TENDER NO. ADB/ITB/COZW/2019/0033
OUTFITTING WORKS FOR THE AFRICAN
DEVELOPMENT BANK OFFICE IN HARARE -
ZIMBABWE

VOLUME 2 – SPECIFICATION
SECTION 1

BUILDER’S WORK AND SHOPFITTING SPECIFICATIONS
EXCAVATION

NATURE OF GROUND

The Contractor must satisfy himself by his own personal examination of the nature of the material to be excavated. No claim for extras arising from his having failed to do this will be entertained.

Should the Contractor deem that the excavations are of such a hardness as to warrant payment on the basis of hard pickable material, rock concrete or brickwork he is to notify the Architect and the Quantity Surveyor, in writing, while such excavations are in progress whereupon the Quantity Surveyor in consultation with the Architect will inspect the excavations. The decision of the Architect and the Quantity Surveyor as to the nature of the excavations being carried out will be final and binding. If written notice is not given the excavation will be valued as pickable material.

PUMPING

The Contractor must keep the works entirely clear of mud, surface and sub-soil water by baling, pumping, etc. Stop off or pipe away all springs that may be opened up.

PLANKING AND STRUTTING

Planking and strutting is to be provided where deemed necessary by the Contractor. Should any ground fall in owing to omission or insufficiency of planking and strutting, it must be cleared away, refilled and rammed as directed at the Contractor's own expense.

EXCAVATIONS GENERALLY

Excavations have been measured nett and no extra quantity will be allowed if excavations are executed too wide irrespective of the class of materials encountered, or FOR INCREASE in bulk or planking and strutting.

All excavations shall be executed to the depths shown or as may be directed to ensure a solid bottom. Should the Contractor excavate below the levels shown or required to obtain a solid bottom he shall fill up the excavations to the correct level with Concrete (Grade 10) at his own expense.

The Contractor shall give notice to the Architect when the excavations are ready to receive the foundations and concrete shall not be laid until the excavations have been inspected and approved.

No work shall commence, or be continued, in excavations which have been flooded until permission has been obtained from the Architect.

NOTICE TO QUANTITY SURVEYOR

The Contractor is to give notice to the Quantity Surveyor, in writing, when the excavations are completed to the approved level and before any concreting is done in order that all provisional work may be measured and adjusted as necessary. The final depth of all foundations, bases, etc., is to be decided on site.
FILLING

Filling under floors, steps, etc., to be an approved non-expansive material obtained from the excavations or carted on to the site, and to be inert and free from all clay, vegetable or other deleterious matter. Filling to be sifted if necessary.

All consolidated filling is to be well watered, consolidated and rammed by means of a mechanical ramming machine in layers of not more than 150 mm thick. Where required the compaction is to be to the density stated.

NOTE: All filling has been measured NETT and no extra quantity will be allowed for consolidation and compaction.

SURPLUS MATERIAL

Surplus material from the excavations which is not to be used is to be carted off the site and will become the property of the Contractor.

GRAVEL

Gravel to be nominal 40 mm maximum size graded to comply with B.S. 2006/1962 Table 4 and to be compacted to the density stated.

HARDCORE

Hardcore to be stone, brick or other hard dry material broken to pass a 50 mm ring and be retained on a 20 mm ring and well consolidated as described for filling.

COMPACITION TESTS

Only tests ordered by the Architect will be for the Client’s account, however the costs of any subsequent tests due to failure of the tests previously ordered shall be to the Contractor’s account.

TERMITE TREATMENT

Where the application of termite treatment is required the following materials and quantities are to be used:-

Termicide “A” soil insecticide mixed with water at the rate of one litre of insecticide to ninety five litres of water and this solution to be applied at a rate of 5 litres per square metre of the surface treated. The treatment to be executed by an approved firm of Specialists with a written ten year guarantee.
ADDITIONAL PREAMBLES

EXPLOSIVES AND BLASTING

Blasting shall only be carried out on sections of the Works for which permission in writing shall have been given by the Engineer and shall be restricted to such hours and conditions as he may prescribe. Such permission shall not be withheld not such hours and conditions imposed unreasonably.

The Contractor shall use explosives for blasting in connection with the work only at such time and places and in such a manner as the Engineer may approve but such approval shall not relieve the Contractor from his responsibility for injury, loss, inconvenience and annoyance to persons, damage to the work and adjoining structures, roads, places and things and injury or damage to animals and property consequent on the use of such explosives. The Contractor shall be entirely liable for any accident which shall occur and shall save the Employer harmless and Indemnified from all claims arising from such use of explosives.

The Contractor shall keep in his office at the Site copies of Laws applying to the transport, storage and use of explosives and shall supply one copy of each Law to the Engineer. The Contractor shall also submit to the Engineer a copy of any instructions or notices which the Contractor may issue to his staff or workmen or post about the site in compliance with such Laws.

The Contractor shall submit to the Engineer details of the explosives which he proposes to use and of his proposals for the transport and storage of explosives.

Any use of explosives which the Contractor wishes to make, shall be carried out in accordance with the Laws and Regulations governing the supply, transport and use of explosives for the time being in force and the Contractor shall comply with any particular requirements of the Commissioner of Mines relative to this Contract.

1. Blast Warning

   The Contractor shall be responsible for the provision, installation and maintenance of ample sirens, barriers, signs, etc., to warn against and prevent access to the area affected by blasting procedures, of any personnel not associated with the Contractor. Any such measures shall be agreed with the Engineer.

2. Excavation Methods

   At the start of the excavations the Contractor shall carry out trials to demonstrate that the excavation methods which he proposes to use will achieve the required dimensions. During the progress of the Works the excavation methods shall be varied as necessary to suit all conditions which may be met and to obtain the best practicable shape and surface condition. Excavation methods shall at all times be subject to the agreement of the Engineer.

   In the case of excavation by drilling and blasting the Contractor shall use methods which will take out the excavation as nearly as possible to the sizes required with a minimum of overbreak and a minimum of disturbance or fracturing beyond the required excavation lines. Blasting or excavation methods which cause unnecessary disturbance or fracturing beyond the excavation lines shall not be permitted.

   The finished faces of excavations shall be scaled to ensure that loose and insecure fragments are removed. Any material which projects inside the required excavation line shall also be removed.

No overbreak due to excessive use of explosives shall be greater than 400 mm beyond the excavation line. Where appropriate, the Contractor may be asked to presplit to the excavation line for which no additional payment may be made.

CLASSIFICATION OF EXCAVATION

For the purposes of measurement of excavation the excavation will be classified as follows:
1. Excavation in ‘rock’ for which purpose rock is defined as:
   a) undecomposed rock occurring in bulk or banks or ledges, the practicable excavation of which requires explosives or drilling, wedging and splitting;
   b) undecomposed boulder each exceeding 0.20 cubic metres in volume.

2. Excavation in ‘hard’ which will be held to be material other than ‘rock’, the economically practicable excavation of which necessitates the use of mechanical breakers, or ripping by bulldozer, or which reduce the rate of excavation of a backacting excavator having a power of at least 0.1 kW per millimetre width of bucket to one third or less of that achieved by the same excavator in soft excavation at a similar depth.

   Laterite, ironpan and cemented gravels will generally fall into this category.

3. Excavation in ‘normal’, which will be held to be all other material not falling into the categories of ‘rock’ or ‘hard’ and will include all loose, decomposed boulders less than 0.20 cubic metre in volume.

   For purposes of payment, items are included in the Bill of Quantities for excavation in the foregoing three classes. The classification of material into these classes shall be agreed by the Engineer and the Contractor as the work proceeds and material shall only be classified as ‘rock’ or ‘hard’ when the Engineer has given his agreement prior to its removal. In the event of a dispute over the classification of materials, the ruling of the Engineer shall be final and binding subject to the terms of the General Conditions of Contract.

   **********
CONCRETE, FORMWORK AND REINFORCEMENT

SPECIFICATION OF MATERIALS AND WORKMANSHIP

1.0 TECHNICAL DEFINITIONS

This specification shall be read in conjunction with the Engineer’s Specification covering Architectural Concrete Finishes' and the Structural Preliminaries clauses.

a) Approved/Approval:
   Approval/Approved in writing by the Engineer (unless otherwise stated). Approval by the Engineer of any item shall not relieve the Contractor of his responsibilities for the adequacy of such item except as may be allowed in the General Conditions of Contract.

b) BS:
   British Standard

SAZS:
   Standards Association of Zimbabwe Standard

1.1 STANDARDS

In all cases, the current issue of a quoted standard, including all amendments, at the commencement of the Contract will apply unless noted otherwise in this Specification. The Contractor should be familiar with the requirements of the quoted standards.

Unless modified by this Specification all concrete, sampling, testing and compliance shall be to BS 5328. In cases of conflict this Specification takes precedence over BS 5328.

2.0 RECORDS

The Contractor shall, with respect to all portions of the Works, maintain written records that contain the following.

a) The date on which each portion was concreted, the concrete grade used, records of all sampling and testing carried out as directed under this Specification, records of all ready-mix or site batched concrete and the manufacturers' batch numbers from the cement used.

b) Daily weather conditions including maximum and minimum temperatures.

c) The location of all samples in the Works and the nature of the samples or testing carried out.

d) Results from all sampling and testing.

   These records, or a copy thereof, shall be available for inspection at all times on the site.

3.0 MATERIALS

3.1 GENERAL

Before any concrete is supplied to the Works, the Contractor shall provide the following, which shall confirm compliance with specified requirements.


b) Information on aggregates in accordance with SAZS : 233 : 1978.
c) Evidence of suitability of concrete mix to Clause 7.5.

d) Workability of concrete mix.

e) All other information regarding constituent materials required by this Specification.

3.2 CEMENT

a) Only Portland Cement (PC) to SAzs : 307 : 1993 is to be used for this project and may be supplied from more than one Manufacturer. Such cement shall only be used independently of all other cement. Concrete containing mixed cement will not be accepted.

b) The Contractor shall seek approval for the types of cement he proposes to use.

c) All cement shall conform to SAzs : 307 : 1993. The Manufacturers’ certificates of testing including compressive strength tests carried out, shall be kept in the Site Records. Records must reflect all batches of cement supplied to the Works.

d) Uniformity of colour is required in the Architectural Concrete finishes and shall be as directed in the Engineer’s Specification.

3.3 WATER

All water shall be potable, clean and free from damaging levels of oil, acids, alkalis, organic matter or other deleterious substances. If water is not supplied from the Municipal mains, the Contractor shall arrange for tests to be carried out to BS 3148.

3.4 AGGREGATES

All aggregate shall conform to SAzs:233:1978.

The Contractor shall ensure that sufficient supplies of course and fine aggregate of the quality, colour and type approved are available to complete the works.

Aggregates having a water absorption greater than 4% by weight shall not be used.

3.5 ADMIXTURES

Admixtures may only be used in the Works with the written permission of the Engineer. Concrete admixtures shall comply with BS 5075. Acceptance of admixtures into the Works will only be made upon provision of satisfactory information relating to source, type, dosage, justification for use and evidence of suitable performance.

Calcium chloride thyocyanates or admixtures containing more than 0.1 per cent chloride ions are not permitted in concrete containing reinforcement, prestressing tendons or other embedded metal or in concrete made with cement complying with BS 915 or BS 4248.

3.6 CHANGES IN CONSTITUENT MATERIALS

The Contractor shall not make any changes in the source or nature of any of the constituent materials or any change greater than 20 kg/m³ in the cement content without first providing evidence that the proposed changes will provide concrete of the required quality, and obtaining the written approval of the Engineer.

3.7 REINFORCEMENT

The types of reinforcement will be identified on Schedules by prefixes to the bar mark numbers.

The prefixes have the following meanings.
a) R: Plain round hot rolled mild steel bars with a characteristic strength of 250 N/mm² and complying with BS 4449.

b) X: Type 1 deformed high yield steel bars with a characteristic strength of 410 N/mm² and complying with BS 4461:1978.

Welded wire mesh fabric shall comply with BS 4483.

3.8 SPACERS AND LIFTING BLOCKS

Spacers and lifting blocks required to positively hold the reinforcement in position prior to concreting shall be sufficiently strong for the purpose required. They shall be provided with fixing devices suitable for maintaining the units in the correct position during concreting.

They shall be made of concrete, sand-cement mortar or shall be approved patent units manufactured of a material which will not corrode, rot or otherwise degrade.

The units will be compatible with the type of finish specified. Spacer blocks in exposed concrete will be made from the same materials used in the surrounding concrete.

3.9 EXPANSION JOINT FORMERS

Materials used to form expansion joints shall be rigidly held in position during concreting, shall not deteriorate or distort when wet and shall be easily removed from the formed joint without damaging the finished concrete.

The Contractor shall submit details of the material he proposes to use.

3.10 EXPANSION JOINT FILLERS

Where directed to do so, the Contractor will fill expansion joint spaces with a filler approved by the Engineer.

3.11 EXPANSION JOINT SEALERS

Where directed to do so, the Contractor will seal expansion joints with a sealer approved by the Engineer.

3.12 WATERBARS

Waterbars shall be extruded form rubber, synthetic rubber or virgin PVC. They shall be jointed with purpose made junction pieces and in accordance with the manufacturer's written instructions.

3.13 HOLLOW CONCRETE BLOCK

Hollow blocks shall conform to the sizes and weights as given on the drawings.

3.14 RELEASE AGENTS

Release agents shall be materials marketed as such and shall be one of the following types:

a) cream emulsion provided it is not subject to freezing;

b) neat oil with surfactant added;

c) chemical release agent; or

d) non-staining mineral oil.
Concrete

Release agents shall be stored and used strictly in accordance with the Manufacturer's written instructions.

3.15 SUBSTITUTION OF MATERIALS

No materials shall be substituted without the approval of the Engineer.

4.0 STORAGE OF MATERIALS

4.1 CEMENT

a) Cement shall be stored on site under cover and off the ground in a manner that provides adequate protection against moisture and other factors which may promote deterioration. Storage in bulk in silos or similar containers is permitted.

b) Cement supplied in sacks shall be so arranged that it can be used in the order in which it was delivered to the site and should not be stacked higher than 12 sacks at a time.

c) Cement shall not be kept in storage for longer than 6 weeks without the Engineer's permission.

4.2 AGGREGATES

Aggregates shall be stored on hard paved, self-draining areas or in suitable hoppers or containers.

Aggregates of different nominal size or source shall be stored separately. Intermixing of different materials will not be permitted.

The Contractor shall ensure that contamination by foreign matter is avoided.

4.3 REINFORCEMENT

Reinforcement shall be stored clear of the ground and protected from mud, oil and other substances which may adversely affect its use in the Works. Excessive rust shall be removed by wire brushing prior to inclusion in the works unless in the opinion of the Engineer, the reinforcement falls under Clause 4.5.

Steel welded wire mesh fabric shall be delivered and stored flat.

4.4 ADMIXTURES

Admixtures shall be stored as directed in the Manufacturers' written instructions.

4.5 DETERIORATED MATERIAL

Material that has deteriorated or that has been contaminated or otherwise damaged shall not be used in concrete. Such materials shall be removed from the site without delay at the Contractor's expense.

5.0 REINFORCEMENT

5.1 BENDING

a) Reinforcing bars shall be bent to the dimensions shown on the working drawings in accordance with BS 4466:1989 'Bending dimensions and scheduling of bars for the reinforcement of concrete'.

b) All bars shall be bent cold and bending shall be done slowly, a steady, even pressure being used without jerk or impact.
c) Reinforcement shall not be cut and bent except as shown in the Bending Schedules unless specifically directed to do so by the Engineer.

d) Each bundle of bars shall be clearly tagged with their schedule and bar mark numbers.

5.2 RE-BENDING

a) Under no circumstances shall reinforcement be re-bent unless the Contractor is specifically directed to do so by the Engineer.

b) All re-bending will be to the Contractor's account unless called for on the Engineer's drawings.

5.3 FIXING

Reinforcement shall be positioned as shown on the working drawings and maintained in those positions within the tolerance given in Table 5.3. It shall be secured against displacement by tying at intersections with 16SWG soft iron wire, or other approved method, or by the use of suitable clips.

<table>
<thead>
<tr>
<th>POSITION OR TYPE OF REINFORCEMENT</th>
<th>TOLERANCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Slabs</td>
<td>+/- 75 mm</td>
</tr>
<tr>
<td><strong>Absolute position specified</strong></td>
<td>+/- 15 mm</td>
</tr>
<tr>
<td><strong>Spacing greater than 150 mm</strong></td>
<td>+/- 10 mm</td>
</tr>
<tr>
<td>*** Specified spacing less than 150 mm**</td>
<td></td>
</tr>
<tr>
<td>2. * Main bars in beams or columns</td>
<td>+/- 10 mm</td>
</tr>
<tr>
<td>3. All bars positioned in bends of other bars</td>
<td>+/- 10 mm</td>
</tr>
<tr>
<td>4. Bars not specified above - absolute position</td>
<td>+/- 50 mm</td>
</tr>
<tr>
<td><strong>Spacing</strong></td>
<td>+/- 15 mm</td>
</tr>
<tr>
<td>5. Longitudinal location of bends: end of bars</td>
<td>+/- 50 mm</td>
</tr>
<tr>
<td>6. Cover (Notwithstanding any tolerances shown above)</td>
<td>+/- 5 mm</td>
</tr>
</tbody>
</table>

* Provided that the horizontal distance between bars shall in no case be less than the nominal coarse aggregate size + 5 mm or diameter of bar whichever is greater.

7. The 'Tolerance' is defined as the maximum permissible displacement of any reinforcement from the position shown on drawings. Where one or more tolerance apply, the lesser shall govern.

5.4 SPACERS AND LIFTING BLOCKS

a) The Contractor shall provide spacers or lifting blocks in order to form and maintain the cover as required in Clause 3.8.

b) Stools for supporting top reinforcement will be shown on the Drawings.

5.5 COVER

The concrete cover to the reinforcement shall be as shown on the drawings. If not so shown the cover shall be as indicated in Table 5.5. The Contractor shall obtain the exposure rating from the Engineer.
Table 5.5 - Nominal Cover to Reinforcement

<table>
<thead>
<tr>
<th></th>
<th>Nominal Cover (mm)</th>
<th>Concrete Grade (MPa)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>20</td>
<td>25</td>
</tr>
<tr>
<td>Mild: e.g. completely protected against weather or aggressive conditions during construction. Plastered and unplastered interior work.</td>
<td>25</td>
<td>25</td>
</tr>
<tr>
<td>Moderate: e.g. sheltered from severe rain and not subject to freezing whilst saturated. Buried in non aggressive soil and concrete continuously under water.</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Severe: e.g. exposed to driving rain, alternately wet and dry and subject to freezing when wet. Subject to heavy condensation or corrosive fumes. Buried in aggressive soils.</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Very Severe</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Note: The above covers are a minimum to any reinforcement including links.

5.6 SPICING

Splicing or joining of reinforcing bars shall be made only as and where shown on the drawings. Welding will not be permitted.

5.7 PROTECTION OF EXPOSED BARS AND RUST STAINING

Reinforcement exposed for future bonding of extensions to the works shall be protected from corrosion by coating the bars with cement grout once all rust has been removed. Rust must be removed by wire brushing or a similar approved method.

Concrete surfaces which will be exposed to view in the finished works shall be protected from staining due to rusting of projecting reinforcement if that reinforcement is to be left exposed for a protracted period.

6.0 FORMWORK AND FALSEWORK

Prior to any construction in the Works, the Contractor shall provide details of the systems of formwork and falsework he proposes to use to form all main structural members and concrete requiring formed finishes.

6.1 DESIGN

a) Formwork shall be so designed and constructed that the concrete can be properly placed and compacted and that the required shapes, positions, levels and dimensions of the concrete work as shown on working drawings are maintained, subject to the tolerances specified, due attention being paid to the accumulation of error when modular formwork is used.

b) The formwork and its supports (together referred to as falsework) shall be capable of resisting with an adequate factor of safety all construction loads, wind forces and all other superimposed loads and forces. Supports shall be adequately braced and suitable precautions shall be taken to protect the falsework against possible impact. The construction shall allow for stripping without jarring or damaging the concrete.
c) Joints in forms shall be tight enough to prevent leakage of cement paste. All sharp corners shall have a 25 x 25 mm fillet unless otherwise shown on the drawings.

d) Wedges and clamps shall be used in preference to nails. Wedges shall be used in pairs. Tie rods are preferable to wire ties. This specification calls for vibrated concrete and adequate cognisance shall be taken of this in the design of the formwork.

e) No metal part of any device for maintaining formwork in the correct location shall remain permanently within the specified concrete cover to the reinforcement.

6.2 CAMBERS

Unless specifically directed to do so on the drawings, or in the Structural Preliminaries, no cambers are to be provided. Where cambers are specified, the formwork shall be constructed such that the following upward cambers exist immediately before sticking.

a) Spanning between supports - 0.2% of span at centre.

b) Cantilevers - 0.4% of span at free end.

Cambers where specified shall be 'domed' and not 'ridged'.

6.3 FORMWORK

6.3.1 Materials

a) Timber used for formwork shall be sound, well seasoned and free from loose knots, large cracks, warping and other defects.

b) Steel forms shall be capable of remaining true to shape. Forms which do not provide a smooth surface or cannot be properly aligned shall not be used.

c) Plywood, blockboard or similar sheeting shall be in good condition. Sheeting which has become excessively porous shall not be used.

d) All bolt and rivet heads which will be in contact with the concrete surface shall be countersunk flush with the surrounding surface.

6.3.2 Ties

a) The type of ties used and their position shall be such that the finish required is achieved and is not marred by subsequent corrosion.

b) Ties shall not cause holes to be formed in excess of 1 000 square millimetre per square metre in cross-sectional area.

c) Unless otherwise required in terms of specific finishes, holes exceeding 300 square millimetres in cross-sectional area shall be plugged with an approved concrete mix. Smaller holes are to be filled with approved dry pack mortar.

d) Approved temporary bolts through the concrete shall be allowed but all such bolts shall be removed and the bolt holes shall be thoroughly grouted with a cement/sand grout of the same colour as the surrounding concrete. The ratio of cement to sand in the grout shall be the same as the ratio of cement to sand in the concrete. The concrete surface at the holes shall be made flush and neat to the satisfaction of the Engineer. Wire connectors through 'off shutter' concrete shall not be allowed. All ferrule or other fastening devices shall present a neat, uniform, tidy pattern to the Engineer's approval.
6.3.3 Repair of Formwork

Damaged formwork shall not be reused if, in the opinion of the Engineer the making good would impair the surface appearance of the concrete.

6.3.4 Re-use of Formwork

Before re-use, all form surfaces that are to be in contact with the concrete shall be thoroughly cleaned without unduly damaging the surfaces of the formwork, and where applicable, reconditioned. The cleaning and reconditioning shall be consistent with the quality of the required finish.

6.3.5 Openings

Where necessary for cleaning, inspection, or placing purposes, temporary openings may be provided in the formwork and care to be taken to ensure that 'off shutter' finishes are not impaired.

6.3.6 Preparation of Formwork

a) Surfaces that are to be in contact with fresh (wet) concrete shall be so treated as below to ensure non-adhesion and easy release of formwork during stripping. Every precaution shall be taken to avoid contamination of the reinforcement during this application.

Timber forms shall be thoroughly wetted or coated with an approved release agent. Steel forms shall be coated with an approved release agent.

b) Formwork which is to receive concrete shall be thoroughly cleaned of all foreign matter before casting.

6.3.7 Formed Surfaces

a) There will be three classes of formed surface according to the standard of surface finish required and the type of form permitted.

b) Appropriate forms must be used to achieve the required finish. The quality of the surface of the concrete on removal of the forms shall be as shown below.

c) Special care shall be taken to protect 'off-shutter concrete finish' surfaces from damage due to construction operations or other causes. All such protective measures shall be to the satisfaction of the Engineer.

d) Finishes shall be as shown in table 6.3.7.
Table 6.3.7 - Formed Surfaces

<table>
<thead>
<tr>
<th>CLASS</th>
<th>DESCRIPTION</th>
<th>TYPE OF FINISH</th>
</tr>
</thead>
<tbody>
<tr>
<td>F1</td>
<td>General</td>
<td>As would be obtained from the use of sawn timber or used steel plates. Forms may consist of any suitable material.</td>
</tr>
<tr>
<td>F2</td>
<td>Fairface</td>
<td>As would be obtained from the use of plywood face shuttering boards or steel forms providing a comparable finish, including sawn timber fillets to all corners. The joints shall be arranged in a grid pattern to the satisfaction of the Engineer.</td>
</tr>
<tr>
<td>F3</td>
<td>Rubbed Fairface</td>
<td>As for F2 surface except that immediately on removal of the forms the surface of the concrete shall be well washed with water after which a Portland Cement wash shall be applied and rubbed in with Carbonundum blocks until the resulting surfaces meets with the Engineer's approval. Any fins or blemishes shall be removed. This operation shall be completed within 48 hours of the removal of the form.</td>
</tr>
<tr>
<td>F4</td>
<td>High Quality Off-Shutter</td>
<td>As would be obtained by the use of new steel forms or smooth pressed hardboard. The Contractor will be required to construct a prototype panel for acceptance by the Engineer prior to construction of any F4 surfaces. Once approved, this will form the standard for acceptance of future work.</td>
</tr>
</tbody>
</table>

6.3.8 UNFORMED SURFACES

a) There will be three classes of unformed surface according to the standard of surface finish required.

b) Finishes shall be as shown in Table 6.3.8.

Table 6.3.8 - Unformed Surfaces

<table>
<thead>
<tr>
<th>CLASS</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>U2 General</td>
<td>The Concrete shall be uniformly levelled and screeded to produce a uniform plain or ridged surface. Surplus concrete shall be struck off by a straight edge immediately after compaction.</td>
</tr>
<tr>
<td>U2 Trowelled</td>
<td>After the concrete has stiffened sufficiently, the type U1 finish shall be floated by hand, or machine, sufficiently to produce a uniform surface free form screed marks.</td>
</tr>
<tr>
<td>U3 High Quality Trowelled</td>
<td>When the surface moisture has disappeared and the concrete has stiffened to prevent laitence from being worked to the surface a type U1 finish shall be steel-trowelled under firm pressure to produce a dense, smooth surface free from travel marks.</td>
</tr>
</tbody>
</table>

6.4 FALSEWORK

6.4.1 Propping Details

a) Not less than two weeks before the start of any pour requiring props, the Contractor shall provide details of the system he intends to use.

b) An appropriate foundation for the falsework shall be prepared so as to afford reasonable protection against undue settlement.
c) Falsework shall be adequately braced to prevent movement due to all possible loadings including accidental loading.

d) Falsework shall be constructed such that it can be easily removed without causing damage to the concrete.

e) Falsework shall be constructed such that it can be removed in the sequence shown on the drawings or as directed by good practice.

f) Falsework shall be constructed such that it does not permit undue deflection during placing and compaction of the concrete.

6.4.2 Prop Spacing

Spacing of props will depend on which, if any, proprietary system the Contractor wishes to use. Regardless of any other constraint, all members shall be supported between permanent supports at no more than 2.0 m centres in each direction.

6.5 REMOVAL OF FORMWORK AND FALSEWORK

a) Formwork and falsework shall not be removed until the concrete has attained sufficient strength to support its own mass and loads that may be imposed upon it.

b) The structure shall not be distorted, damaged or overloaded in any way by the removal of formwork and falsework.

c) The responsibility for the safe removal of any part of the formwork or falsework shall rest with the Contractor.

6.5.1 Minimum Striking Period

a) Forms may not be struck until the concrete has attained the age or strength specified in Table 6.5.1. To prove that the concrete has reached the strength specified in the table, cubes that have been cured under the same conditions as the concrete in the member under consideration, shall be crushed.

b) Formwork shall be removed carefully so that shock and damage to the concrete are avoided. It should be noted that Table 6.5.1 specifies minimum times. These should be increased in the case of special finishes which may be sensitive to damage.

c) Weather may be regarded as 'normal' when the mean atmospheric temperature adjacent to the concrete, as measured by a maximum and minimum thermometer, does not fall below 15 degrees C and as 'cold' when the temperature measured similarly falls below 5 degrees C. When mean temperatures are between those values, stripping times shall not be less than the intermediate values determined by linear interpolation between the specified periods.

d) The striking of forms but not props may be approved if the Contractor can show that this can be done without damage to the concrete.
Table 6.5.1 - Removal of Formwork: Minimum Time in Days

<table>
<thead>
<tr>
<th>Type of structural member of formwork</th>
<th>Alternative strength as % of 28 day strength</th>
<th>Type of cement used</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>OPC PC15 Weather</td>
</tr>
<tr>
<td></td>
<td></td>
<td>N</td>
</tr>
<tr>
<td></td>
<td></td>
<td>PC45 Weather</td>
</tr>
<tr>
<td></td>
<td></td>
<td>N</td>
</tr>
<tr>
<td>1. Beam sides, walls and unloaded columns less than 300 mm thick</td>
<td>20%</td>
<td>2</td>
</tr>
<tr>
<td>2. Ditto but not less than 300 mm thick</td>
<td>20%</td>
<td>1</td>
</tr>
<tr>
<td>3. Slabs with props left under</td>
<td>40%</td>
<td>4</td>
</tr>
<tr>
<td>4. Beam soffits with props left under</td>
<td>60%</td>
<td>7</td>
</tr>
<tr>
<td>5. Beam props except cantilever beams</td>
<td>70%</td>
<td>14</td>
</tr>
<tr>
<td>6. Cantilever beams</td>
<td>100%</td>
<td>-</td>
</tr>
<tr>
<td>7. Slab props</td>
<td>70%</td>
<td>10</td>
</tr>
</tbody>
</table>

N = Normal  
C = Cold

6.5.2 Subsequent Construction

The Contractor shall not impose construction loads on slabs and beams in excess of the design loads shown on the drawings and shall retain the propping in position unless such loads are adequately accommodated. Where floor slab construction is required to support subsequent floor construction over, the new construction shall be supported by means of propping the number of floors shown in Table 6.5.2. Such props shall be placed vertically above each other through the required floors.

