression ring joints in accordance with BS EN 1254 2 1998.

Full way gate pattern valves above 54 mm diameter shall be cast iron construction in accordance with BS 5150 :1990 with bronze trim, non-rising stem. inside screw, wedged disc, and having flanged ends to BS 4504 3.1 : 1998.

Bronze or gunmetal valves shall have polished casting finish and be complete with metal hand wheel. Valves on return pipework for flow regulation shall have a lockshield top for key operation.

Valves on main cold water shall be waterworks pattern manufactured in cast iron, with inside screw, wedge gate valves manufactured in accordance with BS 5163 : 1986 Class 2, having flanged ends to BS 4504 : 1989. All valves on mains cold water shall be provided with wheel head assembly unless otherwise noted on the drawings.

d) Double Regulating Valves

Double regulating valves 50 mm and below shall be oblique pattern, bronze construction, manufactured generally in accordance with BS 5154 : 1991 having screwed or flanged ends as indicated for general valves in similar locations.

Double regulating valves above 50 mm diameter shall be oblique pattern cast iron construction, manufactured generally in accordance with BS 5154 : 1991 with stainless steel seat aluminium bronze disc and flanged ends to BS 4504 :1989.

e) Non-Return Valves - General

Non-return valves 50 mm and below shall be of the swing type of bronze or gunmetal construction manufactured in accordance with BS 5154 : 1991 with screwed bonnets and having screwed or flanged ends, as detailed in general valves in similar positions.

Non-return valves size 65 mm and above shall be of the swing type of gunmetal construction manufactured in accordance with BS 5153 : 1974 with bolted cover, integral air cock having screwed or flanged ends as detailed for general valves in similar positions.

f) Non-Return Valves - Mains Cold Water

Non-return valves on mains cold water size 50 mm and below shall be the horizontal lift type of bronze or gunmetal constructions manufactured in accordance with BS 5154 : 1991 with screwed bonnet, renewable composition disc and having screwed or flanged end as required.

Non-return valves on mains cold water size 65 mm and above shall be of the swing type of gunmetal construction with flanged bonnet, renewable nitrile rubber faced disc and having flanged ends. Test cocks shall be provided on either side of non return valves.

g) Drain Valves and Cocks

Shall be provided as detailed under chilled and heating water except that isolating valves with hose adapters shall be used in place of gland cocks where these are not water board approved.

**2.23. CONNECTIONS TO EQUIPMENT**

Water connections to all items of equipment shall be isolated by means of valve or stopcock as indicated and described.

**2.24. HOSE REEL VALVES**

The supply main to each hose reel shall be fitted with 25 mm fullway gate pattern valve bronze construction in accordance with BS 5154 : 1991 and chromium plated.

The valve shall be supplied with a length of chain padlock and key so that the valve can be locked in the open position.

**PARTICULAR SPECIFICATIONS**

**MECHANICAL**

**SECTION 3**

**AIR CONDITIONING AND VENTILATION INSTALLATIONS**

**3.1. EXTENT OF WORK**

The Sub-Contractor shall supply, install, test and set to work the Air Conditioning and Ventilation Installation, as indicated and detailed in the Schedule of Equipment as described in the Specification.

The installation comprises single split air conditioners, fans and distribution ductwork.

All fans, whether individual units or fitted within air handling units supplied for the above systems shall be in accordance with the BSI Quality Assurance Scheme (BS EN ISO 9001 :1991).

**3.2. SINGLE SPLIT UNIT AIR CONDITIONING**

The Sub-Contractor shall supply and install single split mid-wall air conditioning units, as indicated in the schedule of Equipment.

The units shall be of low noise operation with an air purification system which eliminates bacteria. The outdoor unit shall have a heat Exchange with corrosion resistance, while the heat exchanger repels condensed water on the indoor coil.

**3.3. GRILLES AND DIFFUSERS**

General

Supply, extract and dummy grilles and diffusers shall be provided and fixed in the positions indicated in drawings.

The Sub-Contractor shall include for cross checking with the Supervisor’s Representative drawings for final lengths prior to ordering.

The Sub-Contractor shall include for fixing in sequence with other trades completing their work.

Any imperfect grilles or diffusers scratched or damaged surfaces or fixing screws having damage heads or scratched plating will be rejected.

A sample of each type of supply and extract grille and diffuser of the finish and colour specified shall be submitted to the Supervisor’s Representative for approval prior to supplying the required quantity and the Sub-Contractor is to allow for this.

Unless otherwise specified all diffusers and grilles shall be provided with a white baked enamel finish.

**3.4. SUPPLY AND EXTRACT GRILLES**

The face flange on grilles shall be provided with a rubber sealing strip to give airtight joint between flange and wall/ceiling. The ductwork shall be formed to fit neatly to the rear flange of the grille and sealed with non-drying mastic compound to prevent air leakage.

The Sub-Contractor shall allow for painting matt black all visible dampers and internal ductwork immediately behind grilles.

All grilles shall be supplied with a concealed fixing arrangement and opposed blade dampers unless stated otherwise. Each grille shall be flush faced and flanged on four sides.

**3.6. SUPPLY AND EXTRACT DIFFUSERS**

Rectangular diffusers shall be of the louvre face type suitable for flush ceiling mounting with overlapping flange, or inset mounting without flange to suit the ceiling type.

The diffusers shall be complete with plenum boxes for the live sections incorporating inlet dampers, perforated plate diffusion screens, fixing brackets, hanger rods and universal mounting brackets to provide 'hidden' fixings for the diffusers.

The diffusers volume and directional control blades shall be provided in 300 mm lengths in order to achieve maximum flexibility.

**3.7. LOUVERS**

Air inlet or discharge louvers shall be supplied and installed by the Main Contractor where indicated on the Architects drawings.

Louvers shall be of extruded aluminium construction finished in a stove enamelled aluminium lacquer and shall be supplied and fitted complete with a galvanised mesh bird screen.

The Sub-Contractor shall liaise with the Main Contractor to ensure the louvers are rigidly fixed and will not cause noise and vibration when the air handling system is in operation. The Sub-Contractor shall be responsible for the provision of blanking plates behind louvers and flanged connections for connection of adjoining ductwork.

**3.8. Extractor Fans**

The extractor fans shall be of the axial, wall mounted type and designed to BS 5499 requirements. The fans should be operated via a humidistat which automatically turns on when required; a switch connected to the lights, or should be turned on via a pull cord. If a pull cord is used in the shower or en-suite bathrooms, it must be beyond the reach of anyone using the shower.

**3.9. Ceiling Fans**

Ceiling Fans shall be of minimum sweep 0.8m. Where the room height is less than 2.5m, flush mounts or low profile huggers will be used for installation. Ceiling fans of high air flow efficiency of 75 CFM/watt (CFM: cubic feet per minute) should be selected to maximise energy savings as stipulated by the Energy Star Guidelines.

**3.10. Whirly Birds**

The whirly birds shall be of the spherical vane aluminium vent type. They shall have steel bearings and bearing holders to ensure long bearing life and quiet operations. The type selected should have a breaking system which activates at extreme wind speeds and must be cyclone rated- capable of operating at wind speeds of at least 200km/h without damage. The fans should have variable throat diameter and malleable flashing to enable them to fit varying roof designs and slopes.

**PARTICULAR SPECIFICATIONS**

**MECHANICAL**

**SECTION 4**

**INSPECTION, TESTING AND SETTING TO WORK, BALANCING AND**

**COMMISSIONING, HANDOVER AND RESPONSIBILITY DURING**

**PERIOD OF MAINTENANCE**

**4.1. GENERAL REQUIREMENTS**

The Sub-Contractor shall ensure that the full intention and purpose of the relevant procedures outlined in this section is made known to all office personnel and site operatives as well as the equipment manufacturers and approved specialists.

This section concerns the Sub-Contractor's responsibility during the duration of the Contract including the period of maintenance for:

i) Inspection

ii) Testing and Setting to Work

iii) Hand-over to the User Client

iv) Responsibility during period of maintenance

All the Works provided as part this Contract shall be inspected, set to work and or where called, commissioned in accordance with all relevant British Standard Specifications and Codes of Practice and the details given in the Specification and as indicated, to the entire satisfaction of the Supervisor’s Representative.

The installation shall be inspected and tested in sections as the work proceeds and on completion as composite systems.

