SESAME-Synchrotron Light Source for Experimental Science and Applications in the Middle East

Tender No. (Admin-02/T/2017/03)

Guesthouse Building Project
AL Salt-Alan SESAME Centre

Volume 2
Part 8

Consultant: SESAME Engineering Office

TECHNICAL SPECIFICATION

September 2017
TECHNICAL SPECIFICATIONS

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SECTION: 1: GENERAL CONDITIONS

Preamble

A- Technical Specifications included in Volume 2 Part 8 should be considered complementary and integral to the general specifications, the prices for each item, job, etc., should include all written specification requirements in Volume 2 Division 8 and BOQ.

B- All Works mentioned in Volume 2 Division 8 and BOQ shall be considered a part of the required specifications of the works to be executed, in case of discrepancy between specifications mentioned in Volume 2 Part 8 and BOQ. It is the Decision of SESAME engineer to decided which specifications should be considered.

C- The sentence “according to Specifications” whether it is mentioned or not mentioned in the BOQ. It should be clear that the work to be executed should be according to the general and special technical specifications mentioned in Volume 2 Part 8.

D- Whenever the words “Ditto “or “same as Item No.,” or “same as”, mentioned. it means that the prices and the specifications shall include all the related items, specifications and works of the pointed item. Taking into account any additions or deletions specified in the same item and its technical specifications.

E- Items which have no details, drawings or specifications shall be priced according the national and international codes and specifications taking into account the objective function of the item.

F- In case of any lack or insufficiency in the technical specifications. SESAME Engineer has the right to impose the required specifications, covered in American, British or Jordanian National Building codes & specifications as He/She Decide.
SECTION: 1: GENERAL CONDITIONS

1.1 General
These specifications are to specify the quality of materials, level of workmanship, and methods to be followed and respected in executing and maintaining ….

1.2 Drawings
The contractor shall be provided with a list of drawings included in this bid on page of the drawings file. All expenses burned by the contractor, to execute the conditions included in this section, on the contractor own cost and his unit rates in the bills of quantity shall be deemed to include all costs and expenses.

1.3 Bidding Documents
The bidding documents complete each other and to consider the case which gives the higher quality in executing as the Engineers decides. The contractor is to consider this when he prices the bill.

The contractor who participates in the bid must return all bidding documents, drawings and addenda including the pre-bid meeting, signed and stamped from his behalf. If the contractor didn’t return any of these documents with his offer, the bidding committee has the right to reject his offer.

1.4 Shop Drawings
If during executing the work or before, the Engineer found that the contractor needs shop drawings to execute a certain task, the contractor must prepare these drawings and submit them to the Engineer for approval. The Engineer has the right to instruct the contractor at any time to submit shop drawings, which the Engineer considers necessary for executing a certain task. The contractor is to abide by this instruction and don’t proceed with the task before the Engineer approves the shop drawings. The shop drawings must be fully detailed with a suitable scale and unless otherwise specified be submitted in four copies.

The Engineer has within a reasonable time from receiving the shop drawings approve the drawings. If the Engineer returns the drawings with notes, the contractor shall adjust the drawings as instructed by the Engineer and resubmit to the Engineer for approval and he must point out the adjustment made to the first drawing according to the standard procedure.

1.5 As-Built Drawings
The contractor, at his own cost, shall check drawing number as necessary during execution of works. The contractor is required to obtain the Engineers approval on this adjustment. When the contractor hands over the works, he shall prepare a new set of drawings for the project as executed with all adjustments (if any) and submit to the Engineer for approval. When the Engineer approves the As-Built drawings the contractor shall submit one scaled calculation copy and one computer CD copy (prepared for AutoCAD) written on it the project name and the phrase “AS-BUILT DRAWINGS”.

The final payment to the contractor shall be paid according to the works actually executed as recorded in the AS-BUILT drawings mentioned above.