Table 6.5.2 - Number of Supporting Floors

<table>
<thead>
<tr>
<th>CONSTRUCTION CYCLE IN DAYS</th>
<th>HOT WEATHER</th>
<th>COLD WEATHER</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td>5,6</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>7-9</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>10-13</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>14 and over</td>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>

At the discretion of the Engineer the above number of days given in Table 6.5.2 may be reduced or increased. In such cases the Engineer will confirm to the Contractor in writing the revised duration.

7.0 CONCRETE

7.1 GENERAL

a) The Contractor will be responsible for the design of the concrete mix and for the proportions and suitability of its constituent materials necessary to produce concrete that complies with the requirements set out in Table 7.2.

b) Due consideration shall be given to the production of concrete with minimal bleeding, segregation and shrinkage characteristics. The Contractor shall carry the entire responsibility
for any defects that may arise from bleeding of the concrete unless such defects flow from construction procedures stipulated by the Engineer.

c) The concrete shall have maximum density and minimum free water content consistent with the required strength and workability.

d) Mix proportions must in addition to all other requirements be compatible with the specified surface finish and exposure conditions.

e) Concrete grades will be as shown on the drawings. Trial mixes and tests shall be carried out on concrete grades 25, 30 and 35 MPa.

7.2 CONCRETE MIXES

a) Not less than two weeks before the start of any concrete work on the site, the Contractor shall submit to the Engineer, for his information and approval a statement of mix design. This statement shall provide the following information for each class of concrete.

Mix proportions:  
- Water/cement ratio
- Type and quantity of additives
- Target slump
- Target mean strength

For all concrete the Contractor shall submit a method to be adopted for adjusting the amount of water added to compensate for variation in the moisture content of the aggregate.

b) The type of aggregate and cement, their sources of supply, shall not be altered during the currency of the contract without the prior written agreement of or instruction from, the Engineer.

c) The schedule of specified requirements for concrete mixes is given in Table 7.2. Proportion and design mixes shall have concrete slump limits at point of placement of not less than 25 mm and no more than 100 mm.

Table 7.2 - Schedule of Specified Requirements of Concrete Mixes

<table>
<thead>
<tr>
<th>MIX DESCRIPTION</th>
<th>C10P</th>
<th>C25</th>
<th>C30</th>
<th>C30X</th>
<th>C35</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type of mix (P, D)</td>
<td>P</td>
<td>D</td>
<td>D</td>
<td>D</td>
<td>D</td>
</tr>
<tr>
<td>Type of Cement, SAZS 307</td>
<td>PC15</td>
<td>PC15</td>
<td>PC15</td>
<td>PC45</td>
<td>PC15</td>
</tr>
<tr>
<td>Nominal aggregate max size (mm)</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>Grade</td>
<td>10</td>
<td>25</td>
<td>30</td>
<td>30</td>
<td>35</td>
</tr>
<tr>
<td>Minimum cement content (kg/m³)</td>
<td>NR</td>
<td>250</td>
<td>275</td>
<td>275</td>
<td>300</td>
</tr>
<tr>
<td>Sampling rate (m³)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maximum free-water/cement ratio</td>
<td>0.49</td>
<td>0.49</td>
<td>0.40</td>
<td>0.40</td>
<td>0.40</td>
</tr>
<tr>
<td>Admixtures Permitted</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Temp of fresh conc. (°C) max/min</td>
<td>30°C</td>
<td>30°C</td>
<td>30°C</td>
<td>30°C</td>
<td>30°C</td>
</tr>
<tr>
<td>Density of conc. (kg/m³) max/min</td>
<td>2500</td>
<td>2500</td>
<td>2500</td>
<td>2500</td>
<td>2500</td>
</tr>
</tbody>
</table>

P = Prescribed  
D = Designed  
NR = No special requirements

7.3 CONSISTENCY AND WORKABILITY
a) Unless the Contractor proposes to use other approved methods of controlling the amount of water added, slump tests shall be carried out sufficiently frequently to ensure that measurable variations in the moisture content are allowed for.

b) Slump measurement, shall be taken in accordance with Clause 12.4 and shall conform with the approved values of the slump given in the "Mix Proportion Statement" of Clause 7.2(b).

c) The concrete shall be of such a workability that it can readily be compacted into the corners of the formwork and around reinforcement and produce the required standard of finish.

7.4 EVIDENCE OF SUITABILITY OF CONCRETE MIXES

7.4.1 General

Before concrete is supplied to the Works, evidence shall be provided for each grade of concrete showing that, at the intended workability, the proposed mix proportions and manufacturing method will produce concrete of the required quality.

Sampling and testing shall be in accordance with BS 1881.

7.4.2 Strength

The evidence shall comprise either:

i) The results of cube tests on at least 40 separate batches of concrete of nominally similar proportions of similar materials and produced within the preceding 12 months over a period not less than 5 days but not exceeding 5 months by the same plant under similar supervision.

These results shall demonstrate that the mean strength of the concrete mix exceeds the specified characteristic strength by more than 1.64 times the standard deviation of the results.

OR

ii) The results of trial mixes from three separate batches of concrete each made using the proposed mix and constituent materials and under full scale production conditions.

The workability of each trial batch shall be determined and shall be within the tolerances stated in BS 5328.

Three cubes shall be made from each batch, and shall be tested at 28 days. The average strength of the nine 28 day cubes shall exceed the specified characteristic strength by not less than 11.5 N/mm². Alternatively, earlier tests on nine cubes shall demonstrate that the specified characteristic strength will be exceeded by 11.5 N/mm².

8.0 MEASURING OF MATERIALS

8.1 CEMENT

Cement supplied in standard sacks shall be assumed to contain 50 kg equivalent to 0.033 cubic metres. All cement taken from bulk storage containers and from open or partially used sacks shall be batched by mass, the weighing device having an accuracy within 2 per cent of the mass of cement required for the batch.

8.2 WATER

Mixing water for each batch shall be measured, either by mass or by volume, to an accuracy of within 2 per cent.

8.3 AGGREGATES
Aggregates shall be gauged either by mass or by volume as set out below except that gauging by volume will not be permitted for concrete of characteristic 28 day strength greater than 20 MPa.

8.3.1 **Batching by Mass**

All aggregates shall be weighted. Weighing devices shall be maintained in good order and shall have an accuracy of within 5 per cent.

8.3.2 **Batching by Volume**

The fine and coarse aggregates shall be measured separately in suitable measuring boxes or barrows of such capacity that the quantities of aggregates for each batch are gauged into the mixer.

Batching boxes shall be filled without tamping, ramming or consolidation of any kind other than that occurring naturally during the filling prices, and shall be screened off level with their topmost edges. Any adjustment of the volume shall be made by supplementary containers of a suitable size. Adjustment by the incomplete filling of the batching boxes to marks on their inside faces is not permitted.

Fine aggregate shall be tested for bulking at the following times:

a) commencement of concreting shift;
b) halfway through shift;
c) after rain occurring during a shift;
d) at any other time when it may reasonably be thought that the moisture content of the sand may have changed.

Adjustments shall be made to the batch volume to give the true volume required.

9.0 **MIXING**

9.1 **GENERAL**

Mixing of materials for concrete shall be conducted by an experienced operator. Unless otherwise approved mixing shall be carried out in a mechanical batch-mixer of approved type and capable of producing a uniform distribution of ingredients throughout the batch.

9.2 **CHARGING THE MIXER**

a) A fixed sequence of charging shall be maintained and shall be subject to the approval of the Engineer.

b) The volume of the mixed materials per batch shall not exceed the manufacturer's rated capacity of the mixer.

c) Immediately before commencing mixing, the mixer shall be primed with a mixture of sand, cement and water in the proportions of the proposed mix, sufficient being added to coat all inner surfaces of the drum, any excess being tipped to waste.

d) When admixtures are used, they shall be added to the mix in accordance with the manufacturers instructions.

9.3 **MIXING AND DISCHARGE**
Mixing shall be continued for a period sufficient to ensure a uniform blending of all ingredients. The mixer shall be operated at the speed recommended by the manufacturer. Each batch shall be completely discharged before recharging the mixer.

9.4 MAINTENANCE AND CLEANING OF THE MIXER

If the mixer has stopped running for any period in excess of 30 minutes, it shall be thoroughly cleaned out, particular attention being paid to the removal of any build-up of materials in the drum, in the loader, and around the blades or paddles. Worn or bent blades and paddles shall be replaced.

9.5 READY MIXED CONCRETE

Clause 4.5 of BS 5328:PT3:1990 shall apply in preference to those given in this section if concrete is delivered to the site "Ready mixed".

10.0 TRANSPORTING AND PLACING

10.1 SIZE OF POUR

In establishing the size of any one pour the Contractor shall give due consideration to and will be solely responsible for defects which may arise from shrinkage or bleeding of the concrete unless such defects arise from construction procedures stipulated by the Engineer.

10.2 TRANSPORTING

Mixed concrete shall be discharged from the mixer and transported to its final position in such a manner that segregation, loss of ingredients, and adulteration are prevented. The mix shall be of the required workability at the point and time of placing.

10.3 PLACING

a) The Contractor shall give the Engineer reasonable notice of his intention to place concrete. The concrete shall be placed in its final position in the forms before loss of workability occurs but in no case in excess of fifteen minutes from the time of discharge form the mixer. Re-tempering by the addition of water or other material is not permitted. The forms to be filled shall be clean internally. Excavations and contact surfaces of an absorbent nature shall be dampened but no free water shall be permitted to remain.

b) The Contractor is required to give the Engineer reasonable notice of his intention to cast concrete in any specific area and to advise the Engineer when all the shuttering, formwork and centring is completed, reinforcement placed, all pipe and conduits set in position and all holes, chases and built-in items set in order that he can in the company of the Contractor check all these items against the Engineer's drawings.

c) Wherever possible the concrete shall be deposited vertically into its final position and care shall be taken to avoid segregation and displacement of reinforcement and other embedded items.

d) The working of deposited concrete (whether by means of vibrators or otherwise) to cause it to flow laterally is prohibited. The concrete shall be brought up in horizontal layers of compacted thickness not exceeding 0.5 m and heaping shall be avoided. At the discretion of the Engineer and where practical this may be varied for instance in the case of long walls or similar structural elements.

e) Where chutes are used to convey the concrete, their slopes shall be such as not to cause segregation and suitable spouts or baffles shall be provided for the discharge of the concrete. Chutes shall be suitably "primed" in a manner similar to that specified for the mixer in Clause 9.2.
Concrete

f) Concrete shall not be allowed to fall freely through a height of more than 3 m, and it shall not be placed in water (standing or running) unless so approved, or as directed. Where it is required to deposit concrete through a height exceeding 3 m, suitable chutes shall be provided for the full drop. Casings or driving tubes for lightly reinforced piles will be considered as suitable chutes.

g) The pumping of concrete will be permitted providing the mix design complies fully with the requirements of this specification.

10.4 COMPACTATION

The concrete shall be thoroughly compacted during and immediately after placing. Compaction shall be carried out by mechanical vibration or, if approved, by spading, rodding, or forking. Over-vibration resulting in segregation, surface laitence, or leakage (or any combination of these) shall be avoided. Similarly under vibration resulting in honeycombing or low densities shall be avoided.

10.5 CONSTRUCTION JOINTS

a) Unless construction joints are shown on the drawings, the Contractor shall submit his proposals for construction joint positions. The Contractor shall obtain approval for his proposed positions.

b) Position of Construction Joints

The position of construction joints proposed by the Contractor shall be such as to avoid distress or damage to the Works particularly from thermal movement or shrinkage effects.

The position and spacing of joints which will be acceptable will vary from place to place but the following table gives an indication of acceptable limits.

<table>
<thead>
<tr>
<th>CONSTRUCTION</th>
<th>MAXIMUM AREA (M²)</th>
<th>MAXIMUM DIMENSION (M)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Watertight walls</td>
<td>25</td>
<td>5</td>
</tr>
<tr>
<td>Watertight slabs</td>
<td>100</td>
<td>10</td>
</tr>
<tr>
<td>Slabs with major restraint at both ends</td>
<td>100</td>
<td>13</td>
</tr>
<tr>
<td>Slabs with major restraint at one end only</td>
<td>250</td>
<td>20</td>
</tr>
<tr>
<td>Slabs with little restraint in any direction</td>
<td>500</td>
<td>30</td>
</tr>
<tr>
<td>Walls</td>
<td>40</td>
<td>10</td>
</tr>
</tbody>
</table>

Table 10.5 - Construction Joints

Where the Contractor's proposals result in alterations to the reinforcement the Contractor shall be responsible for providing full revised details for approval prior to the work commencing on site.

c) Concreting shall proceed uninterrupted up to stopping points shown on the drawings or as approved. All construction joints inclined at an angle during compaction shall be formed against a face which will prevent flows and excess loss of mortar.
If, in an emergency concreting has to be interrupted, a construction joint shall be formed which will least impair the durability, appearance, and functioning of the concrete. If in the opinion of the Engineer the construction joint so formed is not suitable, the Contractor shall at his own expense modify the joint and cut back where required to the satisfaction of the Engineer.

The Contractor shall obtain approval of size, position and methods of making good of any temporary openings required.

When bonding fresh concrete to old concrete (and where applicable), hack away any projecting stones or fins of concrete and cut back to solid concrete. Remove any mortar leakage which may have occurred. Where the old concrete surface is smooth, lightly roughen to Engineer's approval. Clean away all loose material. Thoroughly damp down old surface (24 hours soaking where concrete is more than 3 days old). The joint may at the Contractor's discretion be covered with a layer of mortar not exceeding 10 mm thick and composed of cement and sand mixed in the same ratio as the cement and sand in the concrete mixture. This mortar shall be freshly mixed and placed immediately before the placing of new concrete.

Construction joints in "off-shutter concrete finish" shall be so arranged as to limit rain water streaking and weather boards shall be erected where directed by the Engineer. The Contractor shall be held solely responsible for all discoloration caused by rain water streaking, grout spillage or other causes and all such discoloured work shall, where required by the Engineer, be replaced or repaired at the Contractor's expense. The Contractor shall take note of the fact that grout spillage cannot be successfully removed by subsequent washing and wire brushing.

10.6 CASTING AGAINST EXISTING STRUCTURES

All new concrete work shall be separated from adjoining work by means of 12 mm (minimum) thick soft fibreboard or other suitable bond breaking material.

When casting against masonry or similar walls, one layer of bitumastic paint shall be applied.

Concrete shall not be cast in such lifts as will exert excessive pressure on existing adjoining structures or part of structures.

10.7 CURING AND PROTECTION

a) Formwork shall be retained in position for the appropriate period given to Clause 6.5, and, as soon as it is removed, all concrete shall be protected from contamination and loss of moisture by one or more of the following methods:-

i) Ponding the exposed surfaces by means of water, except where atmospheric temperatures are low, i.e. less than 5 degrees C.

ii) Covering with sand, or mats made of a moisture retaining material, and keeping the covering continuously wet.

iii) Continuous mist spraying of the exposed surfaces with water.

iv) Covering with a waterproof or plastic sheeting firmly anchored at the edges.

v) Using liquid curing membrane in accordance with the Manufacturers' written instructions and approved by the Engineer.

b) Intermittent hosing by hand will not be permitted.

c) Whatever method of curing is adopted, its application shall not cause staining, contamination, or marring of the surface of the concrete.
d) The curing period shall be at least 5 days for concrete made with Portland cement, and at least 7 days if PC45 cement is used. When atmospheric temperatures are below 5 degrees C these minimum curing periods shall be extended by 3 and 4 days respectively.

e) Freshly placed concrete shall be protected against heavy rainfall and flowing water for at least 12 hours after placing.

10.8 ADVERSE WEATHER CONDITIONS

a) Cold Weather

When the surrounding atmospheric temperature falls below 5 degrees C, effective measures shall be taken to ensure that the temperature of the concrete from the time of placing is maintained above 5 degrees C for 5 days. All surfaces shall be protected from ice or frost damage.

b) Hot Weather

When the surrounding atmospheric temperature is over 32 degrees C the temperature of the concrete when deposited shall not be allowed to exceed this figure. All metal contact surfaces shall be cooled by spraying with water.

c) It should be noted that a combination of Low Humidity, High Concrete Temperature, High Atmospheric Temperature and High Wind or various combinations of these phenomena, will cause very rapid evaporation from the concrete surface. Appropriate measures should be taken to prevent excessive evaporation.

11.0 CONSTRUCTION DETAILS

11.1 HOLES, CHASES AND BUILT-IN ITEMS

a) No holes or chases other than those shown on the Drawings or approved by the Engineer shall be cut or otherwise formed in the concrete.

b) Holes and openings left in concrete structures for passage of work by other trades, unless otherwise shown or directed, after work of other trades is in place shall be filled in to Engineer's approval.

c) No items for the attachment of fixtures shall be embedded in the concrete unless approved by the Engineer.

d) Built-in items shall be positioned in accordance with the relevant tolerances and shall be securely held in position during concreting. Unless otherwise shown on the drawings items which are to be incorporated into cambered members shall be suitably curved to match the required camber.

11.2 PIPES AND CONDUITS

The location of pipes or conduits embedded in the concrete are subject to the Engineer's approval. The clear space between any such pipes and the clear distance between such a pipe and any reinforcement shall be at least 40 mm or the maximum size of the course aggregate plus 5 mm whichever is greater. The amount of concrete cover over pipes and fittings shall be at least 25 mm.

11.3 EXPANSION JOINTS

Expansion joints shall be formed as shown on the drawings. Adequate care shall be taken to ensure that any joint filler will be securely retained or easily removed, as may be required.

11.4 WATERBARS
Waterbars shall be securely maintained in the desired positions during concreting.

11.5 HOLLOW BLOCKS

Hollow blocks incorporated in the concrete work shall be thoroughly wetted immediately prior to receiving concrete but no free-standing water shall be permitted. Open ends of hollow blocks which are to butt against concrete shall be blocked off with a mortar filler 10 mm to 15 mm thick prior to the blocks being placed in position.

11.6 PATCHING

After removal of the forms, if the concrete shows any defect or if subsequently any defect attributable to the quality of the concrete or its constituents should develop, the Contractor shall at his own cost, on and in accordance with instructions from the Engineer, remove all defective concrete and replace it or make good such defects. The method of making good shall be approved by the Engineer. No patching or making good shall be carried out by the Contractor without the prior approval of the Engineer.

The Engineer's approval of the proposed patching technique shall be obtained at the start of the contract and all patching shall be done under the strict supervision of the foreman. Only work which is unsatisfactorily in limited respects and not classed as defective shall be allowed to be patched.

12.0 SAMPLING AND TESTING

12.1 SAMPLING, TESTING IN GENERAL CERTIFICATES

a) The Engineer shall have free access to the work for the selection of samples and for carrying out tests. The Contractor shall render any assistance necessary for the taking of the samples and for carrying out the tests. If so required, the Contractor shall provide storage and protection for such samples on the site.

b) The Contractor shall provide manufacturer's test certificates if called upon to do so by the Engineer. Such certificates shall be submitted within 14 days of request. The need for such certificates shall be borne in mind at the time of placing orders.

c) Not less than two weeks before the start of any concrete work on site, the Contractor shall supply to the Engineer for his information and approval, samples of the constituent materials of the concrete and items ancillary thereto, together with the necessary evidence supporting compliance with the specification. Samples of aggregate shall be supported by a grading analysis, relative density, geological report and shrinkage tests.
### Table 12.1 - Rates of Sampling and Testing

<table>
<thead>
<tr>
<th>RATES OF SAMPLING AND TESTING</th>
<th>RATE A</th>
<th>RATE B</th>
<th>RATE C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rate of Sampling</td>
<td>At Initial Stages of Contract</td>
<td>To check 3 day, 7 day &amp; 28 day Relationship</td>
<td>Minimum Rate once Quality Control Standard is Established</td>
</tr>
<tr>
<td></td>
<td>1 set per 10m³</td>
<td>1 set per 20m³</td>
<td>1 set per 50m³</td>
</tr>
<tr>
<td>Age to be Tested</td>
<td>1 at 3 Days</td>
<td>1 at 3 Days</td>
<td>2 at 7 Days</td>
</tr>
<tr>
<td></td>
<td>1 at 7 Days</td>
<td>1 at 7 Days</td>
<td>2 at 28 Days</td>
</tr>
<tr>
<td></td>
<td>2 at 28 Days</td>
<td>2 at 28 Days</td>
<td></td>
</tr>
</tbody>
</table>

During the time in which each class of concrete is being placed, samples of the concrete shall be taken at the mixer at the rate specified by the Engineer in accordance with Table 12.1 aforementioned. It should be noted that rates given in the table apply to any one mixer, each additional mixer shall be treated as a completely separate entity for the purpose of sampling and testing and will have to establish its own standard and consistency level. The minimum number of cubes to be taken on any one pour will be four, irrespective of the volume of concrete poured. The samples taken will be in accordance with BS 5328. One set of cubes is to be four cubes.

d) Testing will be carried out at the rate specified by the Engineer until a satisfactory relationship is found between the 3, 7 and 28 day strengths. The Engineer may change the sampling rate as and when he deems fit to do so.

e) The procedure for sampling, making the test cubes, curing, storing and testing and the mould used shall be in accordance with BS 1881.

f) The Contractor shall provide sufficient moulds required for the making of test cubes.

g) Cores which may be drilled in terms of Clause 14.4 shall be tested as specified in BS 1881.

h) Compressive tests shall be carried out by an independent authority approved by the Engineer.

The reports shall contain the project identification name and number, date of concrete placement, name of concrete testing authority, concrete type and class, location of concrete batch in structure, design compressive strength at 28 days, type of cement used, compressive breaking strength and slump.

12.2 GRADING ANALYSIS

The Engineer, may at any time call for a grading analysis to be made for each of the aggregates used. The analysis shall be made by the method given in SAZS:190 or as approved by the Engineer. The Engineer may call for any grading analysis to be carried out by an independent authority.

12.3 DETERMINATION OF CONSISTENCY

The slump test used to measure the consistency of the concrete mix shall be carried out by the method given in BS 1881.
12.4 BULKING OF FINE AGGREGATES

The test for determining the bulking of fine aggregates shall be carried out as described in SAZS:190.

12.5 COST OF TEST

The cost of all tests required by the Engineer shall be borne by the Owner, either as may be specifically measured in the Bills of Quantities or as allowed for as an extra to the contract, except that the costs of the following tests plus incidental expenses related to such tests shall be borne by the Contractor and shall be deemed to have been allowed for in the rates.

a) Slump tests
b) Preliminary tests required in terms of Clause 7.2
c) Bulking tests
d) Such tests (including load tests) as may, in the opinion of the Engineer, be made necessary by failure on the part of the Contractor to meet the requirements of this specification and any tests which fail to meet the requirements of this specification.

13.0 FAILURE

13.1 APPEARANCE

If in the opinion of the Engineer any concrete finishes which do not match up to the requirements of this specification shall be deemed to have failed.

13.2 CONCRETE STRENGTHS

a) Concrete form which test cubes have been prepared shall be considered as having failed if the requirements of BS 5328 are not met.
b) Concrete which exhibits defects as a result of poor workmanship, overloading during construction, fire, premature removal of formwork, bleeding and drying shrinkage shall be considered as having failed.

14.0 REMEDIAL ACTION

14.1 CONDONMENT

The Engineer, in his sole discretion and without prejudice towards any other failures, and without giving any reasons therefore may condone any failure.

14.2 APPEARANCE DEFECT

Concrete which has failed in terms of Clause 13.1 and 14.1 shall be repaired or removed and replaced, to Engineer's approval.

14.3 DIMENSION DEFECT

Concrete which has failed in terms of Clause 13.1 and 14.1 where applicable shall be treated as follow:-

a) In the case of members of excessive size, excess material shall be removed and subject to this procedure not resulting in a weakening of the member for other reasons or adversely affecting the appearance. If the member would be weakened or its appearance affected, it shall be repaired or removed and replaced.
b) In the case of undersized members, they shall be treated as for strength defect (Clause 14.4), if applicable, or they shall be built up to the required size subject to this procedure not affecting the appearance. If the appearance would be affected they shall be repaired or removed and replaced.

c) Notwithstanding the foregoing requirements of this clause, if modification of the members can be avoided by the alteration of other components this will be permitted provided it does not affect strength considerations.

d) All remedial measures shall only be carried out with prior approval of the Engineer for method and procedure.

14.4 STRENGTH DEFECTS

Where concrete has failed in terms of Clause 13.2 the Engineer may call for any or all of the following remedial measures to be implemented:-

a) Change the materials or proportions of the concrete mixture to result in 28 day strengths of at least 5 MPa higher than the target strength of the mix under consideration, to avoid a future recurrence of the defect.

b) Forthwith extend the periods of time given in Clause 6.5 up to a maximum of 14 days extension and/or Clause 10.7 up to a maximum of 28 days extension.

c) Drill and test concrete cores and/or perform non-destructive tests.

d) Strengthen the defective portion.

e) Remove and replace the defective portion.

f) Remove and replace such non-defective portions as may be required for the purposes of strengthening or removal and replacement of defective portions.

g) Carry out a load test in terms of Clause 9.5 of BS 8110 Part 2.

14.5 COSTS

Where the Contractor is found to be responsible for any failure, the following costs shall be borne by him:-

a) The cost of all tests required to establish the nature of the failure and the ultimate adequate of the portion in question (See Clause 12.6);

b) Professional fees incurred by the Employer as a result of the failure;

c) All costs incurred in strengthening, opening up, removal and replacement as applicable;

d) The cost of modifications to other components where necessary.

15.0 CONCRETE TOLERANCES

15.1 GENERAL

This section details all forms of construction tolerances. This will include all permitted deviations of the setting-out grid, levels, formed and unformed concrete finishes. All permitted deviations are deemed to be from the absolute position, dimension or level specified.
15.2 **SETTING OUT GRID**

a) The Contractor will establish a primary setting-out grid as indicated on the drawings. The absolute position of the grid relative to site datums will be as defined by the Engineer.

b) The primary setting out grid is to be monitored throughout the building at all levels. The permitted deviations of the grid are: For any grid line relative to its absolute position ±2 mm.

Permitted deviations for position given below are relative to the defined grid system.

15.3 **PERMITTED DEVIATIONS**

15.3.1 **Position of Element**

The permitted deviations relative to the grid system specified are:

<table>
<thead>
<tr>
<th>Component</th>
<th>Permitted Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Foundations</td>
<td>± 20 mm</td>
</tr>
<tr>
<td>Walls, columns</td>
<td>± 5 mm</td>
</tr>
<tr>
<td>Beams/slab edge</td>
<td>± 5 mm</td>
</tr>
<tr>
<td>Level general</td>
<td>± 5 mm subject to finish specified</td>
</tr>
<tr>
<td>Blinding level</td>
<td>± 10 - 20 mm</td>
</tr>
</tbody>
</table>

15.3.2 **Size of Element**

The permitted deviations relative to the absolute size specified are:

<table>
<thead>
<tr>
<th>Component</th>
<th>Permitted Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Foundations</td>
<td>± 20 mm - 5 mm</td>
</tr>
<tr>
<td>Walls, thickness</td>
<td>± 10 mm</td>
</tr>
<tr>
<td>Columns</td>
<td>± 5 mm</td>
</tr>
<tr>
<td>Beam thickness</td>
<td>± 5 mm</td>
</tr>
<tr>
<td>Slab thickness</td>
<td>± 10 mm - 5 mm</td>
</tr>
</tbody>
</table>

15.3.3 **Formed and Un-formed Finishes**

The permitted deviations for finished concrete faces are:

a) **Formed Surfaces:**

<table>
<thead>
<tr>
<th>Component</th>
<th>Permitted Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>General</td>
<td>± 10 mm unless specified below</td>
</tr>
<tr>
<td>Columns/beams/walls/openings etc.</td>
<td>± 3 mm</td>
</tr>
<tr>
<td>Deviation from 2m template</td>
<td>± 3 mm</td>
</tr>
<tr>
<td>Abrupt irregularities</td>
<td>± 1 mm</td>
</tr>
</tbody>
</table>

b) **Unformed surfaces:**

The permitted deviation for finished concrete faces are:

<table>
<thead>
<tr>
<th>Deviation Type</th>
<th>U1</th>
<th>U2</th>
<th>U3</th>
</tr>
</thead>
<tbody>
<tr>
<td>At any point on the surface</td>
<td>15</td>
<td>10</td>
<td>5</td>
</tr>
<tr>
<td>Deviation form 2m template</td>
<td>10</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>Abrupt irregularity</td>
<td>5</td>
<td>3</td>
<td>1</td>
</tr>
</tbody>
</table>

15.3.4 **Vertical Elements**

The permitted deviation from plumb shall be 2 mm per metre height maximum 10 mm.

Deviation from plumb is relative to each storey height and is not cumulative.
15.4 **Construction Details**

The permitted deviation from specified level and position:

- Cast in items: ± 3 mm
- Drain inverts: +0 - 5 mm

16.0 **PRECAST CONCRETE**

16.1 **GENERAL**

The requirements of the Reinforced Concrete Specification shall apply to all the precast concrete work except where specifically modified by the Clauses set out below.