**4.2. TESTING**

4.2.1. General Test Requirements

The Sub-Contractor shall make all necessary arrangements for conducting the tests as specified and he shall give the Supervisor’s Representative due notice when such tests are to take place.

The Supervisor’s Representative shall be informed of all site tests whether hydraulic or otherwise, for plant and piping and in addition the Supervisor’s Representative will require notice of attendance by the Sub-Contractors Insurance Company for welded pipework.

Final tests shall be carried out in the presence of the Supervisor’s Representative. The Sub-Contractor shall give 7 days' notice in writing of testing any part or parts of the installation.

The Sub-Contractor shall allow for providing all skilled labour, static testing gear, including pumps, tools, thermometers and attendance for himself as required during the balancing and commissioning tests. The Sub-Contractor shall be solely responsible for the proper filling and emptying of the plants and pipes to be tested and shall make good any defects arising out of or made manifest under test or re-testing until the whole of the plant is free from defect and in complete working order to the satisfaction of the Supervisor’s Representative.

The Sub-Contractor shall provide all fuel, power and water necessary for site testing and setting to work.

The Sub-Contractor shall be required to make good any damage caused by his representative during the carrying out of these tests.

The Sub-Contractor shall include for carrying out the hydraulic tests and witnessing performance tests under the actual conditions on the whole of the plant for which he is responsible under the Contract to the entire satisfaction of the Supervisor’s Representative after providing written confirmation that the installation is covered by Insurance.

4.2.2. **Works Inspection and Testing of Equipment**

Except where otherwise stated the Sub-Contractor shall provide all assistance, labour, materials, power, fuel, stores, apparatus and properly calibrated and certified instruments for carrying out necessary tests at his own or his suppliers works, including any retests.

The Supervisor’s Representative shall be entitled at all times during manufacture to inspect, examine and test on the Sub-Contractor's premises their material and workmanship of all equipment to be supplied under the Contract. If part of the said equipment is being manufactured on other premises the Sub-Contractor shall obtain for the Supervisor’s Representative permission to inspect, examine and test as if the said plants were being manufactured on the Sub-Contractor's premises. Such inspection, examination or testing, if made, shall not release the Sub-Contractor from any obligation under the Contract.

The Sub-Contractor shall give the Supervisor’s Representative 7 days' written notice of the date on and the place at which any plants will be ready for testing as provided in the Contract and unless the Supervisor’ss Representative attends at the place so named on the date which the Sub-Contractor has stated in his notice, the Sub-Contractor may proceed with the tests which shall be deemed to have been made in the Supervisor’s Representative's presence, and shall forthwith forward to the Supervisor’s Representative duly certified copies of the test readings. The Supervisor’s Representative shall give the Contractor 24 hours notice in writing of his intention to attend the tests.

In the event of the equipment not so passing the test the Supervisor’s Representative shall be at liberty to seek reimbursement from the Sub-Contractor all reasonable expenses incurred by him in repeating the tests.

If, after inspecting, examining or testing any equipment, the Supervisor’s Representative shall decide that such equipment or any part thereof is defective or not in accordance with the Specification, he may reject the said plant or equipment. In the event of such rejection, the Sub-Contractor shall immediately take steps to rectify the defects to the satisfaction of the Supervisor’s Representative.

Should the Supervisor’s Representative require to inspect any covered work, the Sub-Contractor shall uncover such work to enable the inspection to be carried out to the satisfaction of the Supervisor’s Representative.

Certificates of all hydraulic and manufacturers' tests made at the manufacturers' works shall be forwarded to the Supervisor’s Representative for his approval and his approval will normally be required before the material or apparatus is despatched from the manufacturers works. Certificates will also be required where specified by the BS named herein.

4.2.3. **Hydraulic Tests**

All internal and external services shall be tested to one-and-a-half times the maximum working pressure specified, or one-and-a-half times the working head for heating, chilled water, domestic hot water and cold water installations, whichever is the greater. Safety valves, altitude and pressure gauges shall be effectively isolated or removed during such tests.

For a satisfactory and acceptable hydraulic test the pressure shall be maintained for a period of 4 hours without loss of pressure after dealing with any weak joints, defective fittings and pipes, disclosed by the initial application of the test, all in the presence of the Supervisor’s Representative. All sections and all welds shall be hammer tested.

Certificates of all hydraulic tests made on site shall be forwarded to the Supervisor’s Representative for his approval and such approval must be obtained before any thermal insulation is applied. A separate set of plans will be kept on site by the Sub-Contractor for the purpose of keeping accurate records of site tests.

All test certificates shall be signed by the Sub-Contractor and by the Supervisor’s Representative's representative who witnessed the test. All test certificates shall have the following particulars thereon:

i) Apparatus or section under test

ii) Maker's number (if any)

iii) Nature, duration and conditions of test

iv) Result of test

The Sub-Contractor shall allow for all tests to be carried out either separately or in groups to suit the general building progress and before the application of thermal insulation.

4.2.4. **Testing Water Tanks**

All water tanks shall, after erection, be filled with water and shall remain filled for 24 hours during which time all joints shall be carefully examined. Any divided tank shall then be tested by so testing each section of the tank whilst the remaining section or sections are empty.

Any defects shall be rectified immediately and the test repeated.

**4.3. SPECIAL INSPECTION MEETINGS**

At an appropriate stage in the progress of the Contract Works, before practical completion, the Supervisor’s Representative will hold commissioning meetings, which qualified senior representatives of the Sub-Contractor's site and managing staff shall attend. The meetings will be held at approximately fortnightly intervals and their purpose will be to ensure that all works are properly finished, and set to work/commissioned prior to the issue of the Taking Over Certificate.

The Client shall be given by means of these meetings every facility to enable him to inspect and to become familiar with the extent and operation of the works before the hand-over.

The meetings will continue after issue of the "taking over certificate" for as long as necessary to deal properly with any outstanding works.

All charges arising from the attendance of the Sub-Contractor's senior representative at these inspections and meetings shall be deemed to be included in the Contract Price.

**4.4. SETTING TO WORK**

4.4.1. General

The Sub-Contractor shall be responsible for setting the plants to work and he shall where practicable arrange for all specialist plant items to be initially commissioned and tested by the particular and approved specialist manufacturer.

The Sub-Contractor shall not wait for every part of the works to be completed but shall arrange a progressive setting to work programme to achieve practical completion to the Supervisor’s Representative's agreed programme.

The Sub-Contractor shall give to the Supervisor’s Representative in writing 7 days' notice of the date on which the "Tests on Completion" are to be carried out. If the Supervisor’s Representative fails to appoint a time within 7 days after having been asked to do so, or to attend at any time or place duly appointed for making the said tests, the Sub-Contractor shall be entitled to proceed in the Supervisor’s Representative's absence, and the said tests shall be deemed to have been made in the presence of the Supervisor’s Representative.

If, in the opinion of the Supervisor’s Representative the tests are being unduly delayed, he may by notice in writing call upon the Sub-Contractor to make such tests within 7 days' of receipt of the said notice, and the Sub-Contractor shall make the said tests within the time aforesaid.

If any portion of the Contract Works or items of plant fail to pass the tests, the portions of works or plant shall, be re-tested within a reasonable time under the same conditions, save that all reasonable expense to which the Client and Supervisor’s Representative may be put the repetition of the tests, shall be reimbursed by the Sub-Contractor.

The Sub-Contractor shall, notwithstanding the above Clauses, allow for the regulating, adjusting and testing of the Contract Works, in part or in parts as and when required by the Supervisor’s Representative and in accordance with the Specification.

**4.5. TAKING OVER OF SUB-CONTRACT WORKS**

As a condition precedent to the issue of a "taking over certificate" to the Sub-Contractor he shall have available:

4.5.1. As Installed Drawings

The "as installed drawings" shall show clearly, identify and locate, giving dimensions and sizes where appropriate, the services installed and particularly those devices and equipment, e.g. valves, dampers, sensors, to which access will be required for normal maintenance and operation purposes.

They shall normally include:

i) Routine drawings of all mechanical and public health services covered by the contract.

ii) General arrangement drawings of all plant-rooms showing all equipment installed.

iii) Diagrammatic pipeline and ventilation system drawings together with appropriate valve diagrams.