1.6 Scaffolding
The contractor shall provide, erect and maintain the needed scaffoldings to execute the works of this project. Upon completion, the contractor shall remove them. The contractor is to take all the necessary safety measures related to these scaffoldings and repair any damages caused by the scaffoldings to the permanent works during the execution period.
1.7 Protection of Works

The contractor, in the course of completing his obligation according to contract conditions, is to protect and maintain the existing borders of the area (steel angles). In case they are moved or removed, because of the contractor usage of his equipment or any other reason, the contractor is return these angles to its correct position as per the coordinate provided by the Engineer. The contractor is to cover and protect the works from the climatic conditions or misuse or negligence ... etc, by providing proper barrier, covers according to the Engineer’s approval. The contractor, at his own expenses, shall repair any damages to the works caused by his negligence, or not fulfilling his obligation, according to the Engineer’s instruction and satisfaction.

1.8 Materials and Its Equivalent

All materials and goods must be according to technical specification. In no instance will environmentally harmful products, such as asbestos, dangerous wood varnishes, etc. be used.

The contractor is to submit the specification and description of the materials that he intends to supply with all necessary information to the Engineer to investigate before supplying. This information includes, but not limited to, trade name, manufacturer address and the contractor is to submit samples if asked by the Engineer.

Wherever a trade name or catalogue number to any material or any item of work in the specification or bills of quantities or drawings, this is necessary to specify the level of specification required. The contractor can suggest alternatives for these materials provided it is with the same level of specification, and to obtain the Engineers approval.

When an alternative material, other than mentioned in the contract, is approved and it was not in the same level of specification, the Engineer has the right to refuse deduction to the unit rate of these materials. No increase to the contractor prices should be made if better materials were provided (compared to the required specification).

Wherever, in the bills of quantity or specification or drawings, a trade name is mentioned or materials known by its manufacturer company or distributing company or catalogue number, it is to be automatically understood that the required is these materials or equivalent even if the phrase “or equivalent” is not mentioned.

1.9 Samples

The contractor shall execute the works according to the accepted samples and following the conditions: -

a. The cost of all samples shall be borne by the contractor.

b. The contractor is to submit samples before a reasonable time of starting the work to give the Engineer time to inspect the samples and make the required tests.

c. The samples shall be submitted with a letter containing all the needed information to obtain the Engineers approval.

d. The samples shall be kept at the Engineers office in the site.

1.10 Materials’ Testing

The Engineer has the right to ask the contractor to accompany the required materials with a testing certificate from the source either from the manufacturer or a laboratory approved by the Engineer.

The Engineer has the right to test samples from any material supplied to the site, and whenever needed, either in the lab specified by the Engineer inside the country or outside. Any materials that don’t pass the test shall be rejected.

The contractor is to make for the Engineer and his assistants all necessary assistance and services to test the materials brought to site and taking samples and checking measurements and weighs and provides on his own expenses whatever need from labor, tools, materials …etc.
1.11 The Construction specified for the Use of the Supervision Staff

Supervision office, the cost of the offices for the Engineer’s use shall be included in the contractor’s prices in the bills of quantity as described in the tender documents section III Particular Condition. The contractor should complete constructing the Engineer and inspector’s offices within 30 days of receiving the order to start works, and during this period, the contractor must provide temporary movable offices for the use of the Engineer and supervision staff. If the contractor didn’t provide the above or didn’t provide the required services, the Engineer has the right to deduct a penalty of Euro 50 /day for every day the contractor delays in providing the above. The Engineer shall also have the right to provide these services and needs on the contractor expenses. And all sums shall be deducted from the contractor payment and insurance whatever sum it reach.

The contractor shall during the execution of works provide all the required services for the above-mentioned offices including maintenance, cleaning, keeping and guarding the offices and its content at all times.

The contractor shall be responsible for all the costs of the needed services of the Engineer and inspector’s offices and their maintenance including electricity, water, telephone, cleaning the sewage pit, providing drinking water and all needed papers, books, files, etc., for the works according to Engineer’s approval.

The required offices shall be erected in the place approved by the Engineer, and shall stay during the execution of the works and afterwards shall become the property of the school. The contractor must hand it over in a good condition without any construction or architectural defects.

1.12 Temporary Construction for the Contractor’s Use

The contractor must, from the day of the order to start works, shall be exist in the site in a movable or temporary office for the use of his staff to receive the Engineer’s instruction when needed. The office shall be in the size suitable for the contractor’s needs and requirements and he must obtain the prior approval of the Engineer on this office.

The warehouses needed for the contractor use sufficient to store all construction materials needed for the project including equipment and tools. These warehouses must have all the conditions required to protect the materials from the environmental conditions.