16.2 **DESIGN**

16.2.1 **Precast Concrete**

All precast concrete works have been designed generally in accordance with the recommendations of British Standard Code of Practice Cp 100 and SAZS 166:1975 except where modified by this specification. Working tolerances are as set out in the final Clause of this specification.

16.3 **CONCRETE**

16.3.1 **Grout**

The grout used for filling cavities and ducts shall be made with ordinary Portland Cement and water. Subject to the approval of the Engineer additives may be used provided they do not contain chlorides or nitrates. The grout shall be sufficiently fluid to ensure that all cavities are filled completely.

16.3.2 **Mortar**

The mortar used for dry-packing in joints shall be made of ordinary Portland Cement, sand and water in the proportions of one part cement to three parts sand by volume. Mortar used for dry-packing shall be of such consistency that it can be properly compacted by ramming.

16.4 **REINFORCEMENT**

16.4.1 **Projecting Reinforcement**

Reinforcement shall not be bent up within the formwork unless approved by the Engineer. All projecting reinforcement shall be suitably treated to prevent rust staining of the finished concrete surfaces without affecting the bond resistance of the bar.

16.5 **CONCRETING**

16.5.1 **Steam Curing**

Precast units made with Ordinary Portland Cement may be steam cured at atmospheric pressure. The temperature of the units shall be raised at a steady rate which shall not exceed 22 degrees C per hour and in addition the curing shall comply with the following:

<table>
<thead>
<tr>
<th>Temperature of Unit</th>
<th>Time Taken to Reach Temperature From Commencement of Steam Curing</th>
</tr>
</thead>
<tbody>
<tr>
<td>32 degrees C</td>
<td>Not less than 2 hours</td>
</tr>
<tr>
<td>100 degrees</td>
<td>Not less than 6 hours</td>
</tr>
</tbody>
</table>

16.6 **PRECAST CONCRETE**
16.6.1 Programme

The Contractor shall ensure that units are stored and delivered to the site to suit construction requirements. This programme shall be agreed with the precast concrete manufacturers in writing.

16.6.2 Handling

Before removal from the casting beds the concrete shall have obtained sufficient strength to prevent any damage or distortion or overstressing of the precast units. The Contractor shall provide all necessary lifting devices which shall be subject to the approval of the Engineer prior to manufacture of the units.

16.6.3 Protection

During all subsequent handling, storage and transporting the precast units shall be protected against any damage or surface staining. The Engineer may reject any units which are damaged or stained.

16.6.4 Identification

Immediately after removal from the casting beds all units shall be marked in a manner and in a position approved by the Engineer.

16.6.5 Approval

All precast units shall be made available for checking of dimensions and surface finishes and shall be approved by the Engineer before erection.

16.6.6 Erection

Prior to the commencement of erection the Contractor shall submit for approval of the Engineer, details of his proposed arrangement for lifting and erecting units on site. Units which require temporary fixing in position shall be rigidly propped at a suitable point to be indicated by the Engineer.

16.6.7 Jointing

All joint surfaces shall be thoroughly cleaned. Dry-packed mortar joints shall be formed by compacting the mortar in 25 mm layers with a steel tool. Bedded mortar joints shall be formed by bedding the precast units on a firm layer of mortar. The units shall be levelled on steel shims located with the top surface just below the surface level of the mortar. The shims shall have a minimum cover of 25 mm of mortar or concrete. Thin bedded mortar joints shall be formed with a neat cement mortar spread evenly to form a thin bed just sufficient to take up any high points on the bedding surface.

16.7 STANDARD OF WORKMANSHIP

16.7.1 Tolerances

a) Manufacture

Precast units shall be of the various sizes and in accordance with the details separately scheduled and shall be manufactured with the following tolerances:

<table>
<thead>
<tr>
<th>Length</th>
<th>Tolerance</th>
<th>Limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up to 3 m</td>
<td>+/-</td>
<td>6 mm</td>
</tr>
<tr>
<td>3 to 4,5 m</td>
<td>+/-</td>
<td>9 mm</td>
</tr>
<tr>
<td>4,5 to 6 m</td>
<td>+/-</td>
<td>12 mm</td>
</tr>
<tr>
<td>Additional for every subsequent 6 m</td>
<td>+/-</td>
<td>6 mm</td>
</tr>
</tbody>
</table>

Cross Section (each direction)

<table>
<thead>
<tr>
<th></th>
<th>Tolerance</th>
<th>Limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up to 500 mm</td>
<td>+/-</td>
<td>6 mm</td>
</tr>
<tr>
<td>500 to 700 mm</td>
<td>+/-</td>
<td>9 mm</td>
</tr>
</tbody>
</table>
Concrete

Additional for every subsequent 250 mm +/- 3 mm

Straightness for Bow (deviation from intended line)
Up to 3 m 6 mm
3 to 6 m 9 mm
6 to 12 m 12 mm
Additional for every subsequent 6 m 6 mm

b) Squareness

When considering the squareness of a corner, the longer of the two adjacent sides being checked should be taken as the base line. The shorter side should not vary in its distance from a perpendicular so that the difference between the greatest and shortest dimensions exceeds

Length of shorter sides
Up to and including 1.2 m 6 mm
Over 1.2 m but less than 1.8 m 9 mm
1.8 m and over 12 mm

For the purpose of this requirement any error due to lack of straightness should be ignored; squareness should be measured with respect to the straight lines which are most nearly parallel with the features being checked.

When the nominal angle is other than 90 degrees the included angle between check lines should be varied accordingly.

c) Twist

Any corner should not be more than the deviation stated from the plane containing the other three corners

Up to 600 mm wide and up to 6 m in length 6 mm
Over 600 mm wide and for any length 12 mm

d) Flatness

The maximum deviation from a 1.5 m straight edge placed in any position on a nominally plane surface should not exceed 6 mm.

e) Precast Concrete Paving Slabs to be in accordance with SAZS 104:1974.

**********
BRICKWORK

CEMENT

Cement is to be normal Portland cement as previously described. Blast furnace cement or proprietary mortar cement may be used with prior consent and in strict accordance with the manufacturer's printed instructions.

SAND

Sand is to be clean pit or other approved sand, washed where necessary and screened through a 2.5 mm mesh or as directed and shall conform to SAZ 233.

LIME

Lime to be best quality hydrated building lime of approved manufacture and shall conform to SAZ A15 and is to be run at least four weeks before required for use.

WATER

Water is to be from an approved source and free from acids and alkalis and shall be fit to drink.

CEMENT MORTAR

Generally to be composed of six parts of sand to one part of cement. For foundations, facings and sundry grouting and pointing, etc., the mix is to be strengthened to four parts of sand to one part of cement. No cement mortar which has taken its initial set will be allowed to be used.

MIXING MORTARS

The mortar is to be hand mixed on a non-absorbent close jointed platform with kerb. Gauge boxes are to be used for measuring all materials which are to be strike measured and not tamped down. The ingredients are to be mixed dry until thoroughly incorporated and then clean water is to be added through a rose. The mortar is to be mixed in small quantities and used within one hour of mixing. Machine mixing as described for concrete may be used. Mortar boards and mixing platforms are to be cleaned off daily and any mortar left over must be thrown away.

COMMON BRICKS

Unless otherwise described bricks shall be good, hard, sound, well burnt clay common bricks, uniform in size and shape from an approved kiln equal to samples submitted for approval and shall conform to SAZ 221. Maximum absorption shall not exceed 15%. All soft or inferior bricks shall be rejected. Bricks for foundations shall be selected extra hard burnt bricks.
FACE BRICKS

Face bricks are to be best quality selected bricks as later described similar to samples to be submitted for approval and standard. Face brickwork is to be protected from injury with plastic or other water proof sheeting and salient angles to be cased up to prevent damage. Rates for face brickwork shall include for pointing as described, protecting from injury and cleaning all exposed surfaces with a weak solution of spirits of salts and water on completion and for building a sample panel of not less than 50 bricks for approval and demolishing same on completion. Distribute facing bricks of varying colours evenly throughout the work so that no patches appear. Mix different deliveries which vary in colour to avoid horizontal stripes.

QUARRY TILES

Quarry tiles are to be approved pressed kiln burnt clay quarry tiles of colour as later specified, free from all defects and perfectly true and even, bedded, jointed and pointed in cement mortar (1:4); cased up to prevent injury and cleaned down as specified for face brickwork. Sample to be submitted for approval.

BRICKWORK

Half brick or similar walls to be built in stretcher bond, unless otherwise stated, all remaining brickwork where practicable to be built in colonial bond. (Five courses of stretchers to one course of headers).

No false headers or other broken bricks are to be used except where required for bond. All bricks to be soaked in water before laying. Each course of bricks to be well wetted before bedding the next.

Bricks are to be laid on a solid bed of mortar, all joints flushed up and each course grouted in solid through the whole width. Angles and perpends are to be plumb and courses level. No mortar joint is to exceed 12.5 mm thickness. All brick walls shall be built to the gauge of four courses equals 345 mm (subject to conformation on site after delivery of the bricks and necessary adjustment to suit the structural sizes). No part of the work shall exceed any other by more than fourteen courses in height. Brickwork for plastering to have joints raked.

Cavities of hollow walls are to be kept free from mortar droppings or other matter by movable battens or other means and temporary openings must be left at plinth level through which any droppings, etc., can be removed and the openings made good on completion.

Execute all cuttings, plumb angles, form reveals, cut and fit brickwork between columns, beams, slabs and staircases, etc.

TIES

Where brickwork, etc., is described with wire ties, these are to be 3.25 mm thick galvanised crimped wire BUTTERFLY ties built into brickwork and /or cast into concrete at the rate of FOUR ties per square metre unless otherwise described and when used in cavity walls in no case are they to fall inwards towards the inner skin.

DAMP PROOF COURSES

Damp proof courses are to be formed of one layer of three-ply bituminous sheeting which shall conform to SAZ 276:1993, laid on a level bed of cement mortar trowelled smooth and lapped not less than 150 mm at all joints, angles, intersections etc., and protect from damage.
BRICK REINFORCEMENT

Brick metal fabric reinforcement is to be "Steelforce" or other approved double row of 3.5 mm diameter high tensile wire with 2.8 mm diameter cross wires welded on at 303 mm centres and is to be bedded solidly into horizontal mortar joints of brick walls, lapped full width and wired together at angles and passings.

BUILDING IN, ETC.

Pressed steel door frames are to be set up accurately in position and lugs built into brickwork in cement mortar and the brickwork is to be built into backs of frames and run in and packed around and pointing both sides with cement mortar. Rates are to include for any temporary bracing required in order to prevent distortion of frames, easing hinges and cleaning down on completion.

Steel windows are to be set up accurately in position and lugs are to be cut and pinned to brickwork or plugged and screwed to concrete on all four sides and run in both sides of frame, including completely filling the channel formed by the flanges, in cement mortar and pointing. Rates are to include for easing hinges, locks, catches and stays and cleaning down on completion.

Pressed steel window surrounds are to be built in as described for steel door frames.

Pressed steel window cills are to be bolted to the bottom flange of the window, bedded solid and pointed in cement mortar.

Timber frames are to have galvanised hoop iron cramps with one end turned up and screwed to back of frame and the other end built into joints of brickwork and turned up. The frame to be bedded solid and pointed both sides in cement mortar.

REINFORCED BRICK LINTOLS IN CEMENT MORTAR

Reinforced brick lintols are to be built in cement mortar (1:4) with bricks specially selected for soundness and hardness, special care being exercised to grout all joints solid.

Lintols in cavity walls are to have the bottom two courses built solid. Single lintols are to have a bearing of 345 mm at ends and continuous lintols a bearing of 345 mm at extreme ends.

Brick lintols must be reinforced with straight continuous mild steel rods of the number and size specified or with metal fabric reinforcement, as specified. The rods or fabric reinforcement must extend the full length of the lintol and must be evenly spaced across its thickness from the first horizontal joint above the soffit.

Lintols in cavity walls must have all rods or the fabric reinforcement placed below the solid sections of the wall excepting only those rods specifically scheduled to occur below the cavity over.

************
ASPHALT WORK

MASTIC ASPHALT

Mastic asphalt used for roofing shall conform to SAZ A1 and all blocks delivered on site shall be appropriately marked.

MIXING AND LAYING

The mastic is to be mixed at a temperature not exceeding 230 degrees Celsius and is to be laid on and including an underlay of black sheathing felt, or other approved membrane of a type recommended by the manufacturer, in two layers giving a total thickness of 20 mm for ordinary horizontal work. Skirtings are not to be less than 150 mm high with angle fillets at junction with horizontal.

Mastic asphalt used for tanking shall conform to SAZ A3 and is to be laid in three layers with a total thickness of 30 mm.

SPECIALIST

The work must be carried out by an approved specialist firm with experienced tradesman, and under a written unconditional guarantee for a period of 10 years from the end of the Defect and Liability Period.

APPROVAL OF SURFACES

The specialist firm will be responsible for approving the screed surfaces (or other surfaces) to receive his work and the fact that his roofing material is laid will be taken as evidence of his approval of the surfaces and of his acceptance of responsibility for any faults that may appear in his work.

RATES

Rates must include for compliance with the foregoing Preambles and subsequent descriptions and for hoisting and/or lowering to all levels.

**********
ROOF COVERINGS

All coverings are to be laid or fixed in accordance with the manufacturer's instructions and details, whether these instructions are supplied with the coverings or not.

METAL ROOF SHEETING

All metal roof sheeting where described shall be 24 gauge (0.63 mm) Monarch 5R/27 galvanised roof sheets. Where coloured roof sheeting is specified it shall be fluted from approved pre-coated galvanised sheeting that has had the coloured coating applied by the sheeting manufacturer prior to forming iron into coils for delivery. The colours of the sheeting shall be to approval with a silicone polyester coating to the top side and a Standard Backing Coat to be reverse side.

All sheeting, flashings, capping, trims and fixings shall be supplied, set out, assembled and fixed in strict accordance with the Manufacturer's specifications, requirements and recommendations, whether explicitly described in this Specification or not.

Details and fabrication drawings, calculations and fixing instructions shall be obtained from the Manufacturer's and the Engineer's approval obtained before fabrication commences.

Fluted roof sheeting shall have five box rib flutes 36.50 mm deep spaced at 171.10 mm centres providing a cover width of 686 mm.

Corrugated roof sheeting shall have ten and a half corrugations, 17.5 mm deep providing a cover width of 762 mm.

The sheeting shall be supplied in maximum lengths practicable in each respective application and shall be cut to size bent or otherwise worked, at Works before delivery to Site. No sheet edges, whether cut or uncut shall display unprotected metal, and shall be entirely rust free when fixed.

All flashings, trimmings and cappings, etc., shall be formed from 0.6 mm thickness galvanised sheet steel, finished to match the profile of the sheeting, all cut, bent formed and jointed to the required shape, and in such form and detail as to provide a completely sound and watertight roof.

The design of all sheeting and flashing profiles, spans, fixings and weather-proofing detail shall be such as to provide completely sound watertight roofing areas, in the climatic conditions to be found in Zimbabwe, with particular reference to rainfall, incidence of rain and hail conditions. Calculations shall take as minimum design criteria wind loadings resulting from a wind velocity of 45 m/sec, as defined in N.S.C.P.3 : Chapter 5 : Part 2.

Side Laps: Single overlap embedded in approved Mastic Sealant.

End Laps: Minimum of 300 mm. All bedded in approved Mastic Sealant.

Main Fixings: Galvanised hook bolts and nuts with galvanised steel and felt washer or similar approved, suitable for fixing to steel purlins and or galvanised drive screws with galvanised steel and felt washer or similar approved, suitable for fixing to timber purlins. All fixing holes to be cleanly drilled.

Fixing Centres: Two fixings per sheet per purlin at eaves, apexes and laps, one fixing per sheet per purlin elsewhere.

Side Lap Fixings: Two galvanised beam bolts and nuts with galvanised and felt washer per purlin space.
All flashings, ridges and trims running across the line of ribs shall be complete with polycloser components all in accordance with Manufacturer's recommendations, and bedded in mastic as specified herein under.

All sheeting end and side laps shall be bedded in strips of minimum 25 mm width of approved 1 part Polysulphide Mastic, or Mastic Tape of similar composition, application of succeeding sheets shall ensure that full contact is obtained between sheeting faces over the whole width of lapped sheeting.

All Polycloser components specified above shall be similarly bedded, on upper and lower surfaces, in mastic of the same approved specification.

All sheeting at lowest ends of roof pitches, where rainwater will be discharged, shall be bent on Site to form a drip downstand across the flat portions of sheets between ribs. This work shall be carried out with standard tools designed for the job; galvanising shall remain perfect, undamaged and unscratched. Drips shall be bent to standard identical 30 degree angles.

All materials shall be packed, transported, unloaded, stored, stacked, moved on Site and fixed in such a way as to eliminate damage by distortion, uneven loading, denting, scratching, puncture, etc. Any sheets fixed in a damaged condition shall be removed and replaced. Once fixed, deckboards shall be used by personnel, to protect sheeting surface, and all other necessary protection measures taken. On completion all surfaces shall be washed and cleaned of dust, rubbish and all other blemishes.

METAL SIDEWALL CLADDING

The Specification for metal sidewall cladding is as for Metal Roof Sheet above with the recommendation that the broad flutes are fixed externally with the main and side lap fasteners in the valley of the flutes.

ASBESTOS CEMENT ROOF SHEETING

Asbestos cement roof sheets shall be prepared and fixed strictly in accordance with the Manufacturer's recommendations.

**********
CARPENTRY JOINERY & IRONMONGERY

TIMBER

To be best quality procurable, free from sap, white wood, shakes, large, loose or dead knots, waney edges and other defects. Timber to be sawn to hold the full specified sizes and die square.

Timber and timber products to be guaranteed free from borer and beetle infestation of any kind, any defects traceable to such infestation shall be rectified by the Contractor at his own expense, including any timber adjacent to the affected parts. This guarantee shall be valid for a period of two years from the date of handing over the Works.

Timber to be well seasoned and kiln dried to a moisture content not less than 10% or more than 12%.

SOFTWOOD

Softwood for carpentry to be selected straight grained timber graded in accordance with SAZ 334:1991.

HARDWOOD

Hardwood to be best quality selected wrot straight grained kiln dried of the type specified. Submit sample 600 x 150 x 38 mm for approval.

BLOCKBOARD

All blockboard to be commercial quality faced both sides with core of kiln dried strips (not exceeding 12 mm thick) of selected softwood jointed and glued together under pressure and planed flat and true for 1.5 mm cross veneers glued on both sides with water proof glue. Veneers to be suitable for painting, unless otherwise described.

HARDBOARD

Hardboard to comply with B.S. 1142.

PLYWOOD PANELS AND FACE VENEERS

Plywood panels and face veneers are to be best quality and of approved manufacture with written guarantee. Face veneers to be 1.5 mm thick before sanding and are to be specially selected for grain and colour and the figure carefully matched for pattern. Patterns and colours are to be selected and approved.

PLASTIC SHEETING

Plastic sheeting shall be "Perstorp" or equal approved, cigarette proof quality, and shall be fixed or laminated in accordance with the manufacturer's instructions with approved adhesive and shall have edges finely chamfered at all external angles.
FRAMED DOORS

To conform to SAZ 184 of approved manufacture and constructed of well seasoned timber of the type specified. Unless otherwise described, stiles, top rails and braces to be not less than 114 mm wide, lock rails not less than 152 mm wide and bottom rails to be not less than 228 mm wide. Stiles and top rails to be grooved and chamfered for and filled in flush on one side with 22 mm narrow tongued, grooved and V-jointed boarding twice screwed at intersections with rails and braces.

FLUSH DOORS

To conform to SAZ 184 of approved manufacture and constructed with well seasoned framing covered on both sides with plywood cross banding and veneers selected for evenness of grain and suitable for painting, unless otherwise described, and with vertical edges concealed by solid hardwood edges. Rails to be drilled for ventilation.

The top and bottom edges of doors must be primed with an approved wood primer before the door is hung.

SKIRTINGS

All skirtings are to be ploughed at back to prevent warping.

STRUCTURAL TIMBER

Timber for non-structural framing, battens and branding to be merchantable grade and shall conform to SAZ 257:1991.

Structural timber to merchantable grade marked "M" and shall conform to SAZ 334.

Glued laminated timber shall conform to SAZ 169 and shall bear the mark of the Standards Association.

All timber for carpentry work to be in as long lengths as possible and all laps and joints to be placed over points of support. All wrot timber to be finished clean, smooth and free from tool marks.

WORKMANSHIP

All joinery except that described as "stock" is to be purpose made.

All work to be put in hand immediately upon signing the Contract, fitted together, but not wedged up and glued, stacked in a dry place and framed up and glued just before fixing in position in the building.

All joinery to be constructed in accordance with approved best standard practice, all tenoned joints to be pinned, all joinery over 76 mm to be double tenoned, all moulds to be mitred at external angles and scribed at internal angles. All mouldings will be solid except where shown to the contrary.

No screws are to be hammered. All works wherever possible to be secret fixed.

All exposed woodwork to be wrot and finished clean, smooth and free from tool marks. All exposed angles to be arris rounded (up to 3 mm radius). All work for oiling or polishing to be finished smooth without application of sandpaper.

SCREWING

All screws for hardwood are to be best quality brass screws unless otherwise stated.
SIZES

Thickness of doors, blockboard, etc., are actual dimensions of the finished work after dressing, etc. All other sizes specified are nominal dimensions before dressing or shaping operations, 2.5 mm will be allowed off nominal sizes for each wrot face.

DEFECTS

All joinery which shrinks, warps, or otherwise becomes defective, or any joints which open or give, etc., within the maintenance period shall be replaced or refitted as directed at the Contractor's expense.

PRICES

Timbers described as "sawn" are to include all workmanship and labour in preparing and connecting together by lapping, notching, splay or birdsmouth cutting, halving, scarfing and for all nails and spikes. All nails are to be of the best quality and of gauge, length and strength suitable for the work. They will be long enough to enter the second timber at least one half their entire length before punching. Skew nailing will only be permitted in the framing. All timbers described as "framed" are to include for all workmanship and labour in connecting by mortice and tenon or dowelling and for all nails and spikes.

Timbers, unless otherwise stated, shall include for fixing with nails of the appropriate size and type.

The prices for all joinery fittings are to include for framing and fitting together, transporting to the site and fixing in position.

Hardwood described as "wrot" shall include for lightly sinking the heads of all nails, stopping and finishing the surface to receive decoration.

Where described as "screwed" it shall also include for countersinking the heads and pelleting, unless otherwise stated. Where described as "plugged" it shall include for fixing to concrete, brickwork or similar material with suitable plugs.

Protect all joinery before, during and after fixing from damage and leave in good condition.

IRONMONGERY

To be selected and to be fixed with screws of corresponding metal and colour. The prices are to include for collecting, storing, oiling and easing all locks, fastenings, etc., on completion.

Articles described as brass shall be solid brass and not brass finish.

Stamp all locks with consecutive numbers and the keys with numbers corresponding to the locks they control. Each lock to be supplied with two keys. No key is to pass another lock, unless otherwise specified.

The prices for fixing to wood are to include for fixing to hardwood lipplings and face veneers of flush doors.

The Contractor shall, at any early stage, arrange for approval of all ironmongery to be fitted to steel door frames, etc., so that provision may be made by the manufacturers' for the correct fitting of lock striking-plates, hinges, bolts, keeps, cleat hooks, etc.

All ironmongery is to be removed for decoration, cleaned down and refitted.

All joinery shall be in single lengths except where this is impracticable, in which case splayed heading joints, neatly executed are to be used.
All mouldings are to be neatly mitred at external angles and neatly scribed and fitted at internal angles.

**********
METALWORK

GENERALLY

All cast iron, wrought iron and mild steel shall be of approved manufacture complying with the latest relevant British Standard Specification.

All loose scale, rust, dust or coatings shall be removed before fixing.

WELDING

Welding shall conform to B.S. 693; B.S. 938; B.S. 1775; B.S. 2630; B.S. 2937 and shall include for having the welds ground off smooth and even without blemishes and for welding on steel. If described as primed, rates are to include for thoroughly cleaning free from rust, scale etc., and primed with one coat of approved metal priming suitable for enamel paint.

PRESSED STEEL DOOR FRAMES

Pressed steel door frames, surrounds, etc., to be annealed steel sheets of approved thickness pressed to shape, mitred and welded at angles and provided with approved steel lugs welded on with ends split and fanged for building in. Frames described as with fanlights are to have transoms with welded seams and ends tenoned into frame. Frames are to be fitted with bracing across the bottom. Unless otherwise stated each frame is to be fitted with one pair of 100 mm heavy steel butts welded on with back plate for each door.

Each frame, unless otherwise described, is to be slotted for mortice lock bolt with cup welded on at back. All necessary drilling for ironmongery, fanlight openers, bolt sockets, etc., should be executed by the manufacturers' at works and the Contractor is to supply the correct information for this to be done. Fixings for set screws are to have solid plate welded on at back in all cases. Frames are to be thoroughly cleaned free from rust, scale, etc., and primed with one coat of approved metal priming suitable for enamel paint before delivery.

METAL WINDOWS

Metal windows to be mild steel as described and obtained from an approved manufacturer, thoroughly cleaned free from rust, scale, etc., and primed with one of an approved metal priming suitable for enamel paint before delivery. A sample window is to be delivered before any order is placed. Transoms are to be continuous and riveted to frame, glazing bars are to be scribed to frames with shouldered and riveted ends. All windows to be standard residential section unless otherwise described.

Frames to have standard lugs for building in, and are to be complete with all screws, nuts, curtain rod brackets, if specified, coupling screws, cleats, cords, pulleys etc. **Fit easy clean steel hinges to all windows.**

The sizes specified are overall to the end of the section and the width is given first in all cases to the nearest millimetre.

Top hung fanlights and casements to have bronze peg stay with pegs arranged to lock windows when closed. Side hung casements to have bronze handle with ventilation notches and adjustable bronze sliding stay unless otherwise described.

Each window must be tested after building in and adjusted where necessary to leave in perfect working order.

* * * * * * *
PLASTERING AND WALL LININGS

CEMENT

Cement is to be normal Portland cement as previously described.

LIME

Lime is to be best quality Plasterers lime and shall conform to SAZ A15 and is to be run at least four weeks before required for use.

SAND

Sand is to be washed as directed and shall conform to SAZ 233.

MIXING

As previously described for mortars.

CEMENT PLASTER

Cement plaster for external use to be composed of one part of cement to four parts of sand and for internal use to be one part of cement to six parts of sand.

PROPRIETARY

Proprietary plaster to be used in strict accordance with the manufacturer's printed instructions and steel trowelled to a hard true and glasslike surface unless otherwise described.

WATERPROOFING

Where work is specified as waterproofed, an approved proprietary additive is to be used in strict accordance with the manufacturer's printed instructions.

COMPO PLASTER

Lime composition plaster to be composed of three parts of sand to one part of lime with 10% by volume of cement added immediately before use.

MOULDINGS, ETC.

Mouldings, cornices, etc., shall be run clear and accurately to full size details. Where required, brick or concrete cores have been measured separately to receive the plaster finish.
WALL TILING

All glazed wall tiles are to be first quality (unless otherwise described) cushion edged tiles of approved manufacture and shall conform to SAZ 103, gauged and dipped in water before bedding and jointing in cement mortar (1:3) pointing with approved neat white (or tinted) cement with continuous horizontal and vertical joints. Tiling to be cleaned down immediately after completing. Rates for tiling are to include for a cement and sand (1:4) screed backing and for protecting from injury. Tiles may be fixed with an approved adhesive instead of cement mortar in which case the screed backing to be steel trowelled and the tiles fixed dry. No increase in rates will be considered if adhesive is used.

WORKMANSHIP

All mixing must be in small quantities and must be used within one hour, no mix that has commenced to set will be allowed to be used.

All plastered surfaces shall be kept wet for at least seven days after execution.

DEFECTIVE PLASTER

Plaster that is scratched or crazes, blows, blisters, or flakes off the wall prior to the expiry of the retention period, must be completely removed at the Contractor's expense and be replaced with new plaster before decoration, otherwise re-decorate and replace all damaged woodwork and finishings at the Contractor's expense. Take out and refix any loose, damaged or discoloured wall tiles.

Unsightly patching will not be allowed and if necessary and the Architect so desires, the whole of the work where the defect occurs must be stripped and replastered.

***********
PAVINGS AND FLOOR COVERINGS

CEMENT

Cement is to be normal Portland cement as previously described.

LIME

Lime is to be best quality Plasterers lime and shall conform to SAZ A15 and is to be run at least four weeks before required for use.

SAND

Sand is to be washed as directed and shall conform to SAZ 233.

MIXING

As previously described for mortars.

SCREEDS

To be of the mix specified, rates are to include for thoroughly cleaning off all dust and dirt and a neat cement grout to be applied immediately prior to laying.

LOW MASS SCREEDS

Low mass screeds of approved manufacture of suitable density and laid in strict accordance with the manufacturer's printed instructions and finished on top in one operation to receive the specified finish.

GRANOLITHIC

Screed up to within 9.5 mm of the finished surface with a dry mix of three parts of sharp sand to one part of cement, finish with granolithic composed of two and a half parts of granite chips graded up to particles which will pass a 6 mm mesh and may be retained on a 3 mm mesh and one part cement by volume.

Where granolithic is specified as tinted, "Cementone" of selected colours is to be mixed dry in the proportions of one part of colouring agent to six parts of cement. No dusting on will be permitted.