In each plant-room a valve chart shall be fixed to the wall in a position to be agreed with the Supervisor’s Representative. The chart shall be framed and protected by glass or perspex. The valve charts shall give the identifying number, size, maker and makers figure number and designation of each valve and show diagrammatically the layout of the respective plant-room with the numbers of valves shown in their diagrammatic positions.

One copy of the Contract drawings, shall be kept on site at all times and shall be progressively and neatly modified by the Sub-Contractor to show all alterations made during the course of the installation. These drawings shall be made available for monthly inspection by the Supervisor’s Representative.

All the recorded amendments on the copy of the Contract drawings held on site shall enable a complete set of drawings showing the works as "actually installed" to be produced.

The "as installed" drawings shall clearly state the actual manufacturer of each item of plant or equipment, giving the maker's reference numbers for identification, plant/equipment rating, duty or capacity as appropriate or alternatively shall clearly cross relate in an approved manner to the 'Operational and Maintenance Instruction Manual' where this provides the identical information.

It shall be especially noted that the Client will not accept hand-over of the installation until full information concerning the installation is in the possession of his operation and maintenance staff and therefore a Taking Over Certificate will not be issued until the Sub-Contractor has supplied all the information.

4.5.2. Operating and Maintenance Instructions

Full operating and maintenance instructions for the entire mechanical and public health services shall be provided including the following:

a) For Equipment Items

Three copies shall be provided of all manufacturer's printed operating and maintenance instructions for equipment covered by this Specification for the various systems. When these have been agreed in detail the Sub-Contractor shall supply three sets properly bound in manual form and handed to the Supervisor’s Representative. These shall be in the Supervisor’s Representative's hands one month before the completion of the contract so that two copies may be handed over to the Employer's Operative Supervisor’s Representative at the commencement of the Defects Liability Period.

b) For Complete Systems

Three copies of the Sub-Contractor's operating and maintenance instructions for the overall completed system shall be supplied after agreeing a draft document with the Supervisor’s Representative.

The document, which shall comprise full and complete description of the function and operation of all the plant and components, may be included with manufacturer's installation and operating instructions.

The document shall be divided up into each service with a ready means reference and detailed index.

The manual shall contain all illustrations describing the operational routine together with line diagrams showing the locations of control valves, information on lubrication requirements, colour coding for all services and copies of all plant wiring diagrams.

The Sub-Contractor shall prepare, before handing over, a comprehensive testing report listing all items of plants and reporting the function of each with respect to the design intentions. Also, a complete chart giving the measured air flows and temperature at all grilles, diffusers and pressure relief flaps and temperature drops or rises through all coils and heating equipment, and space temperature and humidifiers with outside conditions shall be prepared.

When all reports and charts have been completed the Sub-Contractor shall accompany the Supervisor’s Representative on a final inspection before handing over, and shall demonstrate to the Supervisor’s Representative that the completed test charts and reports are correct. If the Supervisor’s Representative is not satisfied the Sub-Contractor shall repeat tests as necessary to satisfy the Supervisor’s Representative.

4.5.3. Safety Precautions under Faults Conditions

A special section shall be included in the operating instruction for dealing with fault-finding emergency procedure in case of plant malfunction or equipment failure and shall indicate to the maintenance staff the procedure to be adopted in the event of the possible failures which would occur and the quickest method of rectifying them, may they be temporary measures or entail contacting a manufacturer's emergency service.

4.5.4. List of Names of Manufacturers

A complete itemised list of essential and secondary spares shall be supplied for each item of plant and equipment together with a planned maintenance instructions and data for ordering replacement parts. Fax, telephone numbers and addresses of all the manufacturers whose equipment is employed shall form part of the operating and maintenance manual index.

4.5.5. Test Certificate - Plant Items

Copies of manufacturer's works tests on plant items comprising, tanks, vessels, motors, fans, pumps, controls, electrical and other like equipment shall be provided by the Sub-Contractor.

In the case of fans and pumps, copies of the manufacturer's characteristic curves for the actual unit fitted shall be supplied.

4.5.6. Test Certificate - Hydraulic and Heat Tests

The Sub-Contractor shall provide test certificates for all hydraulic flow tests carried out on site or at manufacturers works. Test results shall include all flow rates and all relevant temperatures i.e. flow and return temperatures, inside and outside ambient temperatures etc.

4.5.7. Labels and Identification

All valves controlling mains and sub-circuits shall be labelled in accordance with this specification and a schedule provided which shall correspond to and be co-ordinated with the "As Installed Drawings".

Motor starters and isolators shall be labelled as described. The labels shall be screwed to the fronts of starters and isolators and shall indicate the service.

Each fan, pump etc., shall bear a metal label as described giving the maker's name, date of manufacture and serial number, test and working pressures, duty, horsepower, phasing, hertz, speeds, BS number m3/s etc, as appropriate to the item of plant so that it may be identified at a later date with ease.

4.5.8. Schedule of Outstanding Items and Defects

Until the installation is finally taken over as complete, the Sub-Contractor shall be responsible for any necessary protection of the installation and electrical safety requirements.

On the completion of the Contract an inspection of the installation will be made by the Supervisor’s Representative. During the inspection a schedule of outstanding items or defects will be provided by the Supervisor’s Representative.

All items included in this Schedule shall be attended to within fourteen days of the date of the inspection.

4.5.9. Certificate of Provisional Acceptance

When the Contractor has demonstrated to the Supervisor’s Representative and to the Supervisor’s Representative's complete satisfaction that the works are operating as intended, and within the design limits and tolerances of the manufactured items, then the Supervisor’s Representative will issue a Certificate of Provisional Acceptance, subject to the clearance of any outstanding items or defects within 14 days of the date of the Certificate and the responsibility for the operation of the plant will pass from the Sub-Contractor to the User Client or as otherwise agreed with the Supervisor’s Representative.

This Certificate will not be authorised until all items in this clause have been cleared to the Supervisor’s Representative's satisfaction.

**4.6. RESPONSIBILITY DURING PERIOD OF MAINTENANCE**

4.6.1. Testing Water Flow Capacities on all Domestic Services

The Sub-Contractor shall include for making checks of the water flow capacities on domestic water services in buildings when occupied and used by the Client and for making normal adjustments to the commissioning settings to tune the installation to the actual building usage.

4.6.2. Certificate of Final Acceptance (Making Good Defects)

The Sub-Contractor shall carry out a thorough detailed examination of the installations between the eleventh and twelfth month of the defects liability period and set right any outstanding works or defects that might have occurred under the Defects Liability Period in the Conditions of Contract.

On completion of such works, and agreement that the requirements of the Conditions of Contract and Specification have been met, the Supervisor’s Representative shall authorise Certificate of Final Acceptance (Making Good Defects).

**PARTICULAR SPECIFICATIONS**

**MECHANICAL**

**SECTION 5**

**DOMESTIC WATER SERVICES**

**5.1. SCOPE OF WORK**

The following specifications cover all water service distribution including water storage tanks, booster pumps, and drinking water installation.

The services specification in this section shall comprise of:

(a) Cold water distribution pipework, valves and fittings.

(b) Cold water pumps and storage.

**5.2. INSULATION**

All pipework and plant shall be insulated in accordance with this Specification.

**5.3. DRAIN AND VENTING**

The requirements for draining and venting of the installations shall be carried out in accordance with Section '2' of this Specification.

Drain cocks shall be 15 mm bore gland packed pattern with gunmetal body complete with hose union and key in accordance with BS.2879.

Air vents shall be installed in accessible positions and be of the float pattern automatic type of bronze construction with stainless steel spindle, nickel alloy valve and seat, brass float and integral lock shield isolation valve.

All automatic air release valves shall be provided with 8 mm bore light gauge copper tube discharge pipe charged to discharge over the nearest drain connection or waste pipe.

**5.4. HOSE UNION BIB TAPS**

Hose Union Bib Taps shall be of the screw down pattern, gunmetal construction and be complete with a bib hose union connection.

The bib taps shall have a polish and be complete with a polish brass dust bonnet.

**5.5. DRAW-OFF POINTS AND ISOLATION OF DRAW-OFF POINTS**

Ball type valves, of brass construction, having compression ends and suitable for control by screw driver shall be provided in the following locations:

On each draw-off connection to a sanitary fitting or/range of fittings fitted at low level under a range of fittings so as to isolate all the fittings on the float.

**5.6. CONNECTIONS TO EQUIPMENT**

Water connections to all items of equipment shall be isolated by means of valve or stopcock as detailed on the drawings, and described in the Specification.