The contractor shall be responsible to guard and maintain all the above-mentioned temporary constructions that are used by the contractor. He shall also be responsible to provide the required services for these constructions.

The contractor shall bear all the costs of constructing these temporary constructions.

1.13 Removing the Temporary Constructions

All temporary constructions for the contractor use shall be kept in all times in a good condition until all stages of works are completed and finally handed over. Afterwards, the contractor shall remove all these constructions and its residuals and cleaning its locations properly so that they leave no trace. If the contractor didn’t fulfill this obligation, the Engineer has the right to execute these tasks on the contractor’s account and deduct all the expenses from the contractor’s payment and insurance with the owner, whatever sum it reach without any legal procedure.

1.14 Temporary and Permanent Services

The contractor shall, at his own expense, redirect public services if exist (like electricity, water, …) which he found during work and according to Engineer’s directions and approval. If existing services is connected to or related to or related to the works, the contractor shall maintain and keep in place until handing over the works.

The contractor shall, on his own cost, repair any damages to the public services like telephone, electrical, sewage and water services for the concerned authorities or a third party.

If the concerned authority or the third party decided to repair the damages by itself, or asking any of its representatives to do so, the contractor shall bear the cost of these repairs done by the
concerned authority or the third party. The owner, according to the contract conditions, shall not be responsible for any claims for such actions.

1.15 Contradiction in the Contract Documents

The contract documents complete each other and in case of contradiction or ambiguity in the contract documents the contractor shall raise it to the Engineer's attention. The Engineer shall make the appropriate decision and inform the contractor. In case of contradiction or ambiguity, as mentioned above, the contractor price shall be as recorded in the bills of quantities. In case any material or work needed to execute the works is not mentioned in the bills of quantities, the contractor has to execute these materials or works and their cost shall be deemed to be automatically included in the contractor's price for the related item.

1.16 Site Meetings

During executing the works and on a periodical base, site meetings shall be held every 2 weeks or whenever needed for the purposes to coordinate the works and to be sure that it is properly executed according to contract conditions and technical specification. Minutes of the meetings shall be prepared by the Engineer or his representative and distributed to all parties and it shall be followed.

The contractor shall present in the meeting detailed of the works intended to be executed in the next two weeks, which shall be discussed and proper instruction shall be given, and these instructions and approval issued in the meeting shall be followed by the contractor.

1.17 Daily Reports

The contractor shall submit to the Engineer (or his representative) a daily report containing the required information on the labor (No.s types & hours), equipment and materials arrived to the site and works executed in that day.

1.18 Photographs of Progress of Works

The contractor at his own expense shall submit once a month, or as the Engineers find suitable, suitable number of colored photographs in 3 copies (size 10x15 cm) for the executed works or works under progress as directed by the Engineer. The original Digital files and all copies shall be the ownership of the owner, and the photos can't be use without his approval.

1.19 Work Schedule

The contractor shall prepare (in 3 copies) and submit schedule of the work including all tasks of the subcontractors any works in the contract condition. The contractor shall keep a copy in his site office and submit 2 copies to the Engineer.

The contractor has to make monthly (or as the Engineers see necessary) adjustment to the schedule according to site conditions and progress of works. Two copies of the revised schedule shall be submitted to the Engineer.

1.20 Measurement of Works

The Engineering measurement (international measurements) shall be used for all works; all openings and intersection shall be deducted. Actual net distances shall be calculated but not exceeding the measurement reported in the drawings. American Measurements and standards like inch, feet, ASTM etc will be used.
1.21 Codes and Standards

Where ever B.S. Standard is mentioned it should be read as follows:

All building materials and equipment should be registered with an international recognized norm institution or correspond to an international recognized norm. The standards used shall be DIN, ISO, and B.S. Standard or approved equivalent.
SECTION 2: EXCAVATION AND EARTHWORKS

2.1. Datum and Nature of Excavation

The Contractor shall be responsible for setting up and maintaining a site datum level. ‘Zero’ datum shall be given on the site by the Engineer, unless otherwise noted on the Drawings. Information pertaining to the nature of the ground may be given to the contractor, when available, but without any guarantee of correctness or accuracy.