Pavings are to be divided into squares as specified with a V-float and margins formed at junction with walls. Finished surfaces must be scrubbed and washed until all discolouration is removed and polished if specified. The concrete sub-floors to be thoroughly cleaned of all dust and dirt and a neat cement grout applied immediately prior to laying.

Skirtings are to be minimum 19 mm thick, run direct on to walls with coved internal angle at floor and rounded at top to break joint with plaster or splayed at top in faced walls and V-jointed at bottom to line with margin of floors. Skirtings are to be set 6 mm forward of wall plaster above.
VINYL ASBESTOS TILE FLOORING

The vinyl asbestos tile flooring shall comply with SAZS 272:1987.

All colours shall be selected by the Architect and the Contractor shall allow for executing the work in these colours to pattern.

Before tiles are laid the screed shall be brushed perfectly clean of all dust, grit, etc.

Tiles shall be laid with an approved adhesive supplied by the manufacturer of the tiles, applied to the screed and underside of the tiles in accordance with the manufacturer’s instructions.

Laying of tiles shall be commenced from the centre of the room and all joints to be close and in true straight lines. No damaged tiles shall be used.

Prices for tiling shall include for all straight cutting and waste to edge and cutting to pattern.

HARDWOOD MOSAIC FLOORING

The wood mosaic shall conform with SAZS 015:1972 and shall be 8 mm thick formed of strips size 24 mm x 12 mm in squares size 483 mm x 483 mm and of approved manufacture out of the best quality of timber specified, well seasoned, entirely free from borers, etc., and from untreated sapwood, and the moisture content shall be not less than 10% or over 15%.

Before flooring is laid the cement screed shall be swept perfectly clean, and the flooring shall be bedded with approved adhesive, the laying commencing from the centre of the room, and all joints shall be close in true straight lines.

Flooring shall be kept 12 mm clear of walls all round and the gap filled with soft setting bitumen.

Floors shall be covered up and protected from injury during the progress of the work and on completion shall be traversed and finished with a sanding machine to the approval of the Architect.

No beads to skirtings shall be fixed until the floors have been sanded.

**********
Sheet Metalwork Plumbing and Drainlaying

Regulations

All plumbing and drainage work shall be executed strictly in accordance with the Local Authority's By-Laws and Regulations.

Licensed Plumbers and Drainlayers

Only licensed plumbers and drainlayers shall be employed to carry out any plumbing and drainage works.

Sheet Iron

All sheet iron to be of approved brand, galvanised and of the thickness specified and shall conform to BS 2989. Galvanised iron nails shall be used for galvanised sheet iron where required.

Flashings etc.

Flashings etc., shall be properly lapped at angles and passings. Dress flashing 38 mm into grooves and 6 mm up at back and wedge with rolled wedges. No screws or nails are to penetrate gutters or flashings. Provision to be made for expansion and contraction under changes of temperature.

Eaves Gutters and Rainwater Pipes in Sheet Iron

Eaves gutters and rainwater pipes shall be formed to sizes and shapes specified. The rainwater pipes shall have close welted and soldered seams, and the joints between lengths are to be riveted and soldered. All joints in the straight length and at angles, stop ends, etc., are to be riveted and soldered. Sizes of gutters are to be effective sizes.

The eaves gutters shall be fixed to falls to outlets on 6 x 25 mm mild steel gutter brackets bent to suit the profile of gutter and twice holed for and screwed to woodwork or bolted to steel at not exceeding 1.00 metre centres. Alternatively, approved fascia brackets may be used.

Rainwater pipes shall be fixed to walls with 4 x 38 mm mild steel straps in two sections, bent around pipe with the ends bent to form flanges 25 mm long holed for and bolted together with and including two 19 x 6 mm gutter bolts with locknuts and one section of the strap riveted to and including 4 mm thick mild steel anchor 33 mm wide and 230 mm girth with end split and fanged for and built in or cut and pinned to brickwork or concrete in cement mortar at not exceeding 1,50 metre centres.

Asbestos Cement Rainwater Goods

Asbestos cement rainwater goods shall be of approved manufacture, and shall include for jointing with special mastic as supplied by the Manufacturer and fixed including brackets strictly in accordance with their instructions.

Concrete Pipes

Concrete pipes and fittings shall conform to SAZ 315 and SAZ A29.
STONEWARE PIPES

Stoneware pipes and fittings to comply with SAZ 342:1977 to be first quality, tested, spigot and socketed piping, jointed with gasket and neat cement finished externally with a smooth fillet all round.

The joints to be wiped smooth internally by passing a badger of 6 mm less than the diameter of the pipe completely through the whole length of the drain.

ASBESTOS CEMENT PIPES

Asbestos cement pipes and fittings shall conform to SAZ 113; SAZ 141 and SAZ 195 and are to be laid in strict accordance with the manufacturer's printed instructions.

PLASTIC PIPES

Plastic pipes and fittings shall conform to SAZ 156; SAZ 177; SAZ 219; SAZ 220; SAZ 327 and SABS 533 and fixed including brackets in strict accordance with the manufacturer's printed instructions.

CAST IRON PIPES

Cast iron pipes and fittings shall conform to SAZ 243. Heavy duty cast iron pipes and fittings shall conform to BS 1130, all pipes and fittings are to be coated with an approved preservative. Pipes are to be jointed with gasket and caulked with molten lead.

STEEL PIPES

Steel pipes and fittings shall conform to SAZ 102 and BS 143 and be galvanised. Pipes are to be jointed with hemp and red lead. Medium quality pipes are to be used, unless otherwise specified. Fix to roof timbers with stout galvanised clips and to walls with galvanised hinged holderbats with brass pins at not exceeding 1 metre centres, built into walls with cement mortar. Sling pipes to soffits on 6 x 32 mm mild steel strip fixed around pipes with 6 mm galvanised bolt with ends split and fanged and cut and pinned to concrete soffit.

COPPER PIPES AND FITTINGS

Copper pipes shall conform to BS 659; BS 1306 and BS 1386, shall be solid drawn seamless, supplied in straight random lengths, round, clean, smooth, free from internal and external grooving, other defects and deleterious film.

All copper pipes carrying hot water are to be supported so as to allow free movement for expansion and contraction, particularly at the end of long runs where a change of direction takes place. Fix tubing to walls with brass hinged holderbats with pins at not exceeding 1 metre centres built into wall with cement mortar. Fix to soffits as described for steel pipes.

Fittings and couplings, etc., for use with copper pipes shall be of the manipulative compression joint type, or other approved type. All fittings, etc., are to be made from suitable corrosion-resistant copper alloy, sound and clean, without flaws or laminations and full bore throughout. All fittings and their component parts shall be capable of withstanding an internal hydraulic pressure of 2,20 MPa without showing signs of leakage or other defects.

SIZES OF PIPES

The sizes of pipes, traps, etc., are the nominal bore except for PVC which shall be the external diameter.
TRAPS

Traps shall be brass, copper, polythene or cast iron as specified. Generally traps to shower trays, baths, lavatory basins, drinking water fountains and domestic sinks shall be tubular copper to BS 1184 of the same size as the waste outlet of the fitment, and shall have tails to suit the waste pipe to which they connect.

STAINLESS STEEL

Stainless steel to be the austenitic type and shall comply with B.S.970 EN58 series and unless otherwise described, to 0,9 mm thick in 18/8 quality and shall be entirely non-magnetic.

BRASSWARE

Brassware is to be of the best quality and equal to samples approved.

All stop valves, bib taps, hose union bib taps and pillar taps shall comply with BS 1010 or SABS 226 and shall have washer plates so secured as to lift with the spindle.

Cold water taps shall in every case be fixed at the right hand side of sanitary fittings.

All ball valves shall comply with BS 1212 and shall be of the sizes and for the pressure indicated or specified. The loose orifice seats shall be of nylon for sizes 15 and 20 mm and bronze for sizes 25, 40 and 50 mm. Ball valves shall be supplied and fixed complete with copper floats to BS 1968 or with plastic floats not less robust and having a lifting effect not less than a BS 1968 copper float for the same duty.

FIRE EQUIPMENT

Portable fire extinguishers are to comply with SAZ 225:1991. All fire equipment to be of a type and manufacture approved by the Fire Officers Committee and the Local Authority concerned.

EXCAVATIONS, ETC.

Excavate bottom of drain trenches to an even fall and lay 75 mm cement concrete (Grade 10-20 mm stone) bed under pipe and support each length of drain pipe with stoolings of cement concrete (Grade 10-20 mm stone) behind each collar and haunch up half way around external diameter of the pipe.

HARD PICKABLE MATERIAL AND ROCK

Extra over trench excavation for pipes for excavation in hard pickable material or rock has been measured as follows: trench not exceeding 1 metre deep average width 500 mm and trench in excess of 1 metre deep average width 800 mm. Subsequent re-measurement will be based on these widths and the Contractor must allow in his rates for any increased width he may require.

GENERALLY

No holes are to be cut through reinforced concrete work unless approved. Where possible sleeves are to be cast into concrete. Where drain pipes pass through wall, etc., they must be arched over to prevent any loads being transmitted from the structure.
TESTING AND CLEANING

All sheet metalwork shall be carefully and efficiently inspected and tested on completion and left perfectly watertight.

All defective work shall be taken out and replaced with new work at the Contractor's expense.

At completion of plumbing and drainage installations, clean down and flush pipes, traps, etc., wash sanitary fittings and test the whole to the satisfaction of the Local Authorities and Architect including making good and re-testing until found perfect. The Contractor must provide all necessary equipment to carry out any tests required.

************
GLAZING

GLASS

All glass is to be of approved manufacture, free from bubbles, waviness, scratches or other imperfections and is to be well bedded, puttied and back puttied and secured with glazing pins or clips in steel sashes or with sprigs in wood sashes.

All glass shall be carefully cut to the required sizes so that all panes of figured or textured glass are uniform in appearance with the pattern parallel to the edges and wired glass shall be so cut that the wires are parallel to the edges.

PUTTY

Putty for glazing to steel sashes is to be of approved proprietary brand specially made for use with steel sashes and shall conform to SAZ A24. Best quality linseed oil putty shall conform to SAZ A24 to be used for wood sashes tinted as necessary when used for glazing to hardwood. Rebates are to be thoroughly back puttied before glazing and all putty is to be carefully trimmed and cleaned off so that back putty finishes level with the top of sections internally, external putty covers sight lines exactly and finished straight and true. Rough surfaces to putty will not be allowed and any defective putty will be cut out and replaced at the Contractor's expense.

Rebates of wood sashes are to be given one coat of priming immediately before glazing.

LOUVRES

Glass louvres are to have ground ends and polished edges and are to be fitted both ends to metal clips unless otherwise described.

MIRRORS

Glass mirrors are to be of the thickness specified, of selected quality glass, silvered on back, with protective sealing coat and arrised edges, unless otherwise described.

GENERALLY

Allow for removing and replacing all cracked, broken or defective glass and leave thoroughly clean and perfect at completion.
PAINTING

COLOURS

Different compartments may be painted different colours and different walls in any one compartment may be painted different colours. Doors and door frames will be different colours.

MATERIALS FOR DECORATION

All paints, primers, varnishes, emulsions, stopping, etc., to be of approved manufacture.

The Contractor is to use proprietary "ready mixed" paints obtained from an approved Supplier.

Where a coat of proprietary paint is applied, the manufacturer's priming and previous coats suitable for the particular type are to be used.

All materials must be brought on to the site in unopened tins, and no dilution or adulteration will be permitted, unless approved by the Architect.

LIMEWASH

To be composed of 45.4 kg of fresh unslaked lime, 6.35 kg of salt, 4.54 kg of tallow or boiled linseed oil, all thoroughly mixed while boiling and applied hot.

COLOURWASH

To be limewash as previously described and tinted to an approved shade with approved colouring pigment.

EMULSION PAINT

Emulsion paint shall be PVA (Polyvinyl Acetate) alkali-resisting formulated with high washability and capable of resisting a 8 000 scrub test. The first coat to be specially formulated base coat for direct application to the specified surface.

KNOTTING

Knotting shall conform to BS 1336.

OIL STAINS

Oil stains shall conform to BS 1215.

FILLERS

High grade cellulose fillers to be used internally and pre-mixed filler to be used externally.
VARNISHES

Varnishes shall be one pack polyurethane type.

LINSEED OIL

Linseed oil is to be refined, pale in colour, perfectly transparent, free from smell and not less than twelve months old.

HIGH GLOSS PAINTS

Primer for application to bare metal to be red oxide primer for iron and steel. For galvanised metal to be an approved zinc chromate or galvanised iron primer. For application on wood and plaster etc., to be an approved alkali primer.

Finish Enamels to be Synthetic Enamel high opacity paint with high coverage and high gloss finish unless otherwise described.

WORKMANSHIP

All surfaces are to be free of moisture, dust, grease and dirt and rubbed down smooth according to approved practice.

All plaster to be free of efflorescence and treated with one coat of petrifying liquid, approved sealer or alkali primer if required. Hardwall plaster to be glass papered before decorating.

Rectifying defects to decorated surfaces due to dampness, efflorescence, chemical reaction, etc., will be to the Contractor's account, as these surfaces must be checked and the appropriate precautions taken before applying the decoration.

Metalwork must be scraped free of rust, primed as described and finished as later specified.

Galvanised sheet iron, pipes, etc., are to be cleaned down to remove manufacturer's ammoniated dichromate protective covering, primed as described and finished as later specified.

Coated pipes are to be cleaned down, stopped and primed with one coat of aluminium primer and finished as later specified.

All knots in woodwork to be treated to prevent bleeding. Large or loose knots to be cut out and replaced with sound wood, or cut back and filled. Small knots to be treated with two thin coats of knotting free from resin and consisting entirely of a solution of Shellac in methylated spirits. Woodwork to be glass papered to a smooth surface with all sharp arrises removed, all cracks, crevices, holes, etc., to be scraped out, primed as described and stopped with hard stopping, faced up and rubbed down to an even surface and finished as later specified.

All metal and woodwork to have the specified number of coats in addition to the priming coats.

Every coat of paint must be a good covering coat and must dry hard and be well rubbed down to a smooth surface before the next coat is applied, otherwise the Contractor will be required to apply extra coats at his own expense.

Each coat of paint to be of a distinctive colour; sample colours are to be prepared for the final coat which is to be to an approved colour scheme and must not be applied without the permission of the Architect. After undercoats are on, the Painter shall check all work and grainfill as necessary with filler as described.
NOTE: (a) ALL PAINTS SPECIFIED ARE TO BE OBTAINED FROM AN APPROVED MANUFACTURER AND USED IN STRICT ACCORDANCE WITH THEIR INSTRUCTIONS. THEIR REPRESENTATIVE WILL CHECK THE PAINTS BEING USED AND THE METHOD OF APPLICATION AND WILL ADVISE ACCORDINGLY.

(b) THIS SECTION OF THE WORK TO BE CARRIED OUT BY AN APPROVED FIRM OF DECORATORS WHO MUST ALLOW FOR THE VERY BEST FINISH POSSIBLE AND OF THE HIGHEST QUALITY OBTAINABLE.

(c) THE PRICES MUST ALLOW FOR THE REMOVAL AND REFITTING OF ALL BEADS, FITTINGS, FASTENINGS, IRONMONGERY, ETC., REMOVED FOR DECORATION PURPOSES TO BE CARRIED OUT BY SKILLED TRADESMEN OF THE APPROPRIATE TRADE.

GENERALLY

Cutting to line of various colours of paints measured only when the two colours are adjacent on the same plane.

**********
EXTERNAL WORKS

ROAD PAVEMENT

ENGINEER’S APPROVAL OF METHOD

The Contractor shall not commence work on the sub-grade, sub-base, base, underfloor fill, facing or shoulders until he has obtained the Engineer’s approval in writing of the plant and methods that he proposes for each and every operation.

The foregoing provisions shall not prevent the Engineer from requiring the Contractor to vary his plant or methods at any time during the execution of the Works, should the Engineer consider this essential for carrying out the Contract. The Contractor shall not vary plant or methods which have been approved by the Engineer, without previously obtaining the Engineer’s approval of such variation in writing.

PREVENTION OF DAMAGE TO PARTIALLY COMPLETED PAVEMENTS

The Contractor shall ensure that the passage of vehicle or plant over partially completed sub-grades, sub-base, pavement, underfloor fill or shoulders shall not occasion any rutting or other damage or disturbance to the partially completed Works, and should any such rutting or other damage or disturbance occur the Contractor shall make good the same as directed by the Engineer’s Representative.

Vehicles and plant passing over the partially complete sub-grade, sub-base, pavement or shoulders shall not be allowed to travel in a single track but such traffic shall be spread out over as great a width as practicable. There shall be no storage or stock-piling of material on top of partially completed pavements or shoulders.

WATER FOR PAVEMENT CONSTRUCTION

The Contractor shall provide all water necessary for the construction of pavements, underfloor fill and shoulders. Such water shall be clean and free from organic matter, waste matter and all plant necessary for conveying and distributing water and the water shall be evenly sprinkled on the surface of material by machine of a type to be approved by the Engineer, such machines being capable of uniformly distributing the water at a known, predetermined and constant rate.

ROLLERS AND MIXING EQUIPMENT

Smooth-wheeled, vibratory and pneumatic tyred rollers where employed for compaction on the roadworks as detailed in subsequent clauses shall be of a type approved by the Engineer. In addition, the Contractor shall supply at least one pneumatic-tyred roller having a loaded weight of 15 tonnes with tyres having pressures which can be safely raised to 1 N/sq mm. The distribution of wheels on any roller shall be such that the whole of the ground surface within the width of the roller is loaded during each pass of the roller.

Equipment necessary for the thorough mixing of the gravel in order to achieve a uniform moisture content throughout the material shall be tractor-drawn disc harrow type machines (or similar to the Engineer’s approval) and the Contractor shall supply sufficient of such units to ensure adequate mixing of the material, taking into account any time limitations and weather conditions.

PAVEMENT AND UNDERFLOOR FILL LEVELS AND TOLERANCES

The pavement underfloor fill and shoulder levels as shown on the Drawings or as directed shall be the finished surface levels or the levels before the application of any bituminous surface dressing or concrete slab.
The level at any point on the surface of each course shall conform to that shown in Column 2 of the Table 6.1. In addition, the surfaces of the finished sub-grade, sub-base, base, shoulders and underfloor fill shall, when tested with a 3 metre straight edge placed in any position on the finished surface parallel to the centre line, have no depressions greater than that shown in Column 3 of Table 6.1.

<table>
<thead>
<tr>
<th>SURFACE OF COURSE</th>
<th>TOLERANCE FROM TRUE SURFACE LEVEL</th>
<th>MAXIMUM DEPRESSION TESTED WITH 3 METRE STRAIGHT EDGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sub-grade</td>
<td>+ 0 mm</td>
<td>10 mm</td>
</tr>
<tr>
<td></td>
<td>- 25 mm</td>
<td></td>
</tr>
<tr>
<td>Sub-base</td>
<td>+ 0 mm</td>
<td>10 mm</td>
</tr>
<tr>
<td></td>
<td>- 25 mm</td>
<td></td>
</tr>
<tr>
<td>Base</td>
<td>+ 20 mm</td>
<td>5 mm</td>
</tr>
<tr>
<td></td>
<td>- 0 mm</td>
<td></td>
</tr>
<tr>
<td>Shoulder</td>
<td>+ 20 mm</td>
<td>10 mm</td>
</tr>
<tr>
<td></td>
<td>- 0 mm</td>
<td></td>
</tr>
<tr>
<td>Underfloor fill</td>
<td>+ 6 mm</td>
<td>5 mm</td>
</tr>
<tr>
<td></td>
<td>- 6 mm</td>
<td></td>
</tr>
</tbody>
</table>

The tolerances in the thicknesses of the materials for the construction of pavements shall be as follows:

- Sub-base thickness: + 20 mm to - 20 mm
- Base thickness: + 20 mm to - 15 mm
- Shoulder thickness: + 20 mm to - 15 mm

The surface of the shoulder where it joins the base, shall in no case be at a higher level than, nor more than 5 mm lower than, the level of the adjacent surface of the base.

TRIAL LENGTHS OF PAVEMENT

The Contractor shall submit in writing to the Engineer’s Representative his proposals for the grading, mixing, transporting, placing, spreading, and compacting the materials comprising the stabilised gravel pavements before the construction of the trial lengths. The Contractor shall construct a trial length of at least 400 square metres of each type of pavement as required by, and in the presence of, the Engineer’s Representative. If, in the opinion of the Engineer, the results of the trial length of pavement indicate that the Contractor’s proposed plant or method will complete the pavement adequately and in accordance with the specification, the Contractor may proceed with the work.

Otherwise the Contractor shall submit in writing proposals for modifying his plant or methods and shall, if the Engineer so requires, construct further trial lengths of pavement until the specified results are obtained. The location of this trial length shall be as directed by the Engineer’s Representative. During the construction of the trial length or trial lengths of pavement, the Contractor shall employ such types and weights of rollers or other compacting equipment in such a manner as the Engineer’s Representative may require.

PREPARATION OF SUB-GRADE

The sub-grade shall be compacted to a depth of 150 mm in the same manner as described for the laying and compaction of gravel sub-base except that the required density shall be as shown on the Drawings, specified by the Engineer or stated in the Bills of Quantities.
Any sub-grade material which in the opinion of the Engineer’s Representative fails to comply with this specification due to being inadequately compacted or being unsuitable material shall be reshaped and recompacted or replaced as directed or approved by the Engineer’s Representative, at the Contractor’s expense.

Any irregularities or depressions which develop in the surface of sub-grades during compaction shall be corrected by loosening the surface of the places affected and added, removing, or replacing smooth and uniform. At all times the surfaces of the sub-grades shall be kept in such condition that they will drain quickly and effectively, and to this end small drainage gaps shall be dug through the sub-grade of the verges wherever required. Any erosion that may develop on the surfaces of sub-grades shall be made good by the Contractor at his own expense.

No sub-grade shall be covered up until it has been inspected, tested for density and approved by the Engineer’s Representative.

PROCUREMENT OF MATERIALS

The Contractor shall be responsible for procuring materials for use in sub-base, base, underfloor fill and wearing course and for ensuring that all materials comply with this specification. Samples of materials that are proposed to be used shall be submitted to the Engineer for approval at least six weeks prior to them being brought onto the site. Materials that are not approved shall not be used in the permanent works.

GRAVEL SUB-BASE

The sub-base material shall comply with the following requirements. Any oversize material in excess of 50 mm shall be removed from the works prior to processing if so directed by the Engineer’s Representative.

Notwithstanding the fact that the Engineer may have approved stockpiles of material for use in sub-base, the Contractor shall ensure that material used in the sub-base complies with the following requirements:

<table>
<thead>
<tr>
<th>Class of sub-base</th>
<th>3.3</th>
<th>3.6</th>
<th>3.9</th>
</tr>
</thead>
<tbody>
<tr>
<td>Texas Triaxial Strength (max)</td>
<td>3.3</td>
<td>3.6</td>
<td>3.9</td>
</tr>
<tr>
<td>Max Ip (%) (Plasticity Index)</td>
<td>10.0</td>
<td>12.0</td>
<td>15.0</td>
</tr>
<tr>
<td>Max Ip (Plasticity Index)</td>
<td>150.0</td>
<td>200.0</td>
<td>450.0</td>
</tr>
</tbody>
</table>

GRADING SPECIFICATION

<table>
<thead>
<tr>
<th>B.S. Sieve (mm)</th>
<th>Percent Passing</th>
</tr>
</thead>
<tbody>
<tr>
<td>37.50</td>
<td>100</td>
</tr>
<tr>
<td>19.00</td>
<td>75 - 100</td>
</tr>
<tr>
<td>9.50</td>
<td>53 - 100</td>
</tr>
<tr>
<td>4.750</td>
<td>37 - 95</td>
</tr>
<tr>
<td>2.360</td>
<td>26 - 75</td>
</tr>
<tr>
<td>0.425</td>
<td>11 - 42</td>
</tr>
<tr>
<td>0.075</td>
<td>5 - 27</td>
</tr>
</tbody>
</table>

GRAVEL BASE

The base material shall comply with the following requirements. Any excess oversize material in excess of 50 mm shall be removed from the works prior to processing if so directed by the Engineer’s Representative.

Notwithstanding the fact that the Engineer may have approved sources of material for use in the base and underfloor fill, the Contractor shall ensure that material used in the base and underfloor fill complies with the following requirements:

<table>
<thead>
<tr>
<th>Class</th>
<th>2.4</th>
<th>2.6</th>
<th>2.8</th>
<th>3.0</th>
<th>3.3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Texas Triaxial</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1-56 Builder’s work and shopfitting specifications
(Strength Max)  
Max Ip (%)  
(Plasticity Index)  
Max PP  
(Plasticity Product)  

<table>
<thead>
<tr>
<th></th>
<th>2.4</th>
<th>2.6</th>
<th>2.8</th>
<th>3.0</th>
<th>3.3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2.0</td>
<td>4.0</td>
<td>6.0</td>
<td>10.0</td>
<td>10.0</td>
</tr>
<tr>
<td></td>
<td>30.0</td>
<td>50.0</td>
<td>80.0</td>
<td>150.0</td>
<td>150.0</td>
</tr>
</tbody>
</table>

**GRADING SPECIFICATION**

<table>
<thead>
<tr>
<th>B S Sieve Size (mm)</th>
<th>2.4</th>
<th>2.6</th>
<th>2.8</th>
<th>3.0</th>
<th>3.3</th>
<th>% Passing</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>37.5100</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>100</td>
</tr>
<tr>
<td>19.065 - 90</td>
<td></td>
<td>75</td>
<td>100</td>
<td></td>
<td></td>
<td>100</td>
</tr>
<tr>
<td>9.545 - 75</td>
<td></td>
<td>53</td>
<td>90</td>
<td>75</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>4.7530 - 50</td>
<td></td>
<td>37</td>
<td>75</td>
<td>53</td>
<td>90</td>
<td></td>
</tr>
<tr>
<td>2.3621 - 40</td>
<td></td>
<td>26</td>
<td>60</td>
<td>37</td>
<td>75</td>
<td></td>
</tr>
<tr>
<td>0.425</td>
<td></td>
<td>8</td>
<td>20</td>
<td>26</td>
<td>60</td>
<td></td>
</tr>
<tr>
<td>0.075</td>
<td></td>
<td>5</td>
<td>12</td>
<td>11</td>
<td>33</td>
<td>11 - 42</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>5 - 27</td>
</tr>
</tbody>
</table>

**GRAVEL WEARING COURSE**

The wearing course gravel to be stockpiled and used in the works shall conform with the following requirements:

All material shall have a grading modulus (GM) of not less than 1.5 and not greater than 2.5 where the grading modulus is defined as the sum of the percentages retained on the 75 micron, the 425 micron and the 2.00 mm sieve divided by 100.

The percentage passing the 75 micron sieve shall not exceed 70% of the percentage passing the 425 micron sieve.

**LAYING AND COMPACTION OF GRAVEL SUB-BASE**

The sub-base shall be deposited and spread in a uniform layer across the road, so that the final sub-base as shown on the Drawings, correct to line, slope widths and level is obtained. The sub-base shall be compacted in one layer in a methodical and orderly manner. It shall be compacted throughout to a minimum dry density of 95% Higher Compactive Effort (HCE), and at a moisture content in the range - 3% to + 1% of Optimum moisture content for the compaction plant being employed.

Compaction shall be carried out by approved compactors or rollers which follow a regular route such that each track slightly overlaps the adjacent previous track and the entire area of each layer is covered. Compaction shall progress form the sides to the centre of the section under construction, or from one side towards previously compacted work.

The surface of the finished sub-base shall be smooth and free from irregularities to the approval of the Engineer. Any parts of the surface of the sub-base which do not comply with the above requirements shall be corrected by being scarified, reshaped, remixed and recompaacted as may be necessary, or shall be otherwise treated as the Engineer may require, at the Contractor’s expense.

**LAYING AND COMPACTION OF GRAVEL BASE AND UNDERFLOOR FILL**

The gravel base and underfloor fill shall be constructed in the same manner and to the same standard as the gravel sub-base, except that it shall be compacted to 97% Higher Compactive Effort.
LAYING AND COMPACTION OF GRAVEL WEARING COURSE

Gravel wearing course shall be constructed to the same standard as gravel sub-base, except that it shall be compacted to 93% Higher Compactive Effort.

STABILISED GRAVEL

Where shown on the Drawing or instructed by the Engineer the base or sub-base shall be stabilised with cement or lime.

The gravel for stabilisation shall comply with the requirements for gravel base or sub-base, whichever the case may be, in all respects except those for Texas Triaxial Strength, Plasticity Product, all of which shall have values which in the Engineer’s opinion render the gravel suitable for use as base (or sub-base) with stabilisation using cement or lime.

The rate of addition of the stabilising agent (expressed as the percentage by weight of the dry material to which it is to be added) shall be as instructed by the Engineer, following the results of tests on samples from the stockpiles which the Contractor proposes to use for stabilised gravel base or sub-base and when planning his operations the Contractor must make due allowance for the delay between stockpiling and the material becoming available for use.

Before the stabilising agent is applied, the material to be stabilised shall be spread, mixed, shaped true to line, grade and cross section and lightly compacted. The loose thickness shall be such as to give the specified thickness after the full compaction has been carried out. The instructed percentage of stabilising agent shall be uniformly spread over the full widths to be stabilised as shown in the Drawings. Only sufficient stabiliser for immediate use shall be spread ahead of the mixing operation and any stabiliser which, in the opinion of the Engineer, becomes defective shall be replaced at the Contractor's expense. No traffic of plant not actually used in the spreading or mixing operations shall be allowed to pass over the stabilising agent, when so spread, until it has been mixed into the material to be stabilised.