**5.7. LININGS TO CONCRETE TANKS**

The tanks shall be lined internally with Butyl sheeting 1.0 mm thick and complying with the test requirements of BS.903.

The lining shall be carried out by an approved specialist contractor in accordance with the details shown on the drawings.

The lining shall be provided to the complete internal area of the respective tanks up to terminate 150 mm above the inlet connections.

The lining shall be secured within the tanks above the water line with suitable continuous fixing to ensure maximum stability.

Connections to the tanks for water supplies shall be carried out using purpose made puddle flange connections provided by the services contractor for building in the structure.

**5.8. INTERNAL ACCESS LADDERS FOR BULK COLD WATER STORAGE TANKS**

Each concrete cold water storage tank shall be provided with an internal access ladder which shall be located below the access manhole situated within the roof slab.

The ladders shall be constructed from GRP (Glass Reinforced Plastic) or other approved non-corrosive material and shall be a minimum of 400 m wide with rungs spaced a maximum of 250 mm apart.

The ladders shall be located a minimum of 300 mm clear of the side wall of the tanks, and shall be of stainless steel together with all necessary support stages.

Care should be taken when installing the ladders to maintain the integrity of the inner Butyl lining of the respective tanks.

**5.9. COLD WATER BOOSTER PUMPS**

The panel shall contain contactor, thermal overload relay unit for each motor, a set of fuses for each motor, a set of fuses for the control phase to neutral Hand/Off/Auto switches for each pump, duty pump selector switch, indicating lamps, "Power On" and 'Duty Pump Fail', main neutral link, alarm accept push button unit for duty pump failed circuits and any necessary pressure switches and adjustable settings for each pump.

The equipment shall be complete with all necessary terminals, labels, interconnections, wiring diagram and spare fuses all enclosed in sheet steel dust and damp proof housing with lockable door.

All control panel labelling shall be in English or French and painted to BS.4800 : 1989.

Low water alarm switches for each pump together with indicating lights in the control panel shall be provided with terminals for remote indication.

Flexible pipe connections shall be provided to each pump set.

The inlet pressure for the pumps shall be from a flooded break tank having 1.5 m maximum positive head.

**Submersible Pump**

The pump shall be of the centrifugal type which is directly coupled to an electric motor. It shall be constructed to be water tight for submersion within the tanks. The pump shall be supported and attached to the discharge pipe.

**5.10. TESTING**

All water service installations described within these documents shall be cleaned and tested in accordance with the following requirements.

The entire installation shall be flushed out to clear dust and debris from the system and all valves, valve settings, filters, etc., shall be cleaned, greased and refixed.

All water service installations described within these documents shall be tested equal to twice the working pressure.

**5.11. CHLORINATION**

All new pipework storage cisterns and/or tanks shall be sterilised.

**PARTICULAR SPECIFICATIONS**

**MECHANICAL**

**SECTION 6**

**SOIL, WASTE, VENT AND RAINWATER PIPES**

**6.1. SCOPE OF WORK**

The scope of work covered by this section of the specification shall include all soil, waste, vent, rainwater pipes and roof outlets, including overflows and warning pipes.

The materials specified in this section shall be used as follows:

UPVC - Main Stacks

 - Branch & Stub - General Sanitary

 - Connections Fittings

Polypropylene - all fittings subject to high temperature discharge

 - Laboratories.

For details refer to the floor plans.

All pipework within main service ducts, and penetrating through structural walls or floors shall be installed to comply with Building Regulations.

**6.2. UPVC PIPEWORK AND FITTINGS**

Shall comply to British Standard BS EN 1452 1 :2001 and bear the British Standard Kite Mark. All pipework and fittings shall be installed strictly in accordance with manufacturer’s recommendations.

All pipework shall be supplied in plain ended lengths.

The pipe and fittings shall be to colour grey, British Standard 5252 with the exception of water closet connections that shall be coloured white where exposed to view.

Method of jointing shall be a combination of solvent welding using the manufacturer's approved solvent cement, with seal ring fittings used where necessary to accommodate thermal movement. The sockets of standard fittings shall be converted to incorporate a rubber sen ring where required.

The pipework shall be installed to accommodate thermal movement, flexible joints shall be incorporated at all fixed points and changes of direction with a secure fixing bracket located in the retention groove moulded on the socket of the fitting.

The natural rubber jointing seal rings shall be of "W" section to the requirements of British Standard 2494, water closet connections shall be to the same British Standard.

Waste boss connections when fitted to the pipes shall consist of two parts with inner and outer flanges, solvent welded as a complete unit with inbuilt gradients of 1 1/4º. Where it is not possible to gain access to the bore of the soil pipe self-locking bosses with integral clamping devise shall be used providing the mating surfaces are suitable for and used with solvent weld cement.

Waste boss connections to branch fittings shall be set to suit the positions of branch fittings, alternative waste boss connection can be made using unequal junctions conforming to British Standard 4514 with solvent welded joints conforming to the same standard.

Access shall be provided to gain entry into all pipework either by means of an integrally moulded door in an access fitting with external fitted rubber seal and secured with two galvanised bolts and nuts, or alternatively a two piece clamp type door fitted into the pipe run.

Where WC connections are to be fixed in a range a single manifold branch shall be used comprising a single branch with a standard WC connector welded together, up to six WCs may be connected on either side of the soil stack using the available left or right hand fittings as required.

The correct angle and type of fitting to suit the application shall be as described in the manufacturers Product Handbook.

The system shall be installed strictly in accordance with the Product Handbook complying with the recommendations of BS.4940.

**6.3. UPVC PIPE SUPPORTS**

Holder bats shall be made of mild steel with galvanised protective coating, and shall have a two position fixing suitable for either acting as a pipe support allowing thermal movement, or alternatively as a clamp fit on fitting crating a fixed point. For optimum fit on pipe supports UPVC spacing pieces shall be used.

Maximum intervals between pipe supports shall be:

Pipe Size 38mm 42mm 50mm 75mm 100mm

Horizontal 0.5m 0.5m 0.6m 0.9m 0.9m

Vertical 1.2m 1.2m 1.2m 1.8m 1.8m

Pipework shall be fixed truly vertical with all horizontal runs laid to gradients in accordance with British Standard 5572 Code of Practice for Sanitary Pipework and in any event not less than 18mm/m unless otherwise instructed.

The pipework shall be fixed to the fabric of the building in accordance with BS CP 304.

The work shall be inspected and tested during installation at the agreed stages, and the Supervisors Representative shall be notified when each section is ready for inspection.

**6.4. PIPE SLEEVES**

Where P.V.C. pipe pass through walls, or floors tubular pipe sleeves of non-combustible material shall be provided of sufficient size to permit the free passage of the pipe through the sleeve to ensure the pipe neither touches the sleeve nor the building structure.

All pipe sleeves shall be set in the walls, or floors before plastering or screeding is completed.

All sleeves shall be suitable for the pipe on which they are to be fitted and shall extend the full thickness of the division through which the pipe is to pass, after installation the gap between pipe and sleeve shall be "fire stopped" with suitable non combustible caulking compound.

**6.5. ROOF VENT FITTINGS**

All vent pipes passing through the roof shall be fitted with roof connector suitable for a weatherproof seal and to ensure a completely watertight arrangement.The pipe shall terminate 450mm above finished roof level with a section of spigot end and vent cage, complete with a weathering shroud to enclose the waterproof finish.

**6.6. RAINWATER ROOF OUTLETS**

All roof outlets shall have a flashing clamp, luting flange, stone guard and dome with a connection suitable for the specified pipe material and designed to fit into insulated roof structure.

**6.7. FLOOR GULLIES**

Floor gullies and channel gratings shall be supplied and installed in accordance with the details given on the drawings and schedules. Where these are of a quality finish they shall be suitably protected until completion of the contract.

Where required for support, cast iron bends or traps shall have weight support lugs cast on.

**6.8. GENERAL ACCESS/INSTALLATION REQUIREMENTS**

It is essential all runs of pipework are fully and practically accessible for cleaning operations.

The general philosophy for the drainage installation requires all sections of pipework to be accessible and the methods for achieving access are indicated on the drawings.

Wide radius bends shall always be used wherever possible to give unrestricted flow conditions.

No offsets shall be provided in vertical stacks unless otherwise unavoidable, when the offsets shall be accomplished by using two 135º bends.