Immediately after the stabilising agent has been spread, the agent and the material to be stabilised shall be thoroughly mixed to form a fine tilt for the full depth of the layer, and mixing shall continue for as long as is necessary to ensure that the resulting mixture is homogenous.

Care shall be taken both during this and during subsequent watering operations that the layer underlying that being stabilised is not disturbed and that no material from the underlying layer of shoulders is mixed with that being processed.

Water shall be added where necessary, and thoroughly mixed in successive increments, to obtain the required moisture content uniformly throughout the depth of the layer. Care shall be taken to avoid a concentration of water at any point, or any flow of water over the surface.

Any portion of the work which becomes saturated after the stabilising agent has been added shall be rejected; this shall apply equally to saturation by rainfall.

The base shall be compacted in one layer and shaped on completion of the mixing and watering operations. Compaction shall be to a minimum dry density of 97% Higher Compactive Effort and at a moisture content in the range - 3% to + 1% of Optimum Moisture Content. The gravel layer shall be shaped in accordance with the correct lines, slopes, widths and levels shown on the Drawings.

The surface finish after compaction shall be free from ridge compaction planes, laminations or other surface irregularities.

All work required to produce the finished pavement layer shall be completed within five hours of spreading the stabilising agent with the exception of rolling to induce cracking.
The Contractor shall roll the finished layer once, not less than six and a half hours, nor more than seven hours, after spreading the stabilising agent, with a 12 tonne or 18 tonne smooth wheeled roller to induce cracking of the layer.

All construction joints with previous work shall be made to a face cleanly cut, vertically at right angles to the road centre line, for compacted portion of the previous work. Previous work must be fully compacted at all times. Test holes shall be backfield by the Contractor at his own expense, with fully stabilised and compacted material, to the same standard as the base course.

The stabilised base shall be continuously kept damp for a period of seven days after constructing. All traffic other than that required for watering shall be kept off the completed base course for this period. The prime coat shall then be applied as soon as practicable thereafter.

The stabiliser content shall not be less than 60% nor more than 140% of the specified amount and the average stabiliser content over 20 samples shall not be less than 90% nor more than 120% of the specified amount.

HYDRATED LIME FOR SOIL STABILISATION

Hydrated lime for soil stabilisation shall comply with SAZ A19: 1964 in all respects except that under Clause 4 of the Chemical properties the 2.40 mm and 420 micron sieve sizes shall read 2.26 mm and 425 microns respectively.

SURFACE DRESSING : PRIME COAT

MATERIALS

Priming materials shall be cut back bitumen grade MC30 in accordance with SAZ no 145 (1975), or alternatively tar prime of grade TP.7 in accordance with SAZ 105 (1974).

CONSTRUCTION

1. PLANT AND EQUIPMENT

   All plant and equipment used on the Works shall be in good condition and operation by experienced, competent personnel. No plant or equipment used during the construction of the surfacing shall be serviced or refuelled whilst standing on the road and furthermore any of the plant and equipment developing leaks (of either fuel, oil or of the tar or bitumen) shall be removed from the Works immediately and not be allowed back on the road until properly repaired.

   Before commencing any spray work the bitumen distributor shall be checked and approved by the Engineer as being in satisfactory condition for use. Distributors should have a valid certificate of approval issued by the Standards Association of Zimbabwe.

2. WEATHER LIMITATIONS

   No spraying of prime, tack or seal binders shall be carried out under the following adverse conditions:

   (a) during misty conditions;

   (b) when rain is threatening;

   (c) when wind is blowing sufficiently hard to disturb spray jets which will result in unsightly edges to the spray line;
(d) When the minimum road surface temperature is less than 10 degrees celcius, or when the air (shade) temperature is:

(i) rising and less than 18 degrees celcius;

(ii) falling and less than 21 degrees celcius;

(e) when the surface to be sprayed is wet or damp (except that a slightly damp base is acceptable for prime);

(f) when the aggregate is damp.

3. PREPARATION OF THE BASE COURSES

Before spraying, the surface of the base shall be broomed and cleaned of all loose or foreign material by means of a rotary broom and/or hand brooms to the satisfaction of the Engineer. With a base constructed of fine cohesionless material it may be necessary to use soft hand brooms or in some cases omit the brooming altogether. The Engineer will indicate his requirements in all cases. The edges of the work shall be carefully set out.

Adequate precautions shall be taken to ensure an absolutely clean edge to the surfacing. This shall be achieved by laying strips of tobacco paper or by providing a windrow (at least 200 mm wide and 10 mm thick) of the base sweepings (or other suitable material) along the edges. On curves with excessive super-elevation a windrow of the base sweepings shall be left along the lower edge of the surface to be primed to prevent prime from running in unsightly streaks across the shoulder.

Immediately before the application of the prime a light spray of water shall be applied to the base surface. If the water is over applied the surface shall be allowed to dry out to a uniform damp condition before priming. On no account shall priming be carried out on a saturated or over wetted base as penetration will not occur.

4. PRIME COAT APPLICATIONS

(a) The prime coat shall be applied by distributor at the application rate of between 0.80 and 0.90 l/square metre.

Trial applications over short sections shall be undertaken to obtain the correct application. The practice shall be to apply a coat of 0.90 l/square metre and then to made adjustments downwards as necessary.

(b) The temperature of the application shall be as given in SAZ 145 or SAZ 105.

(c) Tobacco paper or a suitable substitute shall be used at all transverse joints at the beginning and end of all sprays.

(d) The prime is generally applied in more than one lane and hence allowance shall be made for overlapping of adjoining sprays. End jets shall not be used for these overlapping longitudinal joints. The overlap shall be equal to one half of the width of the coverage obtained from a single jet.

(e) Care shall be taken to protect any kerbing, channelling, etc., from the prime by covering with a suitable protective material prior to spraying.

(f) All traffic shall be kept off the primed surface until the prime has penetrated and cured sufficiently to prevent the wheels picking it up when passing over the surface.

(g) The priming operation shall stop some 15 - 20 metres short of the end of the compacted base. This will ensure no interference with the primed surface when compaction restarts.
SURFACE DRESSING: ASPHALTIC CONCRETE (PREMIX)

MATERIAL

1. BINDERS

Bituminous binders shall comply with SAZ 144 (Penetration grades) (normally Bitumen 80/100).

2. AGGREGATES

(a) The aggregates shall comply with SAZ 232 (1978). Filler may consist of either Portland Cement or approved mineral dust and shall be thoroughly dry and free from lumps. Material in the filler retained on the 0.075 mm sieve shall be regarded as fine aggregate. Where acid aggregates are used, the filler shall be alkaline.

(b) The combined grading of the aggregates, including the filler, shall conform as closely as possible to the ideal grading envelopes as follows:

<table>
<thead>
<tr>
<th>SIEVE SIZE</th>
<th>NOMINAL AGGREGATE SIZE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>7 mm</td>
</tr>
<tr>
<td></td>
<td>% PASSING</td>
</tr>
<tr>
<td>13.2 mm</td>
<td>100</td>
</tr>
<tr>
<td>9.5 mm</td>
<td>100</td>
</tr>
<tr>
<td>4.75 mm</td>
<td>75 - 90</td>
</tr>
<tr>
<td>2.36 mm</td>
<td>45 - 65</td>
</tr>
<tr>
<td>1.18 mm</td>
<td>28 - 42</td>
</tr>
<tr>
<td>0.600 mm</td>
<td>17 - 30</td>
</tr>
<tr>
<td>0.150 mm</td>
<td>6 - 15</td>
</tr>
<tr>
<td>0.075 mm</td>
<td>4 - 10</td>
</tr>
</tbody>
</table>

COMPOSITION AND STABILITY

The premix when tested by the standard method shall comply with the following:

Marshall Stability (min) (Kn)
(at 60 degrees - 75 blows each end of specimen) 3.34

Flow 2 - 4.5

Air voids in mix (%) 3 - 6

As a guide the following is a broad specification for binder contents:

Bitumen (80/100) : 6.5% + - 0.5% by mass of aggregate.
PLANT AND EQUIPMENT

All equipment used shall be of adequate rated capacity and in good mechanical condition.

Spreading machines shall be mechanical self-propelled pavers of approved type capable of spreading the premix true to line and level, to a minimum width of 3 metres and without segregation, dragging, tearing, burning or other surface defects.

Tandem-steel wheel roller and pneumatic tyred rollers shall be supplied and shall conform to the following requirements:

(a) Steel-wheel rollers shall be in the 8 - 10 tonne range and shall be self-propelled.

(b) Pneumatic tyred rollers shall be in the 12 - 20 tonne range, with a working type pressure of up to 600 kPa, and shall be self-propelled. They shall have two rows of smooth tyred wheels so mounted that any gaps between wheels in the front row are covered by wheels in the rear row.

(c) Both types of rollers shall be fitted with adjustable scrapers to keep the wheels clean and an efficient means of keeping the wheels wet.

MIXING

The aggregate shall be screened into different sizes and supplied into separate storage bins. They shall then be mixed in the correct proportions to give the desired grading for each batch, and shall be thoroughly dried and fed at a temperature not exceeding 175 degrees celsius for bituminous premix and 100 degrees celsius for tar premix into a mechanical mixer of approved type. The filler and bitumen (or tar) shall then be added, and mixing shall continue until the aggregate has been uniformly mixed and coated with binder.

The temperature of the binder shall not exceed 175 degrees celsius, in the case of bitumen, and 100 degrees celsius in the case of tar, and shall not be held at it’s maximum for an excessive period. The temperature of the mix on completion of the mixing operation shall be between 135 degrees celsius and 165 degrees celsius (70 degrees celsius - 90 degrees celsius for tar premix).

PREPARATION OF PRIMED BASE

The surface of the primed base shall be completely clean and free from loose material before the premix is applied. Holes and depressions shall be patched out with a fine premix consisting of a densely graded crusher dust or similar material mixed with a stable bitumen emulsion, well compacted and true to profile to the satisfaction of the Engineer.

Where a separate item is included in the Bill of Quantities the Contractor shall obtain written instructions from the Engineer as to where a light spray of bituminous emulsion shall be applied to the primed base immediately before laying the premix. This shall be approved bituminous emulsion diluted with water and sprayed on by an approved pressure distributor to give approximately 0.2 litres/square metre residual bitumen. The day by the premix. Any pools of surplus emulsion shall be removed before the premix is laid.

WEATHER LIMITATIONS

Premix shall be laid only when conditions are such that the specified density can be attained by rolling and a good bond obtained with the primed base.

Laying shall not take place :

(a) when air temperature is below 15 degrees celsius;
(b) during wet or foggy weather;

(c) if the surface is wet.

TRANSPORTATION

The premix shall be transferred from the mixing plant to the site in suitable vehicles and a sufficient number of vehicles shall be available from the plant at the same rate at which it is being produced.

The temperature of the premix on arrival on site shall be not less than 120 degrees celcius for a premix using bitumen and not less than 70 degrees celcius for a premix using tar. If the transportation distance is great, or if rain is likely, the trucks shall be covered with tarpaulin sheets.

LAYING

The premix shall be laid by means of an approved paver to provide the compacted thickness required.

Segregated, dragging, tearing, burning or other surface defects shall be avoided, and backcasting shall not normally be permitted.

A skilled mechanic shall be available to carry out any necessary adjustments to avoid defects in the surface finish.

In special circumstances permission may be given to spread fine material behind the paver or drag-broom the surface. This shall be done before the initial rolling. Any excess material, especially segregated coarse aggregate, resulting from this operation, shall be removed from the surface and rejected.

Every effort shall be made to maintain continuous operation of the paver.

TRIAL AREA

The Contractor shall be called upon to lay and compact a trial area of at least 200 square metres at the designed thickness, for approval by the Engineer, before the commencement of the work. This area shall be inspected and tested for density. If accepted, and if density achieved is to specification, the surface finish and density of all succeeding work shall not be inferior to that of the trial area.

JOINTS

Care must be taken to ensure that construction techniques are such that joints are well compacted and impermeable to weather.

Cold joints between sections shall be cut back to a vertical face, loose materials removed and the face painted with a thin coat of bituminous emulsion, to form a bond between the sections. Joints shall be accurately levelled so that the surface is uniform and true.

Joints shall be either at right angles or parallel to the centre line of the road.

The outside edge of the completed layer shall be trimmed to the exact line to give the specified width.

ROLLING

The rolling technique shall be in accordance with current accepted god practice for the rolling of bituminous concrete surfacing with particular attention paid to the sequence of rolling edges, and the rolling of joints.
The sequence of rollers used shall be at the discretion of the contractor but the Engineer shall have the right to order any alternative sequence to that used by the Contractor.

The compacted layer shall have a density of at least 97% of the Marshall design density.

Longitudinal and transverse joints shall be carefully rolled so that a good bond is obtained and no ridges or depressions are formed.

The length of successive passes of the roller shall be staggered so that a ridge does not develop in the surface at the point where the roller stops and reverses. After completion of rolling, rollers shall not be allowed to stand on the warm recently compacted premix.

QUALITY CONTROL

Samples for analysis to determine mix proportions shall be taken from each day’s work.

FINISHED SURFACE

The premix shall conform closely with the required lines, grades, cross-section and dimensions.

The finished surface shall be free from rutting or other irregularities which may hold water.

The level of any point on the finished surface of the premix shall be within 5 mm of the level specified.

When a 3 metre long straight edge is placed on any part of the surface so as to be on or parallel to the centre line, any gap between the contact edge and the finished surface shall not be more than 5 mm.

KERBING AND CHANNELLING

Precast concrete work shall be of an approved manufacture. All in-situ work shall be in accordance with “Concrete, Formwork and Reinforcement”.

All kerbing and channelling shall be true to line and grade, and precast sections shall be jointed with 1:4 cement and mortar. All kerbing shall be haunched with grade 10 concrete to the Engineer’s approval.

(a) Where the depth of cover over a pipe and surround is less than one metre, culverts shall be constructed using Class 5 concrete pipes with a Grade 20 concrete surround in accordance with the Drawings;

(b) Where the depth of cover over a pipe exceeds one metre, culverts shall be constructed using Class X concrete pipes with a Grade 20 concrete haunch in accordance with the Drawings.

If the Contractor wishes to construct pipe culverts removable formers he shall submit details to the Engineer for approval at the time of submitting his tender.

ROAD MARKINGS

All road marking shall be carried out using an approved PVA paint. The paint shall be applied in two coats to the exact dimensions as shown on the Drawings.

Before any paint is applied the road surface shall be dry and swept clean. The template used shall be in good condition and shall be sufficiently flexible to make continuous contact with the road surface throughout its length.
ROAD SIGNS

Road signs shall be of standard pattern, reflective on metal base, bolted or otherwise securely fixed to 50 mm mild steel tubular supports.

From the lowest point of the sign and commencing with black, Give Way signs shall be painted in alternate black and white bands 300 mm in width. Paint shall be enamel.

The tubular supports shall be set 600 mm into the ground in concrete Grade 15 bases approximately 230 mm square in plan. The bottom ends of the supports shall be crimped to prevent the post being rotated in the concrete.

*********
SPECIALIST SERVICES

NO DISCOUNT ALLOWED FOR

All Provisional and P.C. Sums stated are NETT delivered to site, unless otherwise described. The Contractor must add for profit, if required, to the item following each sum.

ATTENDANCE, ETC.

The Contractor must allow attendance upon all Nominated Sub-Contractors. "Attendance" unless otherwise described, shall mean taking delivery at site, checking, unloading, storing as necessary in Contractor's sheds, hoisting, the provision of all facilities to and attendance on the particular supplier and fixer, giving all reasonable assistance, the provision of water, power, etc., and of necessary builders' scaffolding or building plant, including erecting scaffolding, adjusting as required, maintaining and moving for the execution of the work, making good in all trades after completion of the work, protecting from injury and the availability of toilets, etc. In the case of Nominated Suppliers "taking delivery", unless otherwise described, shall mean taking delivery at site, checking, unloading and storing as necessary in Contractor's sheds until required for fixing.

ADJUSTMENT OF PROFIT AND ATTENDANCE

The "Profit" allowed in the Contractor's original Bills of Quantities will be deemed to have been worked as a percentage profit mark-up on the Provisional or PC Sums and will be adjusted to align with the final cost of the item, excluding allowances for increased costs. Attendance will not be adjusted unless the scope of the work varies or the Contractor states it as a percentage in which case it will be adjusted to align with the final cost of the item, excluding allowances for increased costs.

CONTRACTOR TENDERING

If the Contractor is permitted to tender (and if his tender is accepted) for any work covered by a Provisional Sum in the Bills of Quantities, such Provisional Sum in the original Bills of Quantities will be omitted. Any additional Preliminaries and General allowances and conditions required by the Contractor shall be included in his tender for the work covered by such Provisional Sum, and no additional allowances, etc., will be allowed. Any allowance for "Profit" and "Attendance" in the original Bills of Quantities will be adjusted as above.

**********
SECTION 2

ELECTRICAL ENGINEERING SERVICES

TECHNICAL SPECIFICATION

SERVICES TO BE PRICED FOR BY ELECTRICAL SUB-CONTRACTOR:

2.1 Scope of Works
2.2 General Description
2.3 Electrical Services General Description
2.4 Electrical Supply
2.5 Standards Applicable to the Works
2.6 Distribution Boards
2.7 Lighting Layout
2.8 Socket Outlets and Accessories
2.9 Conduiting and Trunking
2.10 Electrical Services Associated with Mechanical Services
2.11 Emergency Exit Lighting
2.12 Provision for Telecommunication Wiring
2.13 Provision for Data Communication Wiring
2.14 Fire Alarm System Installation
2.15 Armoured Cables
2.16 First Fix Containment and Power Provision for Security System
2.17 Cable Trays
2.18 Standby Diesel Generator
2.19 UPS
2.20 Quality Control
2.21 Earthing and Bonding
2.22 Testing and Commissioning
2.23 Schedule to Completed by the Electrical Contractor
2.24 Schedule of Luminaires (Light Fittings)
2.1 **Scope of Works**

The work generally comprises the Electrical Installation of the African Development Bank Offices in Harare. The Electrical Sub-Contractor shall price for the supply, delivery, installation testing and commissioning of the following:

- 2.1.1 Distribution Boards
- 2.1.2 Lighting Layout
- 2.1.3 Socket Outlets and Accessories
- 2.1.4 Conduiting and Trunking
- 2.1.5 Electrical Services Associated with Mechanical Services
- 2.1.6 Emergency Exit Lighting
- 2.1.7 Provision for Telecommunication Wiring
- 2.1.8 Provision for Data Communication Wiring
- 2.1.9 Fire Alarm System Installation
- 2.1.10 Armoured Cables
- 2.1.11 First Fix Containment and Power Provision for Security System
- 2.1.12 Cable Trays
- 2.1.13 UPS
- 2.1.14 Quality Control
- 2.1.15 Earthing and Bonding
- 2.1.16 Testing and Commissioning, and
- 2.1.17 Safe removal of the Existing Electrical Installation

African Development Bank (ADB) is currently occupying half the space that needs to be refurbished. The Electrical Installation shall be done in three phases. When Phase One is finished ADB Staff will move to the completed area then Phase Two works will commence. The Electrical Contractor shall price for the Preliminary and Generals so that they are able to execute this work in three phases with minimum disturbance to the business operation.
2.2 **General Description**

2.2.1 The development will entail the Electrical Installation of new Electrical Materials.

2.2.2 Electrical Drawings  
i) Lighting and Fire Alarm System Layouts  
ii) Smallpower Layout  
iii) Electrical Reticulation Schematic  
iv) Power Provision to Air Conditioning Equipment

2.2.3 The Electrical Installation shall be done in two Phases.

2.2.4 *In order to minimise disturbance to the business operations noisy works shall be done after hours. The Electrical Contractor shall make provisions in his tender under the Preliminary and Generals for all the overtime costs related to working after hours.*

2.3 **Electrical Services General Description**

2.3.1 The existing Building Electrical Reticulation shall be remodelled to satisfy Requirements of the new Offices for African Development Bank.

2.3.2 The Electrical Reticulation shall be priced in line with the provisions of the Bill of Quantities.

2.3.3 The Electrical sub-contractor shall install the additional switchgear in the Existing Main Board in line with quantities shown in the Bill of Quantities.

2.3.4 The installation of the additional new switch boards and termination of cables shall be done on a Saturday through to Sunday such that on the following Monday the Other Tenants will be able to operate normally. The Electrical Contractor to price for working overtime and during a weekend for this exercise.

2.3.5 The Electrical Contractor shall price for coordinating these works with the local Old Mutual Electrical Maintenance Department.

2.4 **Electrical Supply**

2.4.1 The Electrical Supply to the building shall be at 400V.

2.4.2 Throughout the course of the Installation the Electrical Contractor shall connect power analysing equipment to the power take off point and produce not less than two reports as set out in the Preliminary and Generals.
2.5 Standards Applicable to the Works

2.5.1 The SAZ, IEE, BS and IEC regulations shall be applicable throughout the Installation.

2.5.2 The local ZETDC regulations shall also govern how the works are done.

2.5.3 The Electrical Sub-Contractor shall liaise closely in all cases with ZETDC Inspectors where necessary.

2.5.4 The Electrical Sub-Contractor shall regularly invite Landlord Maintenance inspectors so that preliminary inspection can be done as the works progress.

2.6 Distribution Boards

2.6.1 All switchgear and distribution boards shall conform to the standards set in section 5.5.

2.6.2 The Electrical Contractor shall price for disconnection of the existing distribution boards.

2.6.3 The Electrical Contractor shall price for the new DBs in line with the DB schedules herein presented for the new Offices.

2.6.4 The Electrical Contractor shall provide new wiring for light fittings and all socket outlets and termination shall be done safely in the new distribution boards.

2.6.4 Each distribution board shall have a danger 400v label on the outside.

2.6.6 Each distribution board shall have a designation chart.

2.6.5 Each distribution board shall have an earth bar with a separate connection point for each outgoing circuit.

2.6.6 Each distribution board shall have a neutral bar with a separate connection point for each outgoing circuit.

2.6.7 The Electrical Sub-Contractor shall submit to the Engineer for approval manufacturer’s drawings of all switchboards and distribution boards prior to manufacture.
2.7 Lighting

2.7.1 The lighting installation has been designed with energy efficiency in mind to achieve a long life and economical running.

2.7.2 LED light fittings shall be utilised throughout the installations.

2.7.3 For specification of luminaires refer to Schedule of Luminaires.

2.7.4 All luminaires shall be supplied, installed and tested by the Electrical Sub-contractor.

2.7.5 Recessed luminaries shall be supplied with a 2 metre flexible lead and a 5 amp plug.

2.7.6 The 5A plugs shall be inserted into 5A sockets mounted adjacent to the luminaries.

2.7.7 All metalwork on the luminaires shall be connected to an insulated earth protective conductor.

2.7.8 Where luminaries are fixed to conduit boxes, the boxes shall be secured to the structure by sheridised fixing screws.

2.7.9 Luminaires shall prior to handover be cleaned and polished.

2.7.10 The permanent lighting installation shall not be used for temporary lighting purposes during the contract.

2.7.11 The Electrical Contractor shall price for the supply and installation of materials required for the provision of temporary lighting as set out in the preliminary and generals.

2.7.12 The Electrical Sub-Contractor shall submit for approval by the Architect, Engineer and Client samples of all luminaires prior to manufacture.

2.7.13 The Light Fittings shall be of high quality.

2.7.14 The Electrical Contractor shall price for the supply and installation three samples of the Type A light fitting to enable the Project Team to approve colour and light output prior to placing full orders.
Lighting Control Switches

2.7.15 Lighting control switches shall comply with BS 3676. They shall be of the grid switch pattern Matt Chrome Finish.
2.7.16 Grid chrome high quality MK light switches shall have 10 or 20amp rating.

2.8 Socket Outlet and Accessories

2.8.1 The socket outlets on the work station shall be supplied by the Electrical Contractor.

2.8.2 New socket outlets shall be installed on the Skirting Trunking in line with the allowances made in the Bill of Quantities.

2.8.3 The Electrical Contractor shall be required to supply and install 13A Universal double switched socket outlets with pilot lamps and 2No. USB ports.

2.8.4 The Electrical Contractor shall be required to supply and install 13A MK Single Non Standard Socket Outlets complete with the Non Standard Plug Tops.

2.8.5 The samples of the all Electrical Accessories shall be submitted for approval by the Architect, Engineer and Client prior to placing full orders.

2.9 Conduits and Trunking (JVS)

2.9.1 Conduit cast into the building structure shall be of the heavy duty Pvc Type. The Electrical Contractor shall make provisions for cutting the floor screeds to bury conduits.

2.9.2 All conduit accessories shall be manufactured from the same materials as the conduit.

2.9.3 Every conduit shall contain a circuit earth conductor.

2.9.4 The Electrical Contractor shall price for cutting the screed with heavy duty grinders to create channels for burying in screed 25mm diameter conduits to link various sections of the skirting trunking. This work may take one week to finish and shall be priced such that it is done at night so that it does not disturb the building operation.

2.9.5 The standard flat bank three compartment skirting trunking shall be installed throughout the Offices in line with the contract drawings.

2-6 Electrical specifications
2.9.6 Various types of trunking are specified throughout the building, generally the trunking shall be manufactured to Class 2, medium protection from folded mild steel, ZINTEC coated and stove enamel paint to be advised by the Architect.

2.9.7 The Electrical Contractor shall price for 250 x 50mm three compartment standard bank skirting trunking supplied by JVS.

2.9.8 The Electrical Contractor shall price for a continuous cover with the following knock outs punched on one sheet, 1No. 6 x 3 and 2No. 3x 3 for Power socket outlets, 2No. 3 x 3 for Data Socket Outlets and 2No. 3 x 3 for Telephone Socket Outlets

2.9.9 The Electrical Contractor shall bring to Site the manufacturer of the Skirting Trunking so that they can take measurements of angles for the trunking accessories to be used for bends, tees, offsets etc

2.9.10 Within the suspended ceilings, trunking and trim shall be supported on common supports by screwed rod or similar hangers. Where there are multiple trunking and trays, these structures shall have two rods and a horizontal section unistrut.

2.9.11 Horizontal trunking shall be fixed at centres not exceeding 1500mm.

2.9.12 Cable carrying capacities shall be in accordance with the I.E.E. wiring regulations. During the installation should any trunking exceed the capacity the Engineer should be informed.

2.9.13 Each trunking shall have its own earth protective conductor connected through an earth terminal on every length and fitting.

2.9.14 The Electrical Contractor shall submit samples of the JVS 250 x 50mm Skirting trunking for approval by the Engineer, Architect and Client

2.10 Electrical Services Associated with Mechanical Services

2.10.1 The electrical sub-contractor shall be responsible for the supply and installation of power cables to the mechanical services installation.

2.10.2 The mechanical services control panels shall be supplied and fixed by the mechanical services sub-contractor. The mechanical sub-contractor shall carry out all electrical terminations.

2.10.3 The electrical sub-contractor shall ensure the electrical services installation associated with the mechanical services complies with the electrical services specification for materials and installation methods.
2.10.4 The electrical sub-contractor shall obtain the free issue room temperature sensors from the mechanical sub-contractor, to fix and connect where applicable.

2.10.5 The electrical sub-contractor in addition to supplying and installing tray trunking and conduit, shall supply and install all isolators, connection units, and spurs twin DP switches to connect the complete mechanical services installation.

2.10.6 The exact positioning for the termination of conduit box isolator for the termination to plant shall be arranged to suit the equipment and for easy means of isolation.

2.10.7 Isolators and control switches shall be labelled with traffolite labels to indicate the items they control.

2.10.8 The mechanical services sub-contractor shall be responsible for testing and commissioning the complete system. The mechanical sub-contractor shall employ a recognised commissioning engineer to test and set to work the entire system.

2.11 Emergency Exit Lighting

2.11.1 The emergency exit lighting shall be installed at all exit points.

2.12 Provision for Telecommunication Wiring

2.12.1 The electrical sub-contractor shall be responsible for the supply and installation of the PVC conduits and trunking for the containment of telephone equipment as detailed on the contract drawings.

2.12.2 The telecommunications hardware, cable and terminating, testing and commissioning of the system shall be carried out by specialists under a direct contract with the Employer.

2.12.3 The electrical sub-contractor shall allow in his tender for liaising with the communication specialist to ensure both parties are familiar with each other’s works.

2.12.4 Within the telecommunication equipment room, two 50 x 6mm copper earth bars shall be fixed to the walls.
2.12.5 The first bar shall be a clean earth, which is derived from an independent earth electrode.

2.12.6 The second earth bar is from the main earth. This main earth bar bonds all the conductive systems including water pipe, lighting conductors, structure, sprinklers and telecommunications.

2.12.7 The telecom specialist shall terminate all incoming and outgoing cables and supply and terminate all outlets.

2.12.8 The electrical Sub-Contractor shall install steel draw wires in each conduit for use by the specialist telephone installer.

2.13 Provision for Data Communication Wiring

2.13.1 The data/computer hardware, cable and terminating, testing and commissioning of the Specialists under a direct contract shall carry out system with the Employer.

2.13.2 The electrical sub-contractor shall allow in his tender for liaising with the data/computer Specialist to ensure both parties are familiar with each other works.

2.13.3 The service provider connection frame and intake position are located in the Server Room.

2.13.4 The electrical sub-contractor shall supply and install a containment system trunking and conduits for the data/computer-cabling infrastructure.

2.13.5 The data conduits shall be concealed within slab, ceiling voids, floor voids, rising ducts and building fabric.

2.13.6 All cables by others shall be contained within conduit or trunking or clipped on cable trays and only where the conduits are recessed into the walls, floor or ceiling shall PVC conduit be used.