Access plates and/or rodding eyes shall be provided at locations indicated on the contract drawings in the form of full width rectangular bolted access doors or 135º branch with cap and retention chain to give complete access to the system all set above the flood level of the fittings and located to give direct easy access to face removable duct access panels or tiles, the access plates shall not be located where they are affected by other services fittings or building fabric, to make them impossible to gain entry.

Generally, access plates or rodding eyes shall be located to prevent spillage into ducts, voids, ceiling spaces, habitable or clinical areas, set either in the floor finish or above the flood level of the fittings being served; generally enabling cleaning operations to be carried out above any possible blockage.

**6.9. JOINTING OF PIPEWORK TO WC'S**

The pipework connections to WC's shall be flexible self-sealing connectors incorporating multiple plastic and rubber seal gaskets. The connector shall incorporate outward facing rubber seals and plastic fins for insertion into the pipe, and an internal rubber seal with plastic shroud for connection to the WC pan.

The type of connectors shall be suitable for the type of specified pipe materials.

**6.10. TESTING OF SOIL, WASTE, VENT AND RAINWATER PIPES**

All works which are to be concealed shall be tested before being finally enclosed, a final test shall be made upon completion for soundness and performance strictly in accordance with the British Standard 5572 Code of Practice for Sanitary Pipework, and shall also include for a simultaneous discharge test.

**6.11. SANITARY FITTINGS**

All sanitary fittings associated taps, brassware, waste, outlets, traps, plugs chains, support brackets and fixings shall be as specified within the Sanitary Fitting Schedule elsewhere in the specification.

Include for making all hot and cold water terminal connections between the stopcock/control valves and main distribution pipework.

**6.12. OVERFLOWS AND WARNING PIPES**

All overflows and warning pipes shall be installed in the locations indicated on the drawings and installed in UPVC to BS.5255 incorporating solvent welded fittings.

**6.13. STORAGE OF PIPEWORK AND FITTINGS**

6.13.1. General

Store all pipework, fittings, gaskets and fixing brackets in a well ventilated and covered storage compound out of direct sunlight, and extreme temperatures.

6.13.2. UPVC

Store all pipe work fittings, gaskets, and convents avoiding direct exposure to sunlight, and extreme temperature conditions.

Pipework shall be stored on level ground free from stones or sharp protrusions either on timber bearers 75mm wide and not greater than 1 metre centres and stacked neatly not more than 1 metre high, alternatively pipes shall be stored in loose racks with side support not greater than 1.5 metres apart.

Store all fittings gaskets, and solvents, within a well ventilated cool compartment, retain in the plastic bags and storage containers until ready for installation.

**PARTICULAR SPECIFICATIONS**

**MECHANICAL**

**SECTION 7**

**LABORATORY WASTE INSTALLATION**

**7.1. EXTENT OF WORK**

The laboratory waste installation shall include all pipework and fittings from the main underground foul water drainage installation up to and including the connection to the fittings and roof vent terminal. Unless otherwise indicated on the drawings the drip cups, sinks, troughs, including stub waste connections shall form part of the laboratory bench fittings shall be in accordance with this specification.

All pipework and fittings shall be installed strictly in accordance with the manufacturer's recommendations.

**7.2. STORAGE OF PIPEWORK, FITTINGS AND MATERIALS**

All pipework, fittings and jointing materials including gaskets shall be stacked and stored within storage sheds out direct sunlight and the effects of extreme or fluctuating temperature conditions.

The pipework shall not be stacked more than 900 mm in height and supported to ensure that the barrels of the pipes are not distorted.

**7.3. INSPECTION OF PIPEWORK AND MATERIALS**

All pipework, fittings, jointing materials, and gaskets shall be inspected prior to use and damaged components or pipework shall not be used in the works.

**7.4. PIPEWORK**

The pipework shall be installed in polypropylene using a 'mechanical' jointing method.

**7.5. FITTINGS**

The fittings shall be in polypropylene to the same manufacture as the pipework incorporating a 'mechanical' joint with screwed nut and low density polythene olive.

All bends and branch fittings shall be of polypropylene to the same manufacture as the pipework incorporating 'mechanical' joints with screwed nut and low density polythene jointing ring olive and shall be of a wide sweep pattern.

Threaded in-line couplings shall have a threaded connection with hexagon fixed centre and screwed nut incorporating a mechanical low density polythene olive and shall be of a wide sweep pattern.

**7.6. JOINTING OF PIPEWORK TO DISSIMILAR MATERIALS**

When jointing polypropylene pipework to other materials the surface of the pipe shall be scoured to form a key followed by insertion into the socket and caulked with acid resistant cement or sealing compound, alternatively a special adapter may be used.

**7.7. THERMAL STRESS RELIEF UNITS**

The Thermal Stress Relief Units shall be installed in accordance with manufacturer's recommendations at such locations to ensure that all section of the installation can expand and contract with changing temperature conditions.

The units shall be located and held secure by means of a bracket held in the annular groove making all due allowance for the coefficient of expansion being approximately 4.25 mm per 3 m per 10ºC, with the female member of the unit securely anchored and the male member being free to more in the socket.

The polypropylene stress relief unit shall be designed to work in a horizontal or vertical plane and comprise a slip coupling, incorporating two roll-rings within an enlarged socket with body moulded annular groove to house a pipe clip, all enclosed within a dust and grit proof snap-on cover.

The outlet of the spigot end shall be grooved to accept a 'mechanical' nut and olive.

**7.8. DRIP CUPS**

Large circular drip cups shall be 168 mm diameter moulded in polypropylene with integral grating and incorporating a B.S.P. threaded connection and back nut on a 38 mm outlet, the rim shall be set sealed into the bench unit within a timber support frame.

Small circular drip cups shall be 102 mm diameter moulded in polypropylene with integral grating and incorporating a B.S.P. threaded connection and back nut on a 38 mm outlet, the rim shall be set and sealed into the vench unit within a timber support frame.

Large oval drip cups shall be moulded in polypropylene with deeply curved bowl incorporating an integral grating and B.S.P. threaded connection back nut on a 38 mm outlet, the rim shall be set and sealed into the bench unit within a timber support frame and the bowl shall have either a flat oval, a flat rectangular, or flat angular rim with a bowl size as described on the drawings.

Small oval drip cups shall be 170 mm x 102 mm size moulded in polypropylene with curved bowl incorporating an integral grating and B.S.P. threaded connection with back nuts on a 38 mm outlet, the rim shall be set and sealed into the bench unit within a timber support frame.

All drip cups shall incorporate an anti-syphon bottle trap as described in 'Dilution Recovery Traps'.

**7.9. WASTE OUTLETS**

Waste outlets shall be manufactured in polypropylene to the sizes indicated on the drawing with plain or slotted overflow connection as required incorporating a B.S.P. threaded connection, back nut grid outlet and a butyl rubber gasket.

The plug shall be moulded in polypropylene without a chain.

Standing waste tubes shall be suitable to connect into the specified waste outlet and manufactured in polypropylene and incorporating a hanging loop.

**7.10. DILUTION RECOVERY TRAPS**

All traps shall be to the sizes and described on the drawings.

The traps are to be provided with 'P' outlet, but where an 'S' trap is required the bend shall be provided.

Anti-syphon bottle traps shall be manufactured in polypropylene with a heat resistant borosilicate glass base having a 76 mm liquid seal complete with parallel threaded glass base with tension ring and incorporating a nut and olive for a mechanical joint in union connection.

Dilution recovery trap shall be manufactured in polypropylene of the anti-syphon type having a 76 mm liquid seal and 2.3 litres capacity. The trap shall have a heat resistant horosilicate glass base retained with a bolted flange connection containing six stainless steel nuts, bolts and washers and sealing gaskets. The trap shall be complete with a B.S.P. threaded union connection with nut and olive for a mechanical joint.

The polypropylene traps are provided with a 'P' outlet, where an 'S' trap is required a bend with mechanical joint shall be provided.

Where tubular pattern traps are required these shall be manufactured in polypropylene and made up of 'U' bends and components to give the required fitting and incorporate mechanical joints.

**7.11. ACCESS PIPES**

The access pipes shall be manufactured in polypropylene having a bolted cover with ends grooved to receive a nut and olive for mechanical joints, the cover shall be retained by means of eight stainless steel nuts, bolts and washers, and incorporate a gasket seal and shall give entry to the full width of the pipe.