2.13.5 Within the data/computer equipment rooms two copper earth bars shall be fixed to the walls.

2.13.6 The first bar shall be a clean earth, which is derived from an independent earth electrode.
2.13.7 The second earth bar is from the main earth. This earth bar bonds all the conductive systems including water pipe, lighting conductor, structure, and telecommunications.

2.13.8 The data specialist shall terminate all incoming and outgoing cables and supply and terminate all outlets.

2.13.9 The electrical sub-contractor shall install steel draw wires in each conduit for use by the specialist computer installer.

2.14 Addressable Fire Alarm System Installation

2.14.1 The Electrical Contractor shall be responsible for the installation of an addressable Fire Alarm System.


2.14.3 Pvc conduits and ceiling trunking shall be installed to link the various Fire Alarm System devices and the control point.

2.14.4 The exact routes of the Pvc Conduits and ceiling trunking shall be determined on site in consultation with the Specialist Sub Contractors.

2.14.5 The first fix and power provisions shall be priced in line with the quantities stated in the Bill of Quantities.

2.14.6 The Pvc Conduits arrangements shall be approved by Specialist Fire Sub-Contractors.

2.14.7 The Fire Alarm System Control Panel shall have a capability to shut down the Air-conditioning System.
2.15 **Armoured Cables**

2.15.1 The armoured cables shall be priced in line with the Bill of Quantities.

2.15.2 The cables shall be fixed on Cable Trays.

2.15.3 The Electrical Contractor shall price for glands and shrouds in line with the cables indicated on the distribution board schedules and Electrical Reticulation Schematics.

2.15.4 The exact cable routes shall be determined on Site.

2.16 **First Fix Containment and Power Provision for Security System**

2.16.1 Pvc conduits and ceiling trunking shall be installed to link the various security devices and the control point.

2.16.2 The exact routes of the Pvc Conduits and ceiling trunking shall be determined on site in consultation with the Specialist Sub Contractors.

2.16.3 The first fix and power provisions shall be priced in line with the quantities stated in the Bill of Quantity.

2.16.4 Draw wires shall be put inside the Pvc conduits in which cables shall be installed by Specialist Sub Contractors.

2.16.5 The Pvc Conduits arrangements shall be approved by Specialist Sub Contractors.

2.17 **Cable Trays**

2.17.1 The cable trays shall be installed to provide supports for cable runs in the ceiling voids and on wall risers to distribution boards.

2.17.2 The exact routes of the Cable Trays shall be determined on Site.

2.17.3 The Cable Trays shall be priced in line with the quantities stated in the Bill of Quantities.

2.17.4 The Cable Trays shall be supported by brackets at 1500mm centres
2.18 **Closed Type Sound Attenuated (Silent) PERKINS or FG Wilson Standby Weather-proof Diesel Generator**

2.18.1 The installation of the Closed sound attenuated (silent Standby Diesel Generator complete with an automatic transfer switch shall be done by others.

2.18.2 The Generator armoured cables shall be installed by the Electrical Contractor.

2.19 **UPS**

5.19.1 The installation of the UPS shall be done by others.

5.19.2 The UPS armoured cables shall be installed by the Electrical Contractor.

2.20 **Quality Control**

2.20.1 The Electrical Contractor shall submit a list of Suppliers of Electrical Material to be used for the Project together with their Tender.

2.20.2 The Electrical Contractor shall submit samples all Electrical Material to be used for the Project before manufacture of full orders.

2.20.3 The Electrical Contractor shall price for the high-quality Exit Signs and not the low-cost common box or suspended brass types.

2.20.4 The Electrical Contractor shall price for the modern high quality Hand Driers where the two hands are inserted into the machine with drying of hands achieved by moving the hands up and down.

2.21 **Earthing and Bonding**

2.21.1 The Electrical Sub-Contractor shall supply and install an electrical earth system linking the neutral and equipment earth systems to be provided by the Electricity Supply Authority and that specified to be provided in connection with the Standby Generator installation as indicated on the drawings and detailed below.

2.21.2 The earthing system shall comprise all necessary copper conductors, bonds and insulator supports. The sizes of bonding cables and tapes shall be as indicated on the drawings.

2.21.3 Earthing conductors shall be fixed and dressed to the walls along the horizontal route, not less than 600mm above floor level and held in position by brass saddles, raw plugs and screws.
2.21.4 Incoming water services shall be bonded at the point of entry to the electrical earth system with connections at the main earth bar in the associated building.

2.21.5 The Electrical Sub-Contractor shall also include for bonding all metal sinks, baths, tables etc., and all other extraneous metalwork to the electrical earth system as detailed on the drawings. Metal sinks, baths and tables etc., are shown on the layout drawings by the use of the international earth symbol.

2.21.5 Distribution boards shall be earthed to the main earth bar at the main or sub-main switchboard position, by bonding to the armouring of the services cable and main earth bar by means of a separate bare stranded copper earth conductor run together with the service cables.

2.21.6 Each socket outlet and spur outlet shall be earthed by means of a separate 2.5sq.mm (min) stranded bare copper conductor run together with the circuit conductors. Where outlets are connected on a ring circuit the earth wires shall be connected on a ring circuit as well.

2.22 Testing and Commissioning

2.22.1 The Electrical Sub-Contractor shall include for the Engineer to visit the Suppliers of all materials and equipment in order to carry out Factory tests.

2.22.2 Final site commissioning shall also be witnessed by the Engineer but after satisfactory preliminary tests and submission of results by the Electrical Sub-Contractor to the Engineer.

2.22.3 The Electrical Sub-Contractor shall price for training of four users on the operation of all equipment installed under this contract.

2.22.4 The Electrical Contractor shall price for submission of 3No. hard copies and a soft copy of the as built drawings.

2.22.5 The Electrical Contractor shall price for submission of 3No. Leather book bound Maintenance Manuals for the Electrical Installation.
2.23.1 MATERIAL BASIC PRICE LIST

The Tenderer must submit the Supplier’s materials basic price quotations together with his/her tender for all the materials to be used in this project.
2.23.2  SCHEDULE OF TENDER LABOUR RATES

<table>
<thead>
<tr>
<th>Position</th>
<th>Rate</th>
<th>/hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project Manager</td>
<td>$</td>
<td></td>
</tr>
<tr>
<td>Foreman Supervisor</td>
<td>$</td>
<td></td>
</tr>
<tr>
<td>Electrician Class 1</td>
<td>$</td>
<td></td>
</tr>
<tr>
<td>Electrician Class 2</td>
<td>$</td>
<td></td>
</tr>
<tr>
<td>Electrician Class 3</td>
<td>$</td>
<td></td>
</tr>
<tr>
<td>Electrician Class 4</td>
<td>$</td>
<td></td>
</tr>
<tr>
<td>Skilled Worker Grade 1</td>
<td>$</td>
<td></td>
</tr>
<tr>
<td>Skilled Worker Grade 2</td>
<td>$</td>
<td></td>
</tr>
<tr>
<td>Assistant</td>
<td>$</td>
<td></td>
</tr>
</tbody>
</table>

Any Other (List Below)

These rates will be used on labour increased costs and any extra works of similar nature.

Signature: ..........................................................

Representing: ..........................................................

Date: .............................................................
2.23.3 SCHEDULE OF SUPERVISORY STAFF

Give names and experience of the key staff the Tenderer proposes to employ on the works.

<table>
<thead>
<tr>
<th>NAME</th>
<th>POSITION</th>
<th>YEARS OF EXPERIENCE (GENERAL)</th>
<th>YEARS OF EXPERIENCE IN PROPOSED POSITION</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Project Manager</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Site Foreman</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Qualified Electrician</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Qualified Electrician</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Qualified Electrician</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Others <em>(Specify)</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>3.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>4.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>5.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>6.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

We hereby certify that the information above is correct to best of our knowledge and that we understand it is our responsibility to provide whatever staff is required to complete the works in accordance with the Sub-Contract.

Tenderer : ________________________________
Signed : ________________________________
Date : ________________________________
Name : ________________________________
Title : ________________________________
2.23.4 **SCHEDULE OF WORKS OF A SIMILAR NATURE CARRIED OUT BY TENDERER**

Tenders should complete the following schedule, listing work of a similar nature that they have successfully carried out. Failure to complete this Schedule may prejudice the Tenderer, the implication being that the Tenderer does not have meaningful experience in this field.

<table>
<thead>
<tr>
<th>CLIENT</th>
<th>NATURE OF WORK</th>
<th>VALUE OF WORKS US$</th>
<th>YEAR COMPLETED</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

We hereby certify that the information above is correct to the best of our knowledge.

Tenderer : ____________________________

Signed : ____________________________

Date : ____________________________

Name : ____________________________

Title : ____________________________
# 2.24 Schedule of Proposed Light Fittings for African Development Bank (ADB) Office at Arundel Park in Harare

<table>
<thead>
<tr>
<th>Item</th>
<th>Type</th>
<th>Description</th>
<th>Location</th>
<th>Suggested Supplier</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>A</td>
<td>600 x 600 mm recessed panel LED <strong>Daylight</strong> Panel 45watt Light Fitting (<em>The Electrical Contractor to install sample of the Type A to enable the Project Team to approve colour</em>)</td>
<td>Offices</td>
<td>Lighting World/Lumiance/Streamlight/Radiant Lighting</td>
</tr>
<tr>
<td>2</td>
<td>B</td>
<td>6000mm long LED Strip Light</td>
<td>Fixed below Kitchen wall mounted unit</td>
<td>Lighting World/Lumiance/Streamlight/Radiant Lighting</td>
</tr>
<tr>
<td>3</td>
<td>C</td>
<td>Surface mounted Bulkhead Light Fitting with 1 x 10watt LED lamp</td>
<td>External Exit points</td>
<td>Lighting World/Lumiance/Streamlight/Radiant Lighting</td>
</tr>
<tr>
<td>4</td>
<td>D1</td>
<td>Recessed downlighter with 1 x 6watt LED lamp</td>
<td>Counter Bulkheads</td>
<td>Lighting World/Lumiance/Streamlight/Radiant Lighting</td>
</tr>
<tr>
<td>5</td>
<td>D2</td>
<td>Recessed downlighter with 1 x 12watt LED lamp</td>
<td>Toilets/Reception Area</td>
<td>Lighting World/Lumiance/Streamlight/Radiant Lighting</td>
</tr>
<tr>
<td>6</td>
<td>D3</td>
<td>Recessed waterproof downlighter with 1 x 18watt LED lamp</td>
<td>Toilet</td>
<td>Lighting World/Lumiance/Streamlight/Radiant Lighting</td>
</tr>
<tr>
<td>7</td>
<td>F</td>
<td>High Quality Battery Maintained Emergency Exit Sign complete with an emergency power pack (<em>Note that the box type or suspended brass type are not acceptable</em>)</td>
<td>Exit point</td>
<td>Lighting World/Lumiance/Streamlight/Radiant Lighting</td>
</tr>
<tr>
<td>8</td>
<td>G</td>
<td>High Quality Battery Maintained Emergency Exit Sign complete with an emergency power pack (<em>Note that the box type or suspended brass type are not acceptable</em>)</td>
<td>Exit point</td>
<td>Lighting World/Lumiance/Streamlight/Radiant Lighting</td>
</tr>
</tbody>
</table>

Samples of all light fittings shall be submitted for approval by the Architect, Engineer and ADB before the manufacture of the full order commences.
## DISTRIBUTION BOARD SCHEDULE

<table>
<thead>
<tr>
<th>DB REF:</th>
<th>500V/1(Essential Side)(Ref Sheets A &amp; B)</th>
</tr>
</thead>
<tbody>
<tr>
<td>FEEDER CABLE</td>
<td>4x25 sq mm Pro/Swa cable + 18sq mm BCC</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>LOCATION:</th>
<th>Ground Floor</th>
</tr>
</thead>
<tbody>
<tr>
<td>FEED FROM:</td>
<td>500V/1(Essential)</td>
</tr>
<tr>
<td>DB COLOUR</td>
<td>Structured Grey</td>
</tr>
<tr>
<td>No. OF WAY</td>
<td>36 WAY TP</td>
</tr>
<tr>
<td>CABLE LENGTH</td>
<td>Surface Back Entry/Bottom/Mop</td>
</tr>
<tr>
<td>CABLE TYPE</td>
<td>PVC Sc</td>
</tr>
<tr>
<td>REMARKS</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CIRCUIT NO</th>
<th>DESCRIPTION</th>
<th>PHASE NO</th>
<th>R</th>
<th>Y</th>
<th>B</th>
<th>MCB</th>
<th>SIZE</th>
<th>CABLE</th>
<th>LENGTH</th>
<th>TYPE</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>LIGHTING</td>
<td>10A</td>
<td>2.5</td>
<td>E</td>
<td>PVC Sc</td>
<td>Earth All Luminaires</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>LIGHTING</td>
<td>10A</td>
<td>2.5</td>
<td>E</td>
<td>PVC Sc</td>
<td>Earth All Luminaires</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>LIGHTING</td>
<td>10A</td>
<td>2.5</td>
<td>E</td>
<td>PVC Sc</td>
<td>Earth All Luminaires</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>LIGHTING</td>
<td>10A</td>
<td>2.5</td>
<td>E</td>
<td>PVC Sc</td>
<td>Earth All Luminaires</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>LIGHTING</td>
<td>10A</td>
<td>2.5</td>
<td>E</td>
<td>PVC Sc</td>
<td>Earth All Luminaires</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>LIGHTING</td>
<td>10A</td>
<td>2.5</td>
<td>E</td>
<td>PVC Sc</td>
<td>Earth All Luminaires</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>LIGHTING</td>
<td>10A</td>
<td>2.5</td>
<td>E</td>
<td>PVC Sc</td>
<td>Earth All Luminaires</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>LIGHTING</td>
<td>10A</td>
<td>2.5</td>
<td>E</td>
<td>PVC Sc</td>
<td>Earth All Luminaires</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>LIGHTING</td>
<td>10A</td>
<td>2.5</td>
<td>E</td>
<td>PVC Sc</td>
<td>Earth All Luminaires</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>LIGHTING</td>
<td>10A</td>
<td>2.5</td>
<td>E</td>
<td>PVC Sc</td>
<td>Earth All Luminaires</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>LIGHTING</td>
<td>10A</td>
<td>2.5</td>
<td>E</td>
<td>PVC Sc</td>
<td>Earth All Luminaires</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>LIGHTING</td>
<td>10A</td>
<td>2.5</td>
<td>E</td>
<td>PVC Sc</td>
<td>Earth All Luminaires</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>LIGHTING</td>
<td>10A</td>
<td>2.5</td>
<td>E</td>
<td>PVC Sc</td>
<td>Earth All Luminaires</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>LIGHTING</td>
<td>10A</td>
<td>2.5</td>
<td>E</td>
<td>PVC Sc</td>
<td>Earth All Luminaires</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>LIGHTING</td>
<td>10A</td>
<td>2.5</td>
<td>E</td>
<td>PVC Sc</td>
<td>Earth All Luminaires</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>LIGHTING</td>
<td>10A</td>
<td>2.5</td>
<td>E</td>
<td>PVC Sc</td>
<td>Earth All Luminaires</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>LIGHTING</td>
<td>10A</td>
<td>2.5</td>
<td>E</td>
<td>PVC Sc</td>
<td>Earth All Luminaires</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>LIGHTING</td>
<td>10A</td>
<td>2.5</td>
<td>E</td>
<td>PVC Sc</td>
<td>Earth All Luminaires</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>19</td>
<td>LIGHTING</td>
<td>10A</td>
<td>2.5</td>
<td>E</td>
<td>PVC Sc</td>
<td>Earth All Luminaires</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>LIGHTING</td>
<td>10A</td>
<td>2.5</td>
<td>E</td>
<td>PVC Sc</td>
<td>Earth All Luminaires</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>21</td>
<td>LIGHTING</td>
<td>10A</td>
<td>2.5</td>
<td>E</td>
<td>PVC Sc</td>
<td>Earth All Luminaires</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>22</td>
<td>LIGHTING</td>
<td>10A</td>
<td>2.5</td>
<td>E</td>
<td>PVC Sc</td>
<td>Earth All Luminaires</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>23</td>
<td>LIGHTING</td>
<td>10A</td>
<td>2.5</td>
<td>E</td>
<td>PVC Sc</td>
<td>Earth All Luminaires</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>24</td>
<td>LIGHTING</td>
<td>10A</td>
<td>2.5</td>
<td>E</td>
<td>PVC Sc</td>
<td>Earth All Luminaires</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>25</td>
<td>LIGHTING</td>
<td>10A</td>
<td>2.5</td>
<td>E</td>
<td>PVC Sc</td>
<td>Earth All Luminaires</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>26</td>
<td>LIGHTING</td>
<td>10A</td>
<td>2.5</td>
<td>E</td>
<td>PVC Sc</td>
<td>Earth All Luminaires</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>27</td>
<td>LIGHTING</td>
<td>10A</td>
<td>2.5</td>
<td>E</td>
<td>PVC Sc</td>
<td>Earth All Luminaires</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>28</td>
<td>LIGHTING</td>
<td>10A</td>
<td>2.5</td>
<td>E</td>
<td>PVC Sc</td>
<td>Earth All Luminaires</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>29</td>
<td>LIGHTING</td>
<td>10A</td>
<td>2.5</td>
<td>E</td>
<td>PVC Sc</td>
<td>Earth All Luminaires</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>30</td>
<td>LIGHTING</td>
<td>10A</td>
<td>2.5</td>
<td>E</td>
<td>PVC Sc</td>
<td>Earth All Luminaires</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>31</td>
<td>LIGHTING</td>
<td>10A</td>
<td>2.5</td>
<td>E</td>
<td>PVC Sc</td>
<td>Earth All Luminaires</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>32</td>
<td>LIGHTING</td>
<td>10A</td>
<td>2.5</td>
<td>E</td>
<td>PVC Sc</td>
<td>Earth All Luminaires</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>33</td>
<td>LIGHTING</td>
<td>10A</td>
<td>2.5</td>
<td>E</td>
<td>PVC Sc</td>
<td>Earth All Luminaires</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>34</td>
<td>LIGHTING</td>
<td>10A</td>
<td>2.5</td>
<td>E</td>
<td>PVC Sc</td>
<td>Earth All Luminaires</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>35</td>
<td>LIGHTING</td>
<td>10A</td>
<td>2.5</td>
<td>E</td>
<td>PVC Sc</td>
<td>Earth All Luminaires</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>36</td>
<td>LIGHTING</td>
<td>10A</td>
<td>2.5</td>
<td>E</td>
<td>PVC Sc</td>
<td>Earth All Luminaires</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2-19 Electrical specifications
<table>
<thead>
<tr>
<th>CIRCUIT PHASE NO</th>
<th>DESCRIPTION</th>
<th>R</th>
<th>Y</th>
<th>B</th>
<th>MCB</th>
<th>CABLE SIZE</th>
<th>CABLE TYPE</th>
<th>LENGTH (M)</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>13</td>
<td>SOCKET OUTLET</td>
<td>30A</td>
<td>2.5+</td>
<td>E</td>
<td>PVCsc</td>
<td></td>
<td></td>
<td></td>
<td>SPARE PROVISION</td>
</tr>
<tr>
<td>13</td>
<td>SOCKET OUTLET</td>
<td>30A</td>
<td>2.5+</td>
<td>E</td>
<td>PVCsc</td>
<td></td>
<td></td>
<td></td>
<td>SPARE PROVISION</td>
</tr>
<tr>
<td>14</td>
<td>SOCKET OUTLET</td>
<td>30A</td>
<td>2.5+</td>
<td>E</td>
<td>PVCsc</td>
<td></td>
<td></td>
<td></td>
<td>SECURITY DEVICE PROVISION</td>
</tr>
<tr>
<td>15</td>
<td>SOCKET OUTLET</td>
<td>30A</td>
<td>2.5+</td>
<td>E</td>
<td>PVCsc</td>
<td></td>
<td></td>
<td></td>
<td>SECURITY DEVICE PROVISION</td>
</tr>
<tr>
<td>16</td>
<td>SOCKET OUTLET</td>
<td>30A</td>
<td>2.5+</td>
<td>E</td>
<td>PVCsc</td>
<td></td>
<td></td>
<td></td>
<td>SECURITY DEVICE PROVISION</td>
</tr>
<tr>
<td>17</td>
<td>SOCKET OUTLET</td>
<td>30A</td>
<td>2.5+</td>
<td>E</td>
<td>PVCsc</td>
<td></td>
<td></td>
<td></td>
<td>SECURITY DEVICE PROVISION</td>
</tr>
<tr>
<td>18</td>
<td>SOCKET OUTLET</td>
<td>30A</td>
<td>2.5+</td>
<td>E</td>
<td>PVCsc</td>
<td></td>
<td></td>
<td></td>
<td>SECURITY DEVICE PROVISION</td>
</tr>
<tr>
<td>19</td>
<td>SOCKET OUTLET</td>
<td>30A</td>
<td>2.5+</td>
<td>E</td>
<td>PVCsc</td>
<td></td>
<td></td>
<td></td>
<td>SECURITY DEVICE PROVISION</td>
</tr>
<tr>
<td>20</td>
<td>SOCKET OUTLET</td>
<td>30A</td>
<td>2.5+</td>
<td>E</td>
<td>PVCsc</td>
<td></td>
<td></td>
<td></td>
<td>SECURITY DEVICE PROVISION</td>
</tr>
<tr>
<td>21</td>
<td>SOCKET OUTLET</td>
<td>30A</td>
<td>2.5+</td>
<td>E</td>
<td>PVCsc</td>
<td></td>
<td></td>
<td></td>
<td>SECURITY DEVICE PROVISION</td>
</tr>
<tr>
<td>22</td>
<td>FIRE ALARM SYSTEM</td>
<td>20A</td>
<td>2.5+</td>
<td>E</td>
<td>PVCsc</td>
<td></td>
<td></td>
<td></td>
<td>WITH FUSED SPUR</td>
</tr>
<tr>
<td>22</td>
<td>15A SOCKET OUTLET</td>
<td>15A</td>
<td>2.5+</td>
<td>E</td>
<td>PVCsc</td>
<td></td>
<td></td>
<td></td>
<td>SECURITY DEVICE PROVISION</td>
</tr>
<tr>
<td>22</td>
<td>15A SOCKET OUTLET</td>
<td>15A</td>
<td>2.5+</td>
<td>E</td>
<td>PVCsc</td>
<td></td>
<td></td>
<td></td>
<td>SECURITY DEVICE PROVISION</td>
</tr>
<tr>
<td>22</td>
<td>15A SOCKET OUTLET</td>
<td>15A</td>
<td>2.5+</td>
<td>E</td>
<td>PVCsc</td>
<td></td>
<td></td>
<td></td>
<td>SECURITY DEVICE PROVISION</td>
</tr>
<tr>
<td>24</td>
<td>15A SOCKET OUTLET</td>
<td>15A</td>
<td>2.5+</td>
<td>E</td>
<td>PVCsc</td>
<td></td>
<td></td>
<td></td>
<td>SECURITY DEVICE PROVISION</td>
</tr>
<tr>
<td>24</td>
<td>15A SOCKET OUTLET</td>
<td>15A</td>
<td>2.5+</td>
<td>E</td>
<td>PVCsc</td>
<td></td>
<td></td>
<td></td>
<td>SECURITY DEVICE PROVISION</td>
</tr>
<tr>
<td>CIRCUIT NO</td>
<td>PHASE/NO</td>
<td>DESCRIPTION</td>
<td>R</td>
<td>Y</td>
<td>S</td>
<td>MCB</td>
<td>CABLE SIZE</td>
<td>CABLE TYPE</td>
<td>LENGTH (M)</td>
</tr>
<tr>
<td>------------</td>
<td>----------</td>
<td>-------------------</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>-----</td>
<td>------------</td>
<td>------------</td>
<td>------------</td>
</tr>
<tr>
<td>25</td>
<td>15A</td>
<td>SOCKET OUTLET</td>
<td>15A</td>
<td>2.5+E</td>
<td>PVCsc</td>
<td>SECURITY DEVICE PROVISION</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>25</td>
<td>15A</td>
<td>SOCKET OUTLET</td>
<td>15A</td>
<td>2.5+E</td>
<td>PVCsc</td>
<td>SECURITY DEVICE PROVISION</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>25</td>
<td>15A</td>
<td>SOCKET OUTLET</td>
<td>15A</td>
<td>2.5+E</td>
<td>PVCsc</td>
<td>SECURITY DEVICE PROVISION</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>25</td>
<td>15A</td>
<td>SOCKET OUTLET</td>
<td>15A</td>
<td>2.5+E</td>
<td>PVCsc</td>
<td>SECURITY DEVICE PROVISION</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>25</td>
<td>15A</td>
<td>SOCKET OUTLET</td>
<td>15A</td>
<td>2.5+E</td>
<td>PVCsc</td>
<td>SECURITY DEVICE PROVISION</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>25</td>
<td>15A</td>
<td>SOCKET OUTLET</td>
<td>15A</td>
<td>2.5+E</td>
<td>PVCsc</td>
<td>SECURITY DEVICE PROVISION</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>25</td>
<td>15A</td>
<td>SOCKET OUTLET</td>
<td>15A</td>
<td>2.5+E</td>
<td>PVCsc</td>
<td>SECURITY DEVICE PROVISION</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>25</td>
<td>15A</td>
<td>SOCKET OUTLET</td>
<td>15A</td>
<td>2.5+E</td>
<td>PVCsc</td>
<td>SECURITY DEVICE PROVISION</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>26</td>
<td>15A</td>
<td>SOCKET OUTLET</td>
<td>15A</td>
<td>2.5+E</td>
<td>PVCsc</td>
<td>SECURITY DEVICE PROVISION</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>27</td>
<td>15A</td>
<td>SOCKET OUTLET</td>
<td>15A</td>
<td>2.5+E</td>
<td>PVCsc</td>
<td>SECURITY DEVICE PROVISION</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>27</td>
<td>15A</td>
<td>SOCKET OUTLET</td>
<td>15A</td>
<td>2.5+E</td>
<td>PVCsc</td>
<td>SECURITY DEVICE PROVISION</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>27</td>
<td>15A</td>
<td>SOCKET OUTLET</td>
<td>15A</td>
<td>2.5+E</td>
<td>PVCsc</td>
<td>SECURITY DEVICE PROVISION</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>28</td>
<td>30A</td>
<td>Air Conditioning Unit No.1</td>
<td>6.0+E</td>
<td>PVCewa</td>
<td>With 60ADP ISOLATOR IN 4WAY WEATHERPROOF BOX</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>28</td>
<td>20A</td>
<td>Air Conditioning Unit No.1</td>
<td>4.0+E</td>
<td>PVCewa</td>
<td>With 60ADP ISOLATOR IN 4WAY WEATHERPROOF BOX</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>29</td>
<td>SPARE</td>
<td>PROVIDE BLANK</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>PROVIDE BLANK</td>
<td></td>
</tr>
<tr>
<td>29</td>
<td>SPARE</td>
<td>PROVIDE BLANK</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>PROVIDE BLANK</td>
<td></td>
</tr>
<tr>
<td>29</td>
<td>SPARE</td>
<td>PROVIDE BLANK</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>PROVIDE BLANK</td>
<td></td>
</tr>
<tr>
<td>29</td>
<td>SPARE</td>
<td>PROVIDE BLANK</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>PROVIDE BLANK</td>
<td></td>
</tr>
<tr>
<td>30</td>
<td>SPARE</td>
<td>PROVIDE BLANK</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>PROVIDE BLANK</td>
<td></td>
</tr>
<tr>
<td>30</td>
<td>SPARE</td>
<td>PROVIDE BLANK</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>PROVIDE BLANK</td>
<td></td>
</tr>
<tr>
<td>31</td>
<td>SPARE</td>
<td>PROVIDE BLANK</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>PROVIDE BLANK</td>
<td></td>
</tr>
<tr>
<td>31</td>
<td>SPARE</td>
<td>PROVIDE BLANK</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>PROVIDE BLANK</td>
<td></td>
</tr>
<tr>
<td>32</td>
<td>SPARE</td>
<td>PROVIDE BLANK</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>PROVIDE BLANK</td>
<td></td>
</tr>
<tr>
<td>32</td>
<td>SPARE</td>
<td>PROVIDE BLANK</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>PROVIDE BLANK</td>
<td></td>
</tr>
<tr>
<td>33</td>
<td>SPARE</td>
<td>PROVIDE BLANK</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>PROVIDE BLANK</td>
<td></td>
</tr>
<tr>
<td>34</td>
<td>SPARE</td>
<td>PROVIDE BLANK</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>PROVIDE BLANK</td>
<td></td>
</tr>
<tr>
<td>34</td>
<td>SPARE</td>
<td>PROVIDE BLANK</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>PROVIDE BLANK</td>
<td></td>
</tr>
<tr>
<td>35</td>
<td>SPARE</td>
<td>PROVIDE BLANK</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>PROVIDE BLANK</td>
<td></td>
</tr>
<tr>
<td>35</td>
<td>SPARE</td>
<td>PROVIDE BLANK</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>PROVIDE BLANK</td>
<td></td>
</tr>
<tr>
<td>36</td>
<td>SPARE</td>
<td>PROVIDE BLANK</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>PROVIDE BLANK</td>
<td></td>
</tr>
<tr>
<td>36</td>
<td>SPARE</td>
<td>PROVIDE BLANK</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>PROVIDE BLANK</td>
<td></td>
</tr>
<tr>
<td>36</td>
<td>SPARE</td>
<td>PROVIDE BLANK</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>PROVIDE BLANK</td>
<td></td>
</tr>
<tr>
<td>36</td>
<td>SPARE</td>
<td>PROVIDE BLANK</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>PROVIDE BLANK</td>
<td></td>
</tr>
<tr>
<td>CIRCUIT PHASE NO</td>
<td>DESCRIPTION</td>
<td>R</td>
<td>Y</td>
<td>B</td>
<td>MCB</td>
<td>CABLE SIZE</td>
<td>CABLE TYPE</td>
<td>LENGTH (M)</td>
<td>REMARKS</td>
</tr>
<tr>
<td>-----------------</td>
<td>----------------------</td>
<td>------</td>
<td>------</td>
<td>------</td>
<td>------</td>
<td>------------</td>
<td>------------</td>
<td>------------</td>
<td>--------------------------</td>
</tr>
<tr>
<td>1</td>
<td>LIGHTING</td>
<td>10A</td>
<td>2.5+</td>
<td>E</td>
<td>Pecsc</td>
<td>2.5+</td>
<td>PVCsc</td>
<td></td>
<td>Earth All Luminaires</td>
</tr>
<tr>
<td>2</td>
<td>LIGHTING</td>
<td>10A</td>
<td>2.5+</td>
<td>E</td>
<td>Pecsc</td>
<td>2.5+</td>
<td>PVCsc</td>
<td></td>
<td>Earth All Luminaires</td>
</tr>
<tr>
<td>3</td>
<td>SOCKET OUTLETS</td>
<td>30A</td>
<td>2.5+</td>
<td>E</td>
<td>PVCsc</td>
<td>2.5+</td>
<td>PVCsc</td>
<td></td>
<td>Earth All Luminaires</td>
</tr>
<tr>
<td>4</td>
<td>SOCKET OUTLETS</td>
<td>30A</td>
<td>2.5+</td>
<td>E</td>
<td>PVCsc</td>
<td>2.5+</td>
<td>PVCsc</td>
<td></td>
<td>Earth All Luminaires</td>
</tr>
<tr>
<td>5</td>
<td>SOCKET OUTLETS</td>
<td>30A</td>
<td>2.5+</td>
<td>E</td>
<td>PVCsc</td>
<td>2.5+</td>
<td>PVCsc</td>
<td></td>
<td>Earth All Luminaires</td>
</tr>
<tr>
<td>6</td>
<td>SOCKET OUTLETS</td>
<td>30A</td>
<td>2.5+</td>
<td>E</td>
<td>PVCsc</td>
<td>2.5+</td>
<td>PVCsc</td>
<td></td>
<td>Earth All Luminaires</td>
</tr>
<tr>
<td>7</td>
<td>SOCKET OUTLETS</td>
<td>30A</td>
<td>2.5+</td>
<td>E</td>
<td>PVCsc</td>
<td>2.5+</td>
<td>PVCsc</td>
<td></td>
<td>SPARE PROVISION</td>
</tr>
<tr>
<td>8</td>
<td>15A SOCKET OUTLET</td>
<td>20A</td>
<td>2.5+</td>
<td>E</td>
<td>PVCsc</td>
<td>2.5+</td>
<td>PVCsc</td>
<td></td>
<td>SPARE PROVISION</td>
</tr>
<tr>
<td>9</td>
<td>15A SOCKET OUTLET</td>
<td>20A</td>
<td>2.5+</td>
<td>E</td>
<td>PVCsc</td>
<td>2.5+</td>
<td>PVCsc</td>
<td></td>
<td>SPARE PROVISION</td>
</tr>
<tr>
<td>10</td>
<td>HAND DRIER UNIT</td>
<td>20A</td>
<td>2.5+</td>
<td>E</td>
<td>PVCsc</td>
<td>2.5+</td>
<td>PVCsc</td>
<td></td>
<td>With 20ADP Isolator With Pilot Lamp</td>
</tr>
<tr>
<td>11</td>
<td>GEYSER</td>
<td>20A</td>
<td>2.5+</td>
<td>E</td>
<td>PVCsc</td>
<td>2.5+</td>
<td>PVCsc</td>
<td></td>
<td>With 20ADP Isolator With Pilot Lamp</td>
</tr>
<tr>
<td>12</td>
<td>SPARE</td>
<td></td>
<td></td>
<td></td>
<td>PROVBL</td>
<td>PROVIDE BLANK</td>
<td></td>
<td>PROVIDE BLANK</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>SPARE</td>
<td></td>
<td></td>
<td></td>
<td>PROVBL</td>
<td>PROVIDE BLANK</td>
<td></td>
<td>PROVIDE BLANK</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>SPARE</td>
<td></td>
<td></td>
<td></td>
<td>PROVBL</td>
<td>PROVIDE BLANK</td>
<td></td>
<td>PROVIDE BLANK</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>SPARE</td>
<td></td>
<td></td>
<td></td>
<td>PROVBL</td>
<td>PROVIDE BLANK</td>
<td></td>
<td>PROVIDE BLANK</td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>SPARE</td>
<td></td>
<td></td>
<td></td>
<td>PROVBL</td>
<td>PROVIDE BLANK</td>
<td></td>
<td>PROVIDE BLANK</td>
<td></td>
</tr>
</tbody>
</table>

2-22 Electrical specifications
<table>
<thead>
<tr>
<th>LOCATION</th>
<th>EXTERNAL</th>
<th>DB REF:</th>
<th>500VAC</th>
<th>FEEDER CABLE:</th>
<th>4x35 sq mm Pvc/Swa Cable + 25 sq mm BOC</th>
</tr>
</thead>
<tbody>
<tr>
<td>iso.125A/TP-H + C</td>
<td>18 WAY TP</td>
<td>FEED FROM:</td>
<td>MCB</td>
<td>TYPE OF BREAKERS</td>
<td>M AND G Circuit breaker</td>
</tr>
<tr>
<td>CIRCUIT PHASE</td>
<td>DB COLOUR</td>
<td>ELECTRIC ORANGE</td>
<td>No of Way</td>
<td>CABLE TYPE</td>
<td>LENGTH</td>
</tr>
<tr>
<td>DESCRIPTION</td>
<td>R</td>
<td>Y</td>
<td>B</td>
<td>TYPE</td>
<td>(M)</td>
</tr>
<tr>
<td>1 AIR CONDITIONING UNIT Plant No.1</td>
<td>30A</td>
<td>4.0-E</td>
<td>PVCsc</td>
<td>With 60ADP Iso. in Weatherproof Box</td>
<td></td>
</tr>
<tr>
<td>1 AIR CONDITIONING UNIT Plant No.2</td>
<td>30A</td>
<td>4.0-E</td>
<td>PVCsc</td>
<td>With 60ADP Iso. in Weatherproof Box</td>
<td></td>
</tr>
<tr>
<td>1 AIR CONDITIONING UNIT Plant No.3</td>
<td>30A</td>
<td>4.0-E</td>
<td>PVCsc</td>
<td>With 60ADP Iso. in Weatherproof Box</td>
<td></td>
</tr>
<tr>
<td>2 AIR CONDITIONING UNIT Plant No.4</td>
<td>30A</td>
<td>4.0-E</td>
<td>PVCsc</td>
<td>With 60ADP Iso. in Weatherproof Box</td>
<td></td>
</tr>
<tr>
<td>2 AIR CONDITIONING UNIT Plant No.5</td>
<td>30A</td>
<td>4.0-E</td>
<td>PVCsc</td>
<td>With 60ADP Iso. in Weatherproof Box</td>
<td></td>
</tr>
<tr>
<td>2 AIR CONDITIONING UNIT Plant No.6</td>
<td>30A</td>
<td>4.0-E</td>
<td>PVCsc</td>
<td>With 60ADP Iso. in Weatherproof Box</td>
<td></td>
</tr>
<tr>
<td>3 AIR CONDITIONING UNIT Plant No.7</td>
<td>30A</td>
<td>4.0-E</td>
<td>PVCsc</td>
<td>With 60ADP Iso. in Weatherproof Box</td>
<td></td>
</tr>
<tr>
<td>3 AIR CONDITIONING UNIT Plant No.8</td>
<td>30A</td>
<td>4.0-E</td>
<td>PVCsc</td>
<td>With 60ADP Iso. in Weatherproof Box</td>
<td></td>
</tr>
<tr>
<td>3 AIR CONDITIONING UNIT Plant No.9</td>
<td>30A</td>
<td>4.0-E</td>
<td>PVCsc</td>
<td>With 60ADP Iso. in Weatherproof Box</td>
<td></td>
</tr>
<tr>
<td>4 AIR CONDITIONING UNIT Plant No.10</td>
<td>30A</td>
<td>4.0-E</td>
<td>PVCsc</td>
<td>With 60ADP Iso. in Weatherproof Box</td>
<td></td>
</tr>
<tr>
<td>4 AIR CONDITIONING UNIT Plant No.11</td>
<td>30A</td>
<td>4.0-E</td>
<td>PVCsc</td>
<td>With 60ADP Iso. in Weatherproof Box</td>
<td></td>
</tr>
<tr>
<td>4 AIR CONDITIONING UNIT Plant No.12</td>
<td>30A</td>
<td>4.0-E</td>
<td>PVCsc</td>
<td>With 60ADP Iso. in Weatherproof Box</td>
<td></td>
</tr>
<tr>
<td>5 AIR CONDITIONING UNIT Plant No.13</td>
<td>30A</td>
<td>4.0-E</td>
<td>PVCsc</td>
<td>With 60ADP Iso. in Weatherproof Box</td>
<td></td>
</tr>
<tr>
<td>5 AIR CONDITIONING UNIT Plant No.14</td>
<td>30A</td>
<td>4.0-E</td>
<td>PVCsc</td>
<td>With 60ADP Iso. in Weatherproof Box</td>
<td></td>
</tr>
<tr>
<td>6 AIR CONDITIONING UNIT Plant No.15</td>
<td>30A</td>
<td>4.0-E</td>
<td>PVCsc</td>
<td>With 60ADP Iso. in Weatherproof Box</td>
<td></td>
</tr>
<tr>
<td>6 AIR CONDITIONING UNIT Plant No.16</td>
<td>30A</td>
<td>4.0-E</td>
<td>PVCsc</td>
<td>With 60ADP Iso. in Weatherproof Box</td>
<td></td>
</tr>
<tr>
<td>6 AIR CONDITIONING UNIT Plant No.17</td>
<td>30A</td>
<td>4.0-E</td>
<td>PVCsc</td>
<td>With 60ADP Iso. in Weatherproof Box</td>
<td></td>
</tr>
<tr>
<td>6 AIR CONDITIONING UNIT Plant No.18</td>
<td>30A</td>
<td>4.0-E</td>
<td>PVCsc</td>
<td>With 60ADP Iso. in Weatherproof Box</td>
<td></td>
</tr>
<tr>
<td>7 AIR CONDITIONING UNIT Plant No.19</td>
<td>30A</td>
<td>4.0-E</td>
<td>PVCsc</td>
<td>With 60ADP Iso. in Weatherproof Box</td>
<td></td>
</tr>
<tr>
<td>7 AIR CONDITIONING UNIT Plant No.20</td>
<td>30A</td>
<td>4.0-E</td>
<td>PVCsc</td>
<td>With 60ADP Iso. in Weatherproof Box</td>
<td></td>
</tr>
<tr>
<td>8 AIR CONDITIONING UNIT Plant No.21</td>
<td>30A</td>
<td>4.0-E</td>
<td>PVCsc</td>
<td>With 60ADP Iso. in Weatherproof Box</td>
<td></td>
</tr>
<tr>
<td>8 AIR CONDITIONING UNIT Plant No.22</td>
<td>30A</td>
<td>4.0-E</td>
<td>PVCsc</td>
<td>With 60ADP Iso. in Weatherproof Box</td>
<td></td>
</tr>
<tr>
<td>8 AIR CONDITIONING UNIT Plant No.23</td>
<td>30A</td>
<td>4.0-E</td>
<td>PVCsc</td>
<td>With 60ADP Iso. in Weatherproof Box</td>
<td></td>
</tr>
<tr>
<td>9 AIR CONDITIONING UNIT Plant No.24</td>
<td>30A</td>
<td>4.0-E</td>
<td>PVCsc</td>
<td>With 60ADP Iso. in Weatherproof Box</td>
<td></td>
</tr>
<tr>
<td>9 AIR CONDITIONING UNIT Plant No.25</td>
<td>30A</td>
<td>4.0-E</td>
<td>PVCsc</td>
<td>With 60ADP Iso. in Weatherproof Box</td>
<td></td>
</tr>
<tr>
<td>9 AIR CONDITIONING UNIT Plant No.26</td>
<td>30A</td>
<td>4.0-E</td>
<td>PVCsc</td>
<td>With 60ADP Iso. in Weatherproof Box</td>
<td></td>
</tr>
<tr>
<td>9 AIR CONDITIONING UNIT Plant No.27</td>
<td>30A</td>
<td>4.0-E</td>
<td>PVCsc</td>
<td>With 60ADP Iso. in Weatherproof Box</td>
<td></td>
</tr>
<tr>
<td>10 150A/TP CONTACTOR</td>
<td>CONTACTOR TO BE DENERGISED BY FIRE PANEL</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10 150A/TP CONTACTOR</td>
<td>CONTACTOR TO BE DENERGISED BY FIRE PANEL</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10 150A/TP CONTACTOR</td>
<td>CONTACTOR TO BE DENERGISED BY FIRE PANEL</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11 FRESH AIR FAN No.1</td>
<td>5A</td>
<td>2.5-E</td>
<td>PVCsc</td>
<td>With 5A Socket Outlet In Ceiling Void</td>
<td></td>
</tr>
<tr>
<td>11 FRESH AIR FAN No.2</td>
<td>5A</td>
<td>2.5-E</td>
<td>PVCsc</td>
<td>With 5A Socket Outlet In Ceiling Void</td>
<td></td>
</tr>
<tr>
<td>11 FRESH AIR FAN No.3</td>
<td>5A</td>
<td>2.5-E</td>
<td>PVCsc</td>
<td>With 5A Socket Outlet In Ceiling Void</td>
<td></td>
</tr>
<tr>
<td>12 EXTRACT AIR FAN No.1</td>
<td>5A</td>
<td>2.5-E</td>
<td>PVCsc</td>
<td>With 5A Socket Outlet In Ceiling Void</td>
<td></td>
</tr>
<tr>
<td>12 EXTRACT AIR FAN No.2</td>
<td>5A</td>
<td>2.5-E</td>
<td>PVCsc</td>
<td>With 5A Socket Outlet In Ceiling Void</td>
<td></td>
</tr>
<tr>
<td>12 DIGITAL TIMER No.1, 2 &amp; 3</td>
<td>5A</td>
<td>2.5-E</td>
<td>PVCsc</td>
<td>Controls Fresh Air Fans</td>
<td></td>
</tr>
<tr>
<td>CIRCUIT</td>
<td>PHASE NO</td>
<td>DESCRIPTION</td>
<td>R</td>
<td>Y</td>
<td>B</td>
</tr>
<tr>
<td>---------</td>
<td>----------</td>
<td>-------------------</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>SOCKET OUTLETS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>SOCKET OUTLETS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>SOCKET OUTLETS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>SOCKET OUTLETS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>SOCKET OUTLETS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>SOCKET OUTLETS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>3</td>
<td>SOCKET OUTLETS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>3</td>
<td>SOCKET OUTLETS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>3</td>
<td>SOCKET OUTLETS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>4</td>
<td>SOCKET OUTLETS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>4</td>
<td>SOCKET OUTLETS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>4</td>
<td>SOCKET OUTLETS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>5</td>
<td>SOCKET OUTLETS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>5</td>
<td>SOCKET OUTLETS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>5</td>
<td>SOCKET OUTLETS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>6</td>
<td>SOCKET OUTLETS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>6</td>
<td>SOCKET OUTLETS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>6</td>
<td>SOCKET OUTLETS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>7</td>
<td>SOCKET OUTLETS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>7</td>
<td>SOCKET OUTLETS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>7</td>
<td>SOCKET OUTLETS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>8</td>
<td>SOCKET OUTLETS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>8</td>
<td>SOCKET OUTLETS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>8</td>
<td>SOCKET OUTLETS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>9</td>
<td>SOCKET OUTLETS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>9</td>
<td>SOCKET OUTLETS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>9</td>
<td>SOCKET OUTLETS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>10</td>
<td>SOCKET OUTLETS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>10</td>
<td>SOCKET OUTLETS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>10</td>
<td>SOCKET OUTLETS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>11</td>
<td>SOCKET OUTLETS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>11</td>
<td>SOCKET OUTLETS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>11</td>
<td>SOCKET OUTLETS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>12</td>
<td>THREE PHASE CHANGEOVER</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>12</td>
<td>THREE PHASE CHANGEOVER</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>12</td>
<td>THREE PHASE CHANGEOVER</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2-24 Electrical specifications
## DISTRIBUTION BOARD SCHEDULE

<table>
<thead>
<tr>
<th>NO.</th>
<th>DESCRIPTION</th>
<th>A</th>
<th>B</th>
<th>MCB</th>
<th>CABLE SIZE</th>
<th>CABLE TYPE</th>
<th>MOUNTING</th>
</tr>
</thead>
<tbody>
<tr>
<td>15A</td>
<td>SOCKET OUTLET</td>
<td>20A</td>
<td>2.5+E</td>
<td>PVCsc</td>
<td>SECURITY DEVICE PROVISION</td>
<td></td>
<td></td>
</tr>
<tr>
<td>16A</td>
<td>SOCKET OUTLET</td>
<td>20A</td>
<td>2.5+E</td>
<td>PVCsc</td>
<td>SECURITY DEVICE PROVISION</td>
<td></td>
<td></td>
</tr>
<tr>
<td>17A</td>
<td>SOCKET OUTLET</td>
<td>20A</td>
<td>2.5+E</td>
<td>PVCsc</td>
<td>SECURITY DEVICE PROVISION</td>
<td></td>
<td></td>
</tr>
<tr>
<td>18A</td>
<td>SOCKET OUTLET</td>
<td>20A</td>
<td>2.5+E</td>
<td>PVCsc</td>
<td>SECURITY DEVICE PROVISION</td>
<td></td>
<td></td>
</tr>
<tr>
<td>19A</td>
<td>UPS SUPPLY</td>
<td>16.0+E</td>
<td>PccSwa</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20A</td>
<td>UPS SUPPLY</td>
<td>16.0+E</td>
<td>PccSwa</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>21A</td>
<td>SPARE</td>
<td>PROVIDE BLANK</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>22A</td>
<td>SPARE</td>
<td>PROVIDE BLANK</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>23A</td>
<td>SPARE</td>
<td>PROVIDE BLANK</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>24A</td>
<td>SPARE</td>
<td>PROVIDE BLANK</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CIRCUIT PHASE NO</td>
<td>DESCRIPTION</td>
<td>R</td>
<td>Y</td>
<td>B</td>
<td>MCB</td>
<td>CABLE SIZE</td>
<td>MCB</td>
</tr>
<tr>
<td>-----------------</td>
<td>--------------------------------------------------</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>-----</td>
<td>------------</td>
<td>-----</td>
</tr>
<tr>
<td>1</td>
<td>Generator Automatic Transfer Switch (ATS)</td>
<td>60A</td>
<td></td>
<td></td>
<td>25.0+E</td>
<td>PVCswa</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Generator Automatic Transfer Switch (ATS)</td>
<td>60A</td>
<td></td>
<td></td>
<td>25.0+E</td>
<td>PVCswa</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Generator Automatic Transfer Switch (ATS)</td>
<td>60A</td>
<td></td>
<td></td>
<td>25.0+E</td>
<td>PVCswa</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>SDBG1/1 (Non Essential Side)</td>
<td>60A</td>
<td></td>
<td></td>
<td>25.0+E</td>
<td>PVCswa</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>SDBG1/1 (Non Essential Side)</td>
<td>60A</td>
<td></td>
<td></td>
<td>25.0+E</td>
<td>PVCswa</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>SDBG1/1 (Non Essential Side)</td>
<td>60A</td>
<td></td>
<td></td>
<td>25.0+E</td>
<td>PVCswa</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>SDBG/AC</td>
<td>100A</td>
<td>35.0+E</td>
<td>PVCswa</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>SDBG/AC</td>
<td>100A</td>
<td>35.0+E</td>
<td>PVCswa</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>SDBG/AC</td>
<td>100A</td>
<td>35.0+E</td>
<td>PVCswa</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>SPARE</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>PROVIDE BLANK</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>SPARE</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>PROVIDE BLANK</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>SPARE</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>PROVIDE BLANK</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>SPARE</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>PROVIDE BLANK</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>SPARE</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>PROVIDE BLANK</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>SPARE</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>PROVIDE BLANK</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>SPARE</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>PROVIDE BLANK</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>SPARE</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>PROVIDE BLANK</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>SPARE</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>PROVIDE BLANK</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>SPARE</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>PROVIDE BLANK</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>SPARE</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>PROVIDE BLANK</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>SPARE</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>PROVIDE BLANK</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>SPARE</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>PROVIDE BLANK</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>SPARE</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>PROVIDE BLANK</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>SPARE</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>PROVIDE BLANK</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>SPARE</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>PROVIDE BLANK</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>SPARE</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>PROVIDE BLANK</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>SPARE</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>PROVIDE BLANK</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>SPARE</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>PROVIDE BLANK</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>SPARE</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>PROVIDE BLANK</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>SPARE</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>PROVIDE BLANK</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>SPARE</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>PROVIDE BLANK</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>SPARE</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>PROVIDE BLANK</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>SPARE</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>PROVIDE BLANK</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>SPARE</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>PROVIDE BLANK</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>SPARE</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>PROVIDE BLANK</td>
<td></td>
</tr>
</tbody>
</table>
## DISTRIBUTION BOARD SCHEDULE

**DB REF:** SDBG/1 (Essential Side)  
**FEED FROM:** SDBG/1 (Non Essential)  
**REDDER CABLE:** 4x25 sq mm PVC/Sw a cable + 10sq mm BCC

<table>
<thead>
<tr>
<th>CIRCUIT NO</th>
<th>PHASE</th>
<th>DESCRIPTION</th>
<th>DB COLOUR</th>
<th>STRUCTURED GREY</th>
<th>No of WAY</th>
<th>SWAY TP</th>
<th>MCB</th>
<th>CABLE SIZE</th>
<th>CABLER TYPE</th>
<th>LENGTH (M)</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>SDBG/1 (Non Essential Side)</td>
<td>60A</td>
<td>25.0+E</td>
<td>PVCsws</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>PROVIDE BLANKS</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>SDBG/1 (Non Essential Side)</td>
<td>60A</td>
<td>25.0+E</td>
<td>PVCsws</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>PROVIDE BLANKS</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>SDBG/1 (Non Essential Side)</td>
<td>60A</td>
<td>25.0+E</td>
<td>PVCsws</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>PROVIDE BLANKS</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>SPARE</td>
<td></td>
<td></td>
<td></td>
<td>60A</td>
<td>80A</td>
<td>25.0+E</td>
<td>PVCsws</td>
<td></td>
<td>PROVIDE BLANKS</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>SPARE</td>
<td></td>
<td></td>
<td></td>
<td>60A</td>
<td>80A</td>
<td>25.0+E</td>
<td>PVCsws</td>
<td></td>
<td>PROVIDE BLANKS</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>SPARE</td>
<td></td>
<td></td>
<td></td>
<td>60A</td>
<td>80A</td>
<td>25.0+E</td>
<td>PVCsws</td>
<td></td>
<td>PROVIDE BLANKS</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>SPARE</td>
<td></td>
<td></td>
<td></td>
<td>60A</td>
<td>80A</td>
<td>25.0+E</td>
<td>PVCsws</td>
<td></td>
<td>PROVIDE BLANKS</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>SPARE</td>
<td></td>
<td></td>
<td></td>
<td>60A</td>
<td>80A</td>
<td>25.0+E</td>
<td>PVCsws</td>
<td></td>
<td>PROVIDE BLANKS</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>SPARE</td>
<td></td>
<td></td>
<td></td>
<td>60A</td>
<td>80A</td>
<td>25.0+E</td>
<td>PVCsws</td>
<td></td>
<td>PROVIDE BLANKS</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>SPARE</td>
<td></td>
<td></td>
<td></td>
<td>60A</td>
<td>80A</td>
<td>25.0+E</td>
<td>PVCsws</td>
<td></td>
<td>PROVIDE BLANKS</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>SPARE</td>
<td></td>
<td></td>
<td></td>
<td>60A</td>
<td>80A</td>
<td>25.0+E</td>
<td>PVCsws</td>
<td></td>
<td>PROVIDE BLANKS</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>SPARE</td>
<td></td>
<td></td>
<td></td>
<td>60A</td>
<td>80A</td>
<td>25.0+E</td>
<td>PVCsws</td>
<td></td>
<td>PROVIDE BLANKS</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>SPARE</td>
<td></td>
<td></td>
<td></td>
<td>60A</td>
<td>80A</td>
<td>25.0+E</td>
<td>PVCsws</td>
<td></td>
<td>PROVIDE BLANKS</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>SPARE</td>
<td></td>
<td></td>
<td></td>
<td>60A</td>
<td>80A</td>
<td>25.0+E</td>
<td>PVCsws</td>
<td></td>
<td>PROVIDE BLANKS</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>SPARE</td>
<td></td>
<td></td>
<td></td>
<td>60A</td>
<td>80A</td>
<td>25.0+E</td>
<td>PVCsws</td>
<td></td>
<td>PROVIDE BLANKS</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>SPARE</td>
<td></td>
<td></td>
<td></td>
<td>60A</td>
<td>80A</td>
<td>25.0+E</td>
<td>PVCsws</td>
<td></td>
<td>PROVIDE BLANKS</td>
</tr>
</tbody>
</table>

---

2-27 Electrical specifications
SECTION 3
SECURITY AND FM 200 SUPPRESSION SYSTEM SPECIFICATIONS

Integrated Security Platform (CCTV, Access Control and Intruder Alarm) for African Development Bank (ADB) Harare Office

Architectural and Engineering Specifications
# TABLE OF CONTENTS

**PART I  GENERAL**

1.1 GENERAL DESCRIPTION .................................................. 2
1.2 REQUEST FOR PROPOSAL (RFP) SUBMITTALS ............................... 3
   1.2.A Product Data .......................................................... 3
   1.2.B As-Built Drawings .................................................... 3
   1.2.C Manuals ............................................................... 4
1.3 QUALITY ASSURANCE
   1.3.A Manufacturer Qualifications ....................................... 5
   1.3.B Contractor / Integrator Qualifications ............................ 5
1.4 WARRANTY ...................................................................... 5

**PART II PRODUCTS**

2.2 DESCRIPTION .................................................................. 6
   2.2.A SECURITY MANAGEMENT SYSTEM (SMS) ............................ 6
   2.2.B Video Management System (VMS) .................................... 6
2.3 SMS PERFORMANCE - MONITORING..................................... 7
   2.3.A Monitoring Mode ........................................................ 7
   2.3.B Communication Methods .............................................. 7
2.4 SMS PERFORMANCE - PROGRAMMING & CONFIGURATION ......... 7
   2.4.A User Section ............................................................. 7
   2.4.B Video Integration ...................................................... 8
   2.4.C Devices Section ........................................................ 8
   2.4.D Alarm Interface ....................................................... 9
   2.4.E Intrusion Integration ................................................... 10
   2.4.F Report Section .......................................................... 10
2.5 SMS PERFORMANCE - Web Interface / MOBILE APP ............... 10
   2.5.A Web Interface ........................................................... 10
   2.5.B Mobile APP .............................................................. 11
2.6 SMS OPERATION .............................................................. 11
2.7 SMS EQUIPMENT ............................................................. 11
   2.7.A Integrated Security Platform Appliance Server Specifications .. 11
   2.7.B Workstation Requirements .......................................... 12
   2.7.C Controllers .............................................................. 13
   2.7.D Card and Reader Support ............................................ 13
   2.7.E Network Video Recorder (NVR) Specifications ................. 13
   2.7.F Camera Specifications ............................................... 14
2.8 PERFORMANCE - VMS LIVE DISPLAY MODE ......................... 16
   2.8.A Live Display Mode Features ....................................... 16
   2.8.B Exporting Files ....................................................... 17
   2.8.C Copy, Save and Print Images ...................................... 17
PART I  GENERAL

1.1  GENERAL DESCRIPTION

The Security Management System (SMS) shall be a combined modular secure access management system, Video Management System (VMS), and shall integrate easily with intrusion panels. The system will be used to better manage and protect employee and visitor movements at the Harare Office. The SMS shall be based on an easy to deploy network appliance with all of the required software preloaded.

The Video Management System (VMS) software shall be used for viewing live and recorded video from IP cameras connected to a local and wide area network. The VMS software shall have a Client-Server based architecture that can be configured as a standalone VMS system with the Client software running on the server hardware and/or the Client running on any network connected TCP/IP PC workstation. Multiple client workstations shall be capable of simultaneously viewing live and/or recorded video from a single or multiple servers. Multiple servers shall also be able to simultaneously provide live and/or recorded video to a single or multiple workstation(s).

The application software shall be multi-user and multi-tasking and run on a purpose built appliance. The application software shall be based on a standard, high level programming language. The SMS shall be modular to facilitate its installation and the development of its capabilities while avoiding major modifications in its operation and in saving all defined system and historical data.

The SMS shall be designed to maximize all tools offered by the Windows platform. All commands shall be accessible using nothing more than a mouse, and keyboard use shall be limited to documenting fields requiring numeric or alphanumeric data.