Blanked off plugs shall be manufactured in polypropylene having a tapered sealing surface to be fitted into a screwed mechanical fitting.

**7.12. PIPEWORK**

Jointing

All pipework and fitting shall be jointed and installed strictly in accordance with manufacturer's recommendations using the correct jointing tools and only fittings to suit the manufactured pipework.

Mechanical joints shall be made using an adjustable depth cutting tool incorporating a grooving blade.

The pipe shall be cut to the required length using a pipe cutter designed for plastic pipe, the pipe end shall be square and smooth free from burrs and swarf.

The groove shall be cut using the grooving tool in an anti-clockwise direction, the full depth being achieved in two stages making adjustments for half and full depth.

The olives shall be immersed in hot water to allow expansion and softening, the temperature of the water to be between 80ºC-100ºC with the immersion time of not less than 1 minute per 76 mm and 102 mm and not less than 10 seconds for the smaller sizes.

The olives shall not be left in boiling water for longer than necessary.

To assemble the joint the nut shall be placed onto the pipe followed by the heated olives set firmly into the groove. The pipe ends with olive shall be inserted into the fitting and tightened by hand, then using two moulded spanners around the ribs on the nut the fitting shall be tightened to complete the joint.

All fittings shall be tightened as work proceeds and not left until the completion of the works.

**Pipework Fixings and Support**

All pipework fixings shall be in accordance with the details given in the drawings and manufacturer's recommendations.

Snap-on polypropylene pipe clips shall only be used on vertical pipework and as guides only.

All horizontal and vertical pipework shall be supported on substantial hangers and fixings, and stress relief units shall be securely anchored to the structure as detailed on the drawings.

The vertical support brackets shall be constructed of steel clip to suit the outside diameter of the pipe with a sleeve pushed over the cupped jaws of the clip enclosing a steel ballhead.

The shank section of the ballhead shall be tapped to enable a screw rod to be attached to the assembled clip and fixed secure to the fabric of the building by means of a slotted backplate assembly.

The horizontal support brackets shall be constructed of a steel clip to suit the outside diameter of the pipe with a sleeve pushed over the cupped jaws of the clip enclosing a steel ballhead.

The shank section of the ballhead shall be tapped to enable a screw drop rod to be attached to the assembled clip and fixed secure to the structure by means of a steel bracket and/or approved fixing bolt.

Polypropylene pipework shall be fixed at the following centres:

**Horizontal Fixings**

 38 51 76 102 Nominal Bore mm

1200 1370 1520 1836 mm fixing Centres

**Vertical Fixings**

All Pipe Sizes Nominal Bore mm

1.500 mm Fixing Centres

Where sustained temperatures in excess of 20º are expected, continuous support shall be given to all horizontal runs of pipework.

Horizontal waste pipes shall be provided with a natural fall of 2/3º but not less than 1º or 50 mm per 3 m run.

Where pipework is located within a ceiling void or service duct over a non laboratory or habitable/clinical area a waterproof drip tray shall be fixed below the pipeline. The drip tray shall be adequately supported from the structure by means of drop rods fixed to an angular support and manufactured from UPVC.

**Pipework Identification**

Pipework to contain Radioactive effluent shall be clearly marked with a radiation symbol together with the word 'RADIATION' marked in English and French to warn against radiation hazards. These shall be located at 900 mm centres or part thereof.

**7.13. INSPECTION, TESTING AND COMISSIONING**

Shall be in accordance with the methods described separately within these documents for the Sanitary Pipework and Rainwater Installation.

**PARTICULAR SPECIFICATIONS**

**MECHANICAL**

**SECTION 8**

**SANITARY APPLIANCES**

# 8.1. Close Coupled Syphonic WC

Manufactured from white glazed vitreous china with `p` trap outlet size 720x326x375 mm. high, floor mounted type with bottom inlet.

Each WC shall come complete with the following items:

9 litres close coupled valveless cistern fitting including siphon, bottom inlet ball valve, bottom overflow,

cistern to WC connector, CP reversible lever seat.

 White heavy duty seat and cover.

 Bolts, nuts & washers for floor mounting.

# 8.2. Squat Type WC

Manufactured from white glazed vitreous china size 650x650 mm.

Water to be flushed from a high level cistern set at 1700mm from floor level terminating at a rear inlet flushing spreader. Connection to the inlet to be with a 40mm pipe.

# 8.3. Wall Mounted Lavatory Basin

Manufactured from white glazed vitreous china size 600x440x220 mm with one centre tap hole.

Each basin shall come complete with the following items:

Chromium plated (CP) 15mm pillar tap and 32 mm. deep seal (50 mm) bottle trap. Basin waste, plug, chain, stay and back nut.

# 8.4. Built-in Lavatory Basin

Manufactured from white glazed vitreous china size 600x440x220 mm. deep, with one centre tap hole.

Each basin shall come complete with the following items:

Chromium plated (C.P.) 15mm pillar tap and 32 mm. basin waste, plug, chain stay and backnut

C.P. 32 mm. deep seal (75 mm) bottle trap.

# 8.5. Built-in Sanitary Basin

Manufactured from white glazed vitreous china size 570x420x240 mm. deep, no overflow.

Each basin shall come complete with the following items:

Chromium plated (CP) brass 15 mm. wall mounted mixer fitting with C.P. taps and C.P.50mm unslotted grid waste fitting with long tail.

Wall support aluminium semi concealed bracket and fixing bolts.

C.P. 32 mm. Deep seal (50 mm.) bottle trap.

# 8.6. Wall Mounted Sanitary Basin

Manufactured from white glazed vitreous china size 570x420x240 mm. deep, no overflow.

Each basin shall come complete with the following items:

Chromium plated (CP) brass 15 mm. wall mounted mixer fitting with C.P. taps and and CP 50mm unslotted grid waste fitting with long tail.

Wall support aluminium semi concealed bracket and fixing bolts.

C.P. 32 mm. deep seal (50 mm.) bottle trap.

# 8.7. Pedestal Mounted Lavatory Basin

Manufactured from white glazed vitreous china size 580x500x220 mm. deep, 1 centre tap hole.

Each basin shall come complete with the following items:

Chromium plated (C.P.) single hole basin mixer with rigid nozzles and 32 mm. pop up waste.

C.P. handles.

Pedestal screwed to floor.

Fixing bolts.

Plastic deep seal (50 mm) bottle trap.

# 8.8. Showers

Shower trays generally will be insitu formed with mosaic tile lining as detailed on architectural drawings.

Each shower shall come complete with the following items:

C.P. 15mm. wall mounted shower fitting (for surface pipework including shower arm and adjustable rose).

C.P. hot and cold water tap handles.

50mm shower waste outlet in rough brass screwed male with 75mm diameter CP shower grating.

# 8.9. Service/Cleaners Sink

Manufactured from glazed 304 stainless steel. Single centre Bowl (760x460x380) with drainer, overall size 1200x610mm unless otherwise specified, complete with 150mm high splash back, stainless steel round tubular legs with fixing flanges and stainless steel slatted undershelf.

Each urinal shall come complete with the following items:

C.P. 15 mm. hot and cold bib taps or swivelling mixer taps with exposed inlets and wall plates.

C.P. 15 mm. unslotted grid waste fitting and CP 50 mm. bottle `p` trap with 50 mm. seal and detachable sump.

# 8.10 Urinal

Manufactured from white glazed vitreous china with syphon jet and flushing rim size 430x305 wide, wall mounted type.

Each urinal shall come complete with the following:

9 litres white automatic flushing cistern, with syphon, drip tap and wall hanger (or Flush. Master system)

Exposed stainless steel flush pipes with spreader and clips.

C.P. 50mm. bottle `p` trap with 75mm. seal and detachable sump.

Plastic 50mm. dome outlet grating.

Galvanised steel wall hangers.

White vitreous china bowl urinal division size 675x305 mm. deep. (where applicable)

**8.11** **Laboratory Sink**

Manufactured from white glazed ceramic fireclay 600x400x200 rectangular sink without overflow, with centre back waster outlet complete with the following accessories:

Acid resistant waste and adjustable underslung fixing brackets.

Laboratory taps to consist of bench mounted single flow water mixers conforming to BS 5750.