The server shall contain a database server using a Sybase embedded SQL database. All database management tools shall be included, such as back-up, indexing, and database cleaning tools. No third party database tools or licensing shall be required. The Multi-site gateway shall communicate system information between the server and controllers. The workstations shall be the primary user interface to perform supervisory and programming functions.

The SMS shall enable the selection of at least two user languages. The basic dictionary shall include English, French, Spanish, Italian, Portuguese, Simplified Chinese, Dutch, Turkish, and German, however, the system shall include a vocabulary editor to be used in designing custom language dictionaries. The operator’s profile shall permit the selection of one of the two basic languages.

The SMS shall include RS-232 / RS-485 communication link between the various system components as well as TCP/IP network interface capability. Field devices such as card readers, alarm inputs, control points, etc. shall be connected to fully distributed intelligent field panels capable of operating without host computer intervention in a non-degraded mode.

The SMS shall be able to design customized ID cards directly from the access management software. No specific program or software other than the access management software and no additional licensing shall be required for this function. Any workstation shall be capable of being used as a badging station. Badging shall be fully integrated with the card database.
1.2   REQUEST FOR PROPOSAL (RFP) SUBMITTALS

1.2.A  Product Data

The Contractor shall provide the following:

1. Complete product data and technical specification data sheets that includes manufacturer’s data for all material and equipment, including terminal devices, local processors, computer equipment, access cards, and any other equipment provided as part of the SMS.

2. A system description, including analysis and calculations used in sizing equipment required by the SMS. The description shall show how the equipment operates as a system to meet the performance requirements of the SMS. The following information shall be supplied as a minimum:
   a. Central processor configuration and memory size.
   b. Description of site equipment and its configuration.
   d. Hard disk system size and configuration.
   e. Backup/archive system size and configuration.
   f. Startup operations.
   g. System expansion capability and method of implementation.
   h. System power requirements and UPS sizing.
   i. A description of the operating system and application software.

1.2.B  As-Built Drawings

At the conclusion of the project, the Contractor shall provide “as built” drawings. The “as built” drawings shall be a continuation of the Architectural shop drawings as modified, augmented, and reviewed during the installation, check out and acceptance phases of the project. All drawings shall be fully dimensioned and prepared in DWG format using AutoCAD.
1.2.C Manuals

At the conclusion of the project, the Contractor shall provide copies of the manuals as described herein. Each manual's contents shall be identified on the cover. The manual shall include names, addresses, and telephone numbers of each security system integrator installing equipment and systems and the nearest service representatives for each item of equipment for each system. The manuals shall have a table of contents and labeled sections. The manuals shall include all modifications made during installation, checkout, and acceptance. The manuals shall contain the following:

1. Functional Design Manual

The functional design manual shall identify the operational requirements for the system and explain the theory of operation, design philosophy, and specific functions. A description of hardware and software functions, interfaces, and requirements shall be included for all system operating modes. All operational changes required by customer are to be documented in writing where they differ from original Specification.

2. Hardware Manual

The hardware manual shall describe all equipment furnished including:

a. General description and specifications
b. Installation and test and commission procedures
c. Equipment layout and electrical schematics to the component level
d. System layout drawings and schematics
e. Alignment and calibration procedures
f. Manufacturers repair parts list indicating sources of supply
g. Load calculations of equipment operating at maximum load.


The software manual shall describe the functions of all software and shall include all other information necessary to enable proper loading, testing, and operation. The manual shall include:

a. Definition of terms and functions
b. Use of system and applications software
c. Initialization, startup, and shut down
d. Alarm reports
e. Reports generation
f. Data base format and data entry requirements
g. Directory of all disk files


The operator's manual shall fully explain all procedures and instructions for the operation of the system including:

a. Computers and peripherals
b. System startup and shut down procedures
c. Use of system, command, and applications software
d. Recovery and restart procedures
e. Graphic alarm presentation
f. Use of report generator and generation of reports
g. Data entry
h. Operator commands
i. Alarm messages and reprinting formats
j. System access requirements

3-4 Security specifications

The maintenance manual shall include descriptions of maintenance for all equipment including inspection, periodic preventive maintenance, fault diagnosis, and repair or replacement of defective components. Maintenance manual shall also include a list of recommended spares which are liable to be encountered as part of routine service procedures.

1.3 QUALITY ASSURANCE

1.3.A Manufacturer Qualifications

The manufacturers of all hardware and software components employed in the SMS shall be established vendors to the access control/security monitoring industry for no less than five (5) years and shall have successfully implemented at least 5 systems of similar size and complexity.

1.3.B Contractor / Integrator Qualifications

1. The security system integrator shall have been regularly engaged in the installation and maintenance of integrated access control systems and have a proven track record with similar systems of the same size, scope, and complexity.

2. The security system integrator shall provide a minimum of three (3) references whose systems are of similar complexity and have been installed and maintained by the security system integrator in the last five (5) years.

3. There shall be a local representative and factory authorized local service organization that shall carry a complete stock of parts and provide maintenance for these systems.

1.4 WARRANTY

The Security Management System (SMS) shall be provided with a 36 month product warranty from date of registration. Software version updates shall be available for no charge during this warranty. The software media warranty shall be 90 days. The Integrated Security Platform shall be provided with a 36 month product warranty on the physical appliance appliances.
PART II PRODUCTS

2.2 DESCRIPTION

The Integrated Security Platform consists of both a Security Management System (SMS) and Video Management System (VMS) that are preloaded onto an easy to deploy network appliance.

2.2A SECURITY MANAGEMENT SYSTEM (SMS)

The Security Management System (SMS) shall be an integrated system that utilizes a Sybase embedded SQL database for the storage and manipulation of related data. The SMS shall include a server with applications software, Multi-site gateway for communication between the server and controllers, operator and administrator workstations with appropriate software, hard copy printers and secure backup media.

The access control security field devices (readers, door position switches, REX, etc.) shall communicate with the field panels via a dedicated cable network. The field panels shall communicate to the server via a Fast Ethernet 10/100 TCP/IP network, or RS-232/RS-485 connection.

The SMS shall allow for growth and scalability from a smaller system to a larger, high-end, or enterprise system. The SMS shall be modular in nature, allowing system capacities to be easily expanded without requiring major changes to system operation. All defined system data as well as historical information shall be maintained. The proposed SMS shall provide a minimum of:

- 30 days video retention at a minimum of 15 Frames per second (fps) on motion ONLY recording.
- Access Control records must be retained for at least one (1) calendar year.

2.2B Video Management System (VMS)

The SMS shall have Video Management System (VMS) software pre-installed for viewing live and recorded video from IP cameras and video encoders connected to a local and wide area network. The VMS software shall have a Client-Server based architecture that can be configured as a standalone VMS system with the Client software running on the server hardware and/or the Client running on any network connected TCP/IP PC workstation. Multiple client workstations shall be capable of simultaneously viewing live and/or recorded video from a single or multiple servers. Multiple servers shall also be able to simultaneously provide live and/or recorded video to a single or multiple workstation(s).

The VMS software running on the SMS shall have an open architecture supporting IP cameras and encoders from multiple manufacturers providing best of breed solutions from low cost entry level features to high resolution megapixel features. A minimum of five (6) IP camera manufacturers must be supported from leading companies such as American Dynamics, ACTi, Arecont Vision, Axis, IQinVision, Panasonic, Sony, Bosch and Pelco.

The VMS shall support up to:

<table>
<thead>
<tr>
<th>Quantity</th>
<th>Feature</th>
</tr>
</thead>
<tbody>
<tr>
<td>32</td>
<td>IP Cameras at 4CIF</td>
</tr>
<tr>
<td>Unlimited</td>
<td>Workstation clients</td>
</tr>
<tr>
<td>Unlimited</td>
<td>Web/Mobile clients</td>
</tr>
<tr>
<td>128 Mbps</td>
<td>Overall video throughput</td>
</tr>
</tbody>
</table>

3-6 Security specifications
2.3 SMS PERFORMANCE - MONITORING

2.3.A Monitoring Mode

All events that occur shall appear in real time. The text shall include at least the date, time, and a pertinent description of the event as well as its condition. The display of this screen shall be customizable and a different background and message color can be used for every type of event.

2.3.B Communication Methods

- The SMS shall ensure the communication to remote sites over a LAN or WAN/Internet using a dedicated communication server device. It shall ensure secure communications by the use of 128-bit AES Encryption. It shall reduce bandwidth consumption by managing the communication protocol used.
- In all communication methods, the door controller shall retain in their memory all necessary data for controlling doors that they supervise. In case of communication failure, the door controller shall execute all its functions normally.

2.4 SMS PERFORMANCE – PROGRAMMING & CONFIGURATION

2.4.A User Section

1. This section shall include all functions involved in the issuance of an access or ID card as well as database search and importation tools. During the addition or modification of a card, information about the card shall be sent to the door controllers affected by these new parameters as soon as the operator accepts the addition or modification. An additional command requiring a reloading of the cards database in the door controllers shall not be acceptable.

2. The SMS shall allow adding door access exceptions to the cardholder’s list of access rights.
   a. The SMS operator shall be able to provide a pre-defined access level and separately add a specific door to be part of the cardholder’s access rights.
   b. The door shall have its own schedule.
   c. The SMS operator shall have the option of allowing or disallowing access to that door based on that schedule.
   d. There shall be no limit to the number of doors that can have exceptions.
   e. The door controllers for Access Control system shall keep in memory the door access exceptions even in standalone mode.

3. The SMS shall enable the creation and definition of a user access card. There can be up to five cards per user and users can be managed by cardholder name or card number. When creating user cards, the operator shall be able to select a card format directly from a Card dialog and enter the card number as it is printed on the card.

4. The following user information shall be able to be saved in the user section:
   a. 5 card numbers each with their own expiration date, trace and lost or stolen statuses.
   b. First and last name.
   c. Card type.
   d. Additional information (10 fields).
   e. Start date.
f. Expiry date.
g. Personal ID number (PIN).
h. State of the card.
i. Multi-sweep activation.
j. Comments.

In addition, it shall be possible to associate a photograph, signature, and badge template to a card. The picture of the card holder shall always be visible when the profile is active on the screen.

5. The SMS shall allow for the creation of a day pass to be issued to visitors for a single day. The SMS shall also have the ability to create temporary ID visitor cards.

6. The operator shall be able to quickly view the cardholder’s door list
   a. Operators shall be able to export the door access list.
   b. A detailed view of the door’s schedule shall be show when selecting a door.

7. The SMS shall allow for 250 access levels programmed per loop/site of controllers. Every card shall be assigned an access level which shall determine where and when the access card will be valid. When the system consists of several sites or gateways, it shall be possible to use batch programming of access levels.

2.4.B Video Integration

1. From any of the workstations it shall be possible to do the following:
   a. View one or more camera images from different sources.
   b. Query the history of each recorder and view images saved on disk.
   c. View, modify, or delete programming parameters of a recorder.
   d. Control the movement of all motion cameras directly with the workstation mouse of the SMS (PTZ control).
   e. Export camera images to hard disk and Video Vault (capable of exporting multiple formats, password protected to protect chain of evidence).

2. The SMS shall allow for the creation of an unlimited number of video views. For each video view it shall be possible to connect up to 16 cameras from various sources.

3. The SMS shall allow the playback of all recordings stored on the hard drive of the NVR. The operator shall be able to save the video into the Video Vault.

4. The SMS shall provide the operator access to the complete list of normal and abnormal events that required the activation of video recording. The sequence of images can be saved to a hard drive for subsequent consultation and shall be encrypted. The SMS shall allow the operator to access a complete list of alarm recordings in progress including origin of the alarm. The SMS shall be capable of displaying a list of exported videos.

5. It shall be possible to view recorded video tagged to an Access or Video event by quick linking from the Message desktop.

2.4.C Devices Section

The physical components of the SMS including workstations, Multi-site gateways, gateway, site, controllers, doors, relays, and monitored inputs shall be individually configured and defined. Individual sites shall also be defined. The software shall allow the use of a controller Express Setup feature in order to minimize the time needed for controller definition.
2.4.D Alarm Interface

1. The SMS shall interface with any external alarm system thereby arming or disarming the system by presenting a valid card to an entry / exit door. It also shall be possible to associate a keypad with a reader forcing the cardholder to enter a number in the keypad after presenting a card. This integration shall only be possible with the use of a Multi-site gateway. It shall be possible at a minimum to:

   a. Set a monitored input as an arming button.
   b. Associate a usage schedule with an arming button.
   c. Set the exit and entry delay.
   d. Determine whether the system must wait for a valid access to arm.
   e. Determine whether the system must wait for a valid access card swipe and appropriate pin number to disarm. Determine whether the door must relock on arming request.
   f. Associate a monitored input with an alarm panel condition.
2.4 E Intrusion Integration

1. The SMS shall allow interface with the DSC PowerSeries PC1616, PC1832, PC1864 and MAXSYS 4020 series alarm panels intrusion panel thereby eliminating hardwired integration between the SMS controllers and the DSC PowerSeries® intrusion panel. The DSC PowerSeries® intrusion panel shall communicate with the Multi-site gateway via RS-232 or directly to Access Control door controller. The SMS shall allow for:

   a. Single/multiple partitions arming and disarming via reader.
      i. Disarm via card only or forced valid card and pin.
   b. Single/multiple partitions arming and disarming via operator commands.
   c. Receive events from intrusion panel.
   d. Receive partition names, user codes and zone names programming.
   e. Update user codes.
   f. Assign user codes to cardholders.

2.4. F Report Section

1. The SMS shall include templates for various types of reports to include the following:

   a. Card use reports.
   b. Manual operations reports.
   c. Alarm reports.
   d. Historical reports.
   e. Time & Attendance reports.
   f. Detailed reports.
   g. Summary reports.
   h. Statistical reports.
   i. Roll Call Reports.

2. The SMS shall allow for the creation of custom reports based on any event or component in the system. The SMS shall support an unlimited amount of customized reports.

3. All reports shall be able to be displayed on screen, printed, or sent by e-mail on a daily, weekly, or monthly basis. All event reports can be automated to be generated and sent at a specific time for a specific time period.

4. The SMS shall support at a minimum the following report formats: Sybase, Dbase IV, CSV, XLS, PDF, RTF, and TXT.

5. The SMS shall be able to generate an access report in CSV with all the card information associated to that access event.

2.5 SMS PERFORMANCE – Web Interface / MOBILE APP

2.5.A Web Interface

1. Web interface application shall be an optional tool that will allow for performing certain functions from a remote location to be used with the regular SMS system via a Web browser.

2. Web interface shall offer the following operations:

   Operator specific security rights. The SMS workstation shall allow configuring operators to be able to access Web Portal. It shall also allow the operator’s security rights and
workspaces to be used on the Web Portal. An operator who cannot add cards on the SMS workstation shall not be able to do the same on Web Portal.

2.5.B Mobile APP

1. Mobile App is an optional tool that will allow performing certain functions from a remote location to be used with the regular SMS system via iPad, iPhone, Android phones and Android tablets. The Mobile App provides card management to guards, secretaries, or managers without the need to deploy a full workstation. A concurrent connection option shall provide access to a predetermined number of simultaneous users.

2. The Mobile App shall be downloadable at no-charge from the App Store® and Google Play®.

2.6 SMS OPERATION

The SMS shall perform the following tasks:

1. Allow card access management for the building.

2. Control access to various doors equipped with a card reader. Allow the ability to set card use count options to limit the number of times a card can be used.

3. Monitor all defined alarm points as well as all doors controlled by card readers based on programmed schedules.

4. Send transactions for which printing is required to one or more printers, based on a set schedule.

5. Access the system using the main and secondary menus (to which access is limited by a password) to make additions and required changes to various data files so that they can be updated by the user without the manufacturer’s assistance.

6. Enable the entry of access code data for every card or group of cards.

7. Seamlessly connect to onsite alarm systems.

8. View and/or save video images.

9. When integrated into a NVR system, allow the management of the recordings of all the cameras via access system workstations.

2.7 SMS EQUIPMENT

2.7.A Integrated Security Platform Appliance Server Specifications

The server shall meet the following minimum requirements:

1. The server shall come with pre-installed access control software, video management software, pre-configured IIS server, integrated diagnostic gadgets, and custom shell so as to eliminate any software installation on the server.

2. It shall be possible to remotely manage the server using a web browser and self-discovering configuration utility.

3. The server shall measure (HxWxD) 6.4 x 30 x 29 cm (2.5 x 11.8 x 11.4 in).
4. The server shall have the option of being wall mounted, rack mounted, or placed on the desktop.
5. The server shall have an i3-2330E processor or better.
6. The server shall have an 80-watt power supply 100-240 VAC, 50-60Hz, 2.0A
7. The server shall have 4 GB RAM, non-ECC, 800MHz DDR3 SODIMM
8. The server shall have a 32GB SSD boot drive
9. The server shall have a 3TB high reliability DVR grade SATA (3Gb/s) hard drive.
10. The server shall have a dual gigabit Ethernet 10/100/1000 Base-T network adapter.
11. The server shall have 6 USB ports.
12. The server shall have 1 RS-232 port.
13. The server shall support multiple video outputs and support dual display configurations (VGA and HDMI or VGA and DVI).
14. The server shall monitoring CPU voltage and temperature.
15. The server shall include 2 eSATA storage expansion ports
16. The server shall include 2 highly visible LEDs that provide visual power status, applications status, watchdog status, and other abnormal status that can easily be seen from a distance when rack mounted.
17. The server shall include a hardware watchdog monitor that will reboot the appliance when an abnormal condition is detected.
18. The server shall have a high quality multilingual keyboard.
19. The server shall have a two button ergonomic mouse.
20. The server shall have an On-Off switch.
21. The server shall be connected to an appropriately sized UPS.

2.7.B Workstation Requirements

The SMS workstations shall meet the following minimum requirements:

1. The workstation shall have a dual core processor or better.
   a. If doing video, the workstation shall have an Intel quad core processor or better.

2. The workstation shall have a 500-watt power unit.

3. The workstation shall have 4 GB RAM.
   a. If doing video, the workstation shall have an 8GB of RAM or more.

4. The workstation shall have 20 GB hard disk drive space.

5. The workstation shall have a 48x CD-ROM drive.

7. The workstation shall have a 10/100/1000 Base-T network adapter.

2.7.C Controllers

The SMS shall support the following Access Control door controllers:

An Ethernet-ready door controller with several monitored points, on-board door strike power, multiple reader outputs, four relay outputs, and auxiliary power output. It shall accept Wiegand, proximity, ABA clock and data, bar code, magnetic, integrated keypad, and smart card reader types. It supports RS-232, RS-485 and 128-bit AES Encrypted Ethernet 10/100Base-T communication. It supports expansion modules to provide 256 inputs and 256 outputs. It shall support up to support 8 card.

2.7.D Card and Reader Support

1. The SMS shall support up to 8 card formats per door controller.
2. The SMS shall support readers that provide Wiegand signaling and magnetic ABA signaling to include:
   a. Wiegand swipe readers.
   b. Proximity readers.
   c. Biometric readers.
   d. Smart card readers.
   e. Wireless readers.
   f. Magnetic readers.
3. The Card readers shall be Keyless Entry Lock for Aluminum & Glass Doors. They will be mounted together with Adams Rite deadbolts, dead latches and exit devices.

2.7.E Network Video Recorder (NVR) Specifications

The Network Video Recorder ("NVR") shall be an appliance to acquire, record, store, and display video signals from both directly connected analog cameras and IP network video cameras and encoders.

The NVR appliance hardware shall have the following minimum characteristics:

i. Chassis: <2 RU rack-mount> or <4 RU rack-mount> or <Desktop>

ii. Camera inputs: Minimum of 32 IP Channels

iii. Storage capacity: 20TB


v. Alarms:
   a) Inputs: provision for 8 external TTL
   b) Outputs: provision for 4 external TTL, 1 external relay

vi. Server characteristics:

3-13 Security specifications
b) Windows: 120 GB SSD or Linux: 30 GB SSD  
c) Monitor outputs: 1 DVI-I + 1 HDMI +1 Display Port (max 2 simultaneous)  
d) Processor: Gen 4 Intel® Core i3; Intel® Core i5 or i7 (Optional)  
e) Memory: 4 GB; 8 GB, 16GB (optional)  
f) Network: 2 x 1000 BASE-T (Gigabit) 
g) USB 2.0 ports: 6  
h) USB 3.0 ports: 2  
i) Electrical Input voltage: 120/240 VAC auto-sensing

2.7.F Camera Specifications

The network IP camera (s) shall have the following minimum specification:

1. Built-in web server
2. Support multiple streams, up to 3840x2160 resolution
3. Progressive scan imager
4. Motorized varifocal lens
5. Onboard storage for local recording
6. Complies with ONVIF Profile S
7. Capable of integration with network recording systems which support ONVIF Profiles S
8. Capable of operation as a standalone device on the network

A. Functions

1. Video Compression
   a. H.265
   b. H.264 (default)
   c. MJPEG
2. Standards: ONVIF Profile S
3. Web Browser access:
   a. Microsoft Internet Explorer
   b. Google Chrome
   c. Mozilla Firefox
   d. Apple Safari
4. Streaming methods for audio, video and metadata:
a. Unicast
b. Multicast

5. **Minimum 2MP resolution** camera shall support multiple streams with the following resolution options with maximum fps dependent on resolution:

1) H.265, H.264
   a) Maximum of 15 ips @ 3840x2160 with True WDR
   b) Maximum of 60 ips @ 1920x1080 without True WDR

2) MJPEG
   a) Maximum of 15 ips @ 1920x1080 with True WDR
   b) Maximum of 60 ips @ 1920x1080 without True WDR

B. Cyber Security and Authentication:

1. Enhanced Security:
   a. One-Click Security Hardening
   b. Certificate Management
   c. Disabling Unused Protocols
   d. User Access Log for Cyber Audit Trail
   e. Validate Complex Credentials

2. IEEE 802.1x:
   a. EAP-TLS – RFC 5216
   b. EAPoL – RFC3748 & RFC5247
   c. PEAP

3. HTTPS Encryption (HTTP over TLS) – RFC2818

4. IP Address Filtering

5. Multi-Level Password Protection

6. TLS – RFC5246 v1.2

7. WS-Security

C. Camera Characteristics:

1. Memory:
   a. ROM/Flash: 256 MB
   b. RAM: 512 MB
2. Video Codec Settings:
   a. H.265

3. Blur Detection

4. Illuminator:
   a. Smart IR
   b. Adaptive IR
   c. IR Distance: 25 m
   d. Wavelength: 850 nm

5. Lens:
   a. Format: 1/2.7"
   b. Design: 1 Aspheric glass lens
   c. Mount: Phi 14mm
   d. Focal Distance: Integrated 2.8-12 mm Varifocal Megapixel Lens
   e. Aperture Range: F/1.4 (Wide) ~ F/2.7 (Telephoto)
   f. Focus Type:
      1) One-Touch Motorized Focus
      2) Motorized Varifocal
      3) Lens Calibration
   g. Iris Type: P-Iris
   h. IR Correction: Optical Corrective
   i. Day/Night: True D/N with ICR
   j. View Angles:
      1) Horizontal: 98° (Wide) and 35° (Telephoto)
      2) Vertical: 71° (Wide) and 26° (Telephoto)

2.8 PERFORMANCE - VMS LIVE DISPLAY MODE

2.8.A Live Display Mode Features

A live display mode shall have features for users to view live video. The live display mode shall have the following features to navigate and view live video:

1. Layout Icons – shall have features to organize the camera video view panel in the following patterns:
   a. 1 camera (full screen) layout
   b. 4 camera (2 x 2) layout
c. 9 camera (3 x 3) layout  
d. 12 camera (4 x 3) layout  
e. 16 camera (4 x 4) layout  
f. 20 camera (5 x 4) layout  
g. 30 camera (6 x 5) layout  
h. 48 camera (8 x 6) layout  

2. Navigation Tree – shall display cameras, alarms, monitor & audio icons that are connected to the VMS server.

3. Navigation Pane – shall display a hierarchy of cameras, audio input and serial port input icons organized by Cameras (cameras connected to servers), Groups (logical grouping of cameras) and Views (Saved live display layouts). Clicking on navigation pane bars shall switch the navigation tree into the desired navigation tree display.

2.8.B Exporting Files  
The VMS software shall provide the option of exporting video clips in the following formats:

1. Standalone Exe (*.exe) – includes an executable player with the video & audio data

2. AVI File (*.avi)

3. PS File (*.ps)

2.8.C Copy, Save and Print Images  

1. The VMS software shall have features to save and print a picture (image). The VMS software shall have the capability to copy a picture to a clipboard and paste it into a document.
FIRE DETECTION AND FM-200 SUPPRESSION SYSTEM FOR SERVER ROOM

A. **SCOPE:** This specification outlines the requirements for a total flooding FM-200 fire suppression system. The work described in the specification consists of all labor, materials, equipment, and services necessary and required to complete and test the system.

B. **REQUIREMENTS:** This installation shall be made in accordance with the drawings submitted and additional specifications supplied and to applicable standards. Should a conflict occur between the drawings and specifications, the specifications shall prevail.

C. **GENERAL:** Qualifications of installer/contractor:

a) The system shall be installed by an experienced firm regularly engaged in the installation of automatic FM-200 fire extinguishing systems in strict accordance with NFPA standards.

b) The contractor's firm must have a minimum three (3) years' experience in design, installation, and testing FM-200 or similar fire suppression systems. A list of systems of similar nature and scope shall be provided at the time of proposal.

c) The installation Contractor must be certified fire systems installer by City of Harare Fire department

D. **SYSTEM DESCRIPTION AND OPERATION**

1. The system shall be total flooding FM-200 extinguishing system designed to provide a uniform concentration of 8.5%, at normal average ambient temperature, minimum of FM-200.

2. The system shall be actuated by a combination of smoke detectors. Automatic operation in the protected area shall be as follows:

a) Actuation of one (1) detector in either loop shall:
1) Illuminate the respective zone (circuit) lamp on the control unit.

2) Energize a pre-alarm audible or audible/visual signal associated with that area in which the detector was operated.

3) Transmit a signal to the building's fire alarm system.

b) Actuation of a second detector in the same area, but on the second detection loop, shall:
   1) Illuminate the respective zone (circuit) lamp on the control unit.
   2) Energize an evacuation audible and visual signal associated with the area in which the detector was operated.
   3) Start time-delay sequence.
   4) Shut down any cooling/ventilation system.

c) Discharge of the FM-200 shall occur at the end of time-delay period.

3. The system shall be capable of being actuated by manual discharge stations located at the server room exit. Operation of manual discharge station shall duplicate the cross-zones sequence description above, except that time-delay shall be bypassed.

E. MATERIALS AND EQUIPMENT

a) All devices and equipment shall be UL listed and/or FM approved.

b) All wiring shall be furnished and installed by the contractor. Unless a written variance is obtained, all wiring shall be installed in conduits.

c) The complete electrical installation of the system and all components shall be grounded in accordance with the National Electrical Code.

d) The protected area shall make use of Pre-engineered FM200 Cylinders and no piping is expected.
F. SYSTEM INSPECTION AND CHECKOUT

a) The complete system shall be functionally tested in the presence of the Owners, and all functions must be operational prior to the final acceptance test.

1. Each detector shall be tested in accordance with the manufacturer’s recommended procedures. The system and equipment interlocks, such as audible and visual alarms and equipment shut-downs shall function at that time.
2. Each circuit shall be tested for trouble by inducing a trouble condition to the system.

G. TRAINING AND MAINTENANCE REQUIREMENT

a) Prior to final acceptance, the contractor shall provide operation training of the Owner’s personnel. The training session shall include emergency procedures, abort functions, system control panel operation, trouble procedures, and safety requirements. The session shall include a complete demonstration of the system.

b) Prior to final acceptance, the contractor shall provide complete operation and maintenance instruction manuals to the owner. Checklists and procedures for emergency situations, troubleshooting techniques, and maintenance operations shall be included.

H. FM-200 SYSTEM INSPECTIONS

a. The contractor shall provide two (2) inspections of THE system under this contract during the one-year warranty period. The first inspection shall be at the six month interval after system acceptance, and the second at the 12 month interval. Inspections shall include determination of agent container weight and pressure and that the system is in proper working order.

b. Inspection shall also include a complete checkout of the control and alarm system. All inspections shall be done in accordance with NFPA 2001.

I. WARRANTY

All FM-200 system components furnished under this contract shall be guaranteed against defective design, materials, and workmanship for
the full warranty time which is standard with the manufacturer, but in no case less than ONE (1) YEAR from the date of system acceptance.

J. BILL OF MATERIALS

Below are the recommended minimum Gas Calculations for the protected area:

<table>
<thead>
<tr>
<th>Dimensions</th>
<th>Room</th>
<th>Ceiling</th>
<th>Floor</th>
<th>Project Name</th>
<th>City</th>
<th>Country</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>ADB</td>
<td>Harare</td>
<td>Zimbabwe</td>
</tr>
<tr>
<td>Width</td>
<td>2.9</td>
<td>2.9</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Height</td>
<td>2.7</td>
<td>0.3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Design Conc</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Risk Name</th>
<th>Height above sea level</th>
<th>City</th>
<th>Room Temperature</th>
<th>No. of Doors</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Server Room</td>
<td>1473</td>
<td>Harare</td>
<td>21</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Cylinder Size</th>
<th>No of Cylinders</th>
<th>Total Gas in Kg</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>25</td>
<td>1</td>
<td>14</td>
<td>Room Void</td>
</tr>
<tr>
<td>6</td>
<td>1</td>
<td>3</td>
<td>Floor Void</td>
</tr>
</tbody>
</table>

3-21 FM200 suppression system specifications