**PARTICULAR SPECIFICATIONS**

**MECHANICAL**

**SECTION 9**

**BORE HOLE SITING AND DRILLING**

**9.1 Bore hole Identification**

The Contractor shall comply with the procedures for assigning bore hole identification, descriptions and numbers, following the approved identification system of the country. The Contractor Shall include the latitude, and longitude and national grid references in the bore hole identification system.

9.2 **Geophysical Surveys and Borehole Sitting**

The Contractor shall propose methodologies of geophysical survey and bore hole siting, which shall be used to locate bore hole sites. This should include the justification for the appropriateness of the methods in relation to the hydrogeology of the areas where the bore holes shall be sited. These shall be rural and peri-urban bore holes and in line with Government policy, the sitting shall also consider the beneficiary’s preference.

Proposals for geophysical surveys that use electromagnetic or resistivity methods should also give details of the penetration depths of the instruments that shall be employed. It is recommended that the use of Vertical Electrical Soundings be carriel out using either the Wenner or Schlumberger Arrays of sufficient separation so as to give penetration estimation in excess of 50 metres. Both apparent resistively plots and interpretations must be provided with the interpretation methods, which must be specified. Contractors shall obtain a report of the soil conditions in each location from geological survey department of each country in order to determine the best method for carry out the survey. In all cases using geophysical methods should be balanced with the wishes of the beneficially.

9.3 **Drilling**

(i) The planning and mobilisation in one lot to be employed by the Contractor should be specified in the schedule of particulars.

(ii) In general terms the planned drilling method to be employed by the contractor should be specified in schedule of particulars.

(iii) All drilling may commence at any diameter with a final diameter being attained by reaming where applicable. In consolidated but possible unstable material the employer would normally expect the contractor to drill a diameter at least 50 mm in excess of the completion diameter for large diameter casing (≥Ø160 mm) and at least 35 mm in excess for smaller diameter casings (<160 mm) and to back fill using suitable formation stabiliser.

(iv) It is envisaged that aquifer may be interspersed with impermeable layers; that is the drilling method should thus take full account of the desirability of identifying even minor aquifer sections that may contribute to the final yield.

(v) If direct circulation rotary is specified, the flushing medium should be air, water or stable foam. Contractors must demonstrate familiarity with foam drilling. If, at any stage, the use of mud is considered necessary either as a primary fluid or as an additive to create “stiff foam, only degradable high quality polymer will be acceptable. Bentonite is specifically prohibited.

(vi) As high consolidated sedimentary formations may be encountered the contractor may wish to make provision for down hole hammer drilling of certain sections. It should be noted that despite apparent hardness such formations are liable to be sensitive to drilling damage and this possibility must be taken into account. If necessary air mist or degradable hammer foam additives will be permitted.

(vii) Geo-logging of Samples to ascertain high yield yielding aquifers and bore hole design.

(viii) Unwashed and washed drilling samples are to be collected at 1 m intervals, stored in heavy gauge polythene bags labelled and kept on site until the completion of drilling and testing. The samples are to be logged by the driller and record of strata at 1m intervals will be kept on a daily log sheet. The record of strata will show:

lithology;

degree of consolidation or hardness;

If unconsolidated, nature of granular material, i.e. subjective description of grain size, degree of rounding, clay content, colour.

* 1. **Interim Yield Tests**.
1. On striking water interim yield tests must be initiated. These tests should be repeated at the

contractor’s discretion though flushing of the hole should take place after the drilling of every rod length. The method employed for establishing interim yields will be at the discretion of the contractor. Details should, however, be included in the Methods Statement. In general air lifting will be regarded as the ideal method for interim yield tests with measurement of the discharge being made by channelling the flow into either (i) a container of known volume and measuring the time taken to fill that container using a reliable stop watch; or (ii) a V notch weir of suitable dimension for the yield to be accurately established.

1. Interim tests should be carried out for at least 20 minutes to establish yields of less than 1.0 1/sec. Once a yield which is regarded as the optimum for the borehole is indicated, however, the test should be continued for at least 60 minutes to confirm the result.
2. The results of interim yield tests against a total depth at time of test must be recorded on drilling records.
	* 1. **Drilling Diameters**
3. As the final inside diameter of any completed bore hole section should not be less that 171 mm. All drilling should be carried out with that completion diameter in mind.
	1. **Rate of Drilling**

Accurate records of penetration rate per metre shall be maintained and included on the daily log sheet.

9.7. **Straightness and Verticality**

Bore holes shall be constructed and all linings installed plumb and true to line such that all pumping plant can be easily installed.

9.8. **Drilling Depth**

The depth to be drilled at each location will be determined from the results of the interim yield tests. The acceptable minimum yield for bore holes is 0.25 l/sec but drilling will continue beyond that depth assuming a continuing incremental increase in yield is indicated by the results to that depth.

In all cases interim yield tests shall be performed as per section 17. Unless otherwise directed by the Supervisors Representative bore holes should be terminated as soon as the acceptable yield is obtained. The average target depth is 60m. Drilling beyond 60 metres may only take place if clearly authorized by the Hydrogeologist. Such authorisation being noted on the daily drilling record.

9.9 **Casing and Screen**

All plain and slotted casings shall be provided by the Contractor. These shall be UPVC pipe in 3m or 6m length. The diameter to be installed shall not normally be less than 160mm OD for Climax or electrical pumps. The UPVC should be National Bureau of Standards or ECOWAS compliant. UPVC casing must not be stored in direct sunlight at any time. The slotted casings should give an open area of at least 10 per cent.

Following attainment of the final depth details of the proposed bore hole design should be submitted to the Hydro geologist. The completion of an effective and efficient bore hole design is the responsibility of the contractor. In general terms it is recommended that slotted pipes be emplaced across all sections where incremental increases in interim yield have been recorded. A 1m length of plain casing of the same diameter as the slotted shall be installed below the slotted casing. The bottom of this plain casing shall be sealed with a suitable end cap/bail plug. Plain casing shall be installed from the depth at which water was struck to a height of 1m above the ground and capped. To ensure that the casing is central and vertical in the bore hole and to provide a uniform annular space for the filter pack, centralisers (for which the contractor shall provide a design) shall be fixed to the casings at intervals not exceeding 6m.

9.10 **Formation Stabiliser**

The primary purpose of formation stabiliser is to keep the bore hole open. A second function is to maintain or augment the hydraulic conductivity of the natural formation. The stabiliser material should be well sorted so as to enhance the natural porosity and hydraulic conductivity of the materials outside the well screen.

The Contractor is responsible for the procurement of suitable pack or stabiliser material the grading of the material being consistent with a bore hole completion that does not impede the entry of water but ensures sand free discharge.

The establishment of sand free pumping completions are entirely the responsibility of the contractor.

Stabiliser of filter pack installation shall be carried out as a continuous feed operation (to prevent segregation) using water to flush as necessary.

Where temporary drill casing has been installed, initial packing shall continue inside the drill casing prior to casing pull back, to a height of 1.5m above the base of the drill casing. At this stage the drill casing should be withdrawn 1m and the process repeated until the filter pack reaches the required height.

Placement of filter material and casing pull back shall proceed until the filter material has settled without bridging to a height of 3.0m above the top of the PVC casing at which point gentle well development will commence. Gravel shall be topped up as necessary during development to maintain this level.

9.11 **Borehole Cleaning and Development**

On completion of drilling any chemical aids or additives used shall be removed from the boreholes.

Well development may be carried out using:

water jetting

air jetting

surge block

If either (a) or (b) in (ii) above is used jetting must take place using a tool of approved design. Care must

be taken to ensure removal of jetted fines. Air lifting whilst jetting is preferred.

Development shall continue for at least 10 hours when 5 visually sand free water samples of at least 1 litre collected over five separate 1 minute periods at least 10 minutes apart should be obtained from the total discharge. (Actual sand tolerance will be 5 mg/1.)

Should such a sample not be obtained development shall continue up to a maximum of 20 hours. If 5 sand free sample cannot be obtained at this point the bore hole will be considered to have an unsatisfactory design and construction.

9.12 **Test Pumping**

All forms in Appendix A are to be completed. Test pumping will be approved only if the detailed description in appendix A is thoroughly followed and the test results are recorded in enclosed forms.

The result of the pump testing (completed forms, appendix A) should be presented at client office at latest one week after striking water.

9.13 **Water Quality Tests**

To ensure that water being delivered from the newly drilled bore holes is potable, the contractor shall be required to carry out quality tests on the water samples. “Water quality” is a term used here to express the suitability of water to sustain uses or processes.

Any particular use will have certain requirements for the physical, chemical or bacteriological characteristics of water. The water quality tests to be performed on water for drinking purposes will have to include bacteriological (E. col and Faecal streptococci), physical and chemical (pH, Suspended Solids, Turbidity, Electrical Conductivity, Total Dissolved Solids, Carbonate, Bicarbonate, Chloride, Sulphate.

The laboratory water tests may be carried by any other laboratory as the contractor may wish but the results will have to be checked by the Water Authoritys laboratory personnel.

9.14 **Cement Grout**

After the test pumping is completed the annulus shall be sealed with cement grout containing no aggregate from a depth of 3m to the ground surface.

9.15 **Records and Reports**

The Contractor shall submit daily log sheets and a construction report for each completed bore hole to Supervisors Representative. The log will be completed on forms an example of which shall be provided to the Supervisors Representative prior to the start of drilling. Data will include:

District or province

Locality

Bore hole number

Grid reference

Distance from previous destination

Contractors Name

Driller‘s name and signature

Registration numbers of equipments

Date arrival on site

Date of starting drilling

Daily drilling activities with time or duration

Problems during drilling

Logging samples – size ,type, degree and geology

Hole diameter

Items installed

Consultants Name and signature

Geophysical survey report

Pumping test report- draw-down, yield, recovery etc.

9.16 **Dry Holes**

The contractor will be paid for wet holes only.

Dry holes shall be at the expense of the contractor

9.17 **Technical Schedule of Particulars**

Contractors should enter full particulars of equipment, which will be used. General entries of equipment held by the Contractor but which will not be available for definite allocation to the Contract should not be included. It should be noted that the time of, but prior to, the tender award the first choice Contractor will be asked to firmly guarantee the availability of the equipment described as a pre-condition for the final contract award.

|  |  |  |  |
| --- | --- | --- | --- |
| 1. | Drilling rigs | 5. | Compressor |
|  | Number |  | Number |
|  | Make |  | Make |
|  | Model |  | Free Air Delivery |
|  | Age |  | Normal effective working pressure |
|  | Gross Nos(Allocated rigs) |  |  |
| 2. | Foam pump type | 6. | Auxiliary Equipment – List |
| 3. | Mud pump | 7. | Development Method Proposed with tool design |
|  | Type |  |  |
|  | Make |  |  |
| 4. | Drill String | 8. | Test pumps |
|  | Drill pipe (mm) |  | Type  |
|  | Pipe Length |  | Make |
|  | O.D. joint (mm) |  | Length Runaway |
|  | Drill Collar |  |  |
|  | Quantity |  |  |
|  | Length mean (m) |  |  |
|  | Stabilisers |  |  |
|  | Max O.D |  |  |

9.18 **Supply and Installation of Submersible Pump and Wiring for Electrical**

 **Installations**

9.18.1 **Technical Specifications for Submersible Pump**

Each submersible pump shall have a label with the following information:

Manufacturer’s name and address

Model No.

Serial number

Ratings:

Country of origin

Date of manufacture (month and year).

Warranty period: Minimum 10 years.

9.18.2 **Installation**

Installation work shall be done by certified technicians or under supervision of certified technicians. After the installation the contractor shall stick a label at main switch box. The label shall indicate following information:

Supplier(installer’s information (name, address, telephone)

Name of certified technician who installed/supervised the system and his certified number.

Date of installation.

9.18.3 **User’s Manuals for Submersible Pump**

Installer shall provide user’s manuals and shall explain contents to users.

User’s manuals shall include description of maintenance of submersible pump.

9.18.4 **Installation of Wiring**

Cables can be joined by use of junction boxes, block connectors or soldering (with insulation sleeves). All cable joints must be contained in a suitable junction box.

Overhead wiring should not be used.

Conduits and/or cab tire cables (double insulated weather resistant cable) shall be used for underground cables.

Underground cables shall be buried a minimum of 0.4 meters below the surface and be indicated with a red marking tape 0,2 meter above the cable.

Cables through roofing shall be contained in roof entry boxes, which shall also form a waterproof seal to avoid leakages. Holes through roofing should be avoided where possible.

All indoor installations shall have wall mounted brackets. The appropriate type of the bracket shall have to be approved by the consultant before installation.

**PARTICULAR SPECIFICATIONS**

**MECHANICAL**

**SECTION 10**

**SOLAR SERVICES GENERAL**

# 10.1 SOLAR SERVICES – GENERAL

Service employing solar power technology considered for installation in this project comprise of solar powered lighting, solar water pumping,

Fundamental and basic installation and performance requirements are outlined, however, the specific detail of installation and adjustments on site performance shall be carried out by the contractor following manufacturers specifications and recommendations. In any case the contractor shall ensure that performance criteria outlined herein and on design drawings are fulfilled.

The solar power systems shall be supplied installed and commissioned including recommended spares.

# 10.2 SOLAR POWERED WATER SUPPLIES

Solar pumping systems are indicated on layout drawings. These consist of solar pump and elevated tank solar arrays and regulators.

Solar arrays and regulators shall be basically as specified elsewhere but shall be compatible with pumping duty specified and to manufacturers recommendations.

The pump shall be multistage centrifugal with radial impellers direct coupled to a submersible motor. The pump shall be entirely made of stainless steel with corrosion bearings. The electric motor shall also be entirely made out of stainless steel and corrosion free bearing.

The solar pump system shall be capable of delivering the capacity indicated in drawings into an elevated tank as well as the day to day demand.

# 10.3 SOLAR WATER HEATING SYSTEM

GENERAL

In areas where water hardness is considered to be high, the indirect solar water heating system where water hardness is considered to be high, the indirect solar water heating system shall be installed at the positions indicated on the drawings.

Direct solar water heating systems shall only be installed in areas where water hardness is not very aggressive. However the direct solar water heating system shall be the one manufactured from copper and not that of galvanised steel.

# 10.4 INDIRECT SOLAR WATER HEATING SYSTEM

Indirect solar water heating appliance shall be installed to operate with the type of water envisaged.

The indirect water heating system appliance is as described below-:

The indirect solar water heating system shall be of the closed circuit type consisting of an exclusive closed circuit fluid that absorbs heat energy from the solar collector panels.

The fluid flows in a sealed jacket around the water storage cylinder and transfers heat to the water.

The cylinder shall be protected from harshest water with corrosion free material as two coats of special primaglaze high temperature vitreous enamel.

The cylinder shall bee insulated by a pressure injected CFC free polyurethane foam.

The solar collector panels shall be large enough to absorb the available solar energy to the maximum and transfer it to the closed circuit fluid efficiently. It shall be the type, which is covered by low tempered solar glass and insulated by polyester. The solar glass shall be of tougher superior quality to provide better performance, protection, and appearance.

# 10.5 INDIRECT SOLAR WATER HEATING SYSTEM INSTALLATION

The contractor shall supply and install the solar water heating systems at the positions located in the drawings.

The systems shall be mounted on the roof or other structure as shown in the layout drawings.

The solar water heating *system* shall be supplied as a complete unit with solar collector panels, water storage cylinder electric booster element. (where applicable) etc.

The solar collector panel shall be tilted south as shown on the drawing and to such final detail installation or angular adjustments recommended by the manufacture.

**10.6 DIRECT SOLAR WATER HEATING SYSTEM**

Where the existing water supply is sourced from a borehole system or town main or treated water, the water is considered less aggressive .a direct solar water heating system shall be installed at the locations shown on the drawings.

The direct water heating system shall operate on the thermosyphon principal.

Where water circulates in the tank- collector circuit through natural- convection.

The system shall mainly consist of an insulated tank and solar collector, and it shall be capable of producing water at an average temperature of at least 500-550 C (1300 F) throughout the year.

The collector and the tank shall be manufactured from copper.

**10.7 DIRECT SOLAR WATER HEATING SYSTEM INSTALLATION**

The direct solar water heating system shall be installed at the roof or other structure with the solar panels tilted at South as shown in the drawings and to such detail installation and angular adjustments recommended by the manufacture.

The solar collector panels shall be installed away from any obstacle, which may cast a shadow.

The solar collector panels shall be capable to absorb and transfer solar energy to water efficiently. They shall be of a tough quality to provide better performance protection and appearance.