2.2. Bench Marks

The Trade Contractor shall establish permanent benchmarks determined by an approved land surveyor or professional civil engineer. Maintain all established bounds and benchmarks and replace as directed by the Construction Manager those, which are destroyed or disturbed due to the excavation operations, at no cost to the Owner.

Each Benchmark (B.M.) or centerline for the building and/or other constructions to be under this contract, shall be properly set out by the Contractor as shown on the Drawings and inspected and approved by the Engineer prior to commencing excavations.

2.3. Surface Leveling

All earth works on Site shall be completed before any fill is deposited. Excavations over areas of Site or filling with approved material shall be carried out where required to the levels shown on the Drawings or to such other levels as may be directed by the Engineer.

2.4. Size and Depth of Excavation

Excavation shall be cut to the size of the foundation shown on the Drawings and taken down to the foundation levels shown on the Drawings. If, without the Engineer’s written instructions, the Contractor goes down below the foundation level specified, he shall fill up the part so excavated with concrete of the same type and grade as that required for the piles as defined in Concrete Works and the Bill of Quantities at his own expense.

2.5. Reduced Levels

All excavation for reduced levels shall be carried out to the lines and levels shown on the drawings or to such lines and levels as directed by the Design Professional. If, from any cause whatsoever, excavation is carried out beyond their true line and level other than that directed by the Design Professional, the Trade Contractor shall, at his own cost, make good to the required lines and levels with mass concrete as directed by the Design Professional. All excavations shall be performed so that the works are continually and effectively drained.

2.6. Shoring Excavations and Dewatering

The sides of excavations shall be supported as necessary to maintain a vertical face and/or to prevent caving-in of any nature, especially during subsequent operations. The Contractor shall be responsible for the design, supply, fixing, safety and removal of all planking, strutting and shoring required to the side of the excavation. The Contractor is responsible on the type and nature or soil to be excavated; also he is to use any equipment, including dewatering equipment, to carry out the work required by this Contract.
2.7. Types of Excavations

Excavations shall be classified according to the nature of the materials to be removed either as excavation in rock or as excavation in earth. Excavation in rock shall be classified as including all excavations in hard and consolidated materials which cannot be removed by normal excavation tools and equipment, and which require drilling or other special means for their removal. All excavation which is not in rock shall be defined as excavation in earth.

2.8. Required Bearing Capacity

The Contractor shall notify the Engineer and obtain instructions if the required bearing capacity:
(1). is obtained at a lesser depth than that shown on the drawings.
(2). is not obtained at the depth shown on the drawings.

Excavation bottoms are to be approved before new work is laid on them. The Contractor is to inform the Engineer when excavations are ready for inspection. If, after approval, surfaces become unsuitable due to flooding or other causes, the Contractor shall excavate further, backfill with approved filling material and compact to approval at no extra cost to the owner.

Should the soil condition, after the Engineer has been informed the excavations are ready for inspection, be such that the Engineer deems it necessary to carry out tests, the Contractor shall perform such tests to the satisfaction of the Engineer. Any expenses incurred in the performance of such tests are deemed to be included by the Contractor in his tender.

2.9. Filling

All filling materials shall be approved by the Engineer before being placed in position. Approved earth, sand, or any other suitable material free from rubbish shall be used to make up levels as shown on the Drawings. The material shall be placed in successive layers each having a finished thickness not exceeding 250 mm before compaction, watered and compacted to at least 98% compaction ratio of the maximum dry density of the Modified Proctor test (ASTM D-1557) prior to the placement of the succeeding layer.

Any exposed side or edge of fill shall be properly and evenly graded to a slope as directed or specified. When the required quantities of approved fill are not found on Site the Contractor shall, at his own expense, obtain them from locations approved by the Engineer.

Filling to make up levels under building shall be executed with approved suitable material from existing ground levels up to underside of ground floor slab, and shall be placed in successive layers each having a finished thickness not exceeding 250mm, compacted to at least 98% compaction ratio of the maximum dry density of the Modified Proctor test (ASTM D-1557) prior to the placement of the succeeding layer.

The ground surrounding the building and pavements shall be filled with approved material, fine sand and coarse materials, free of foreign materials, debris, clay lumps, organic and vegetation.

a) Coarse materials

Such as sandy gravel, gravelly sand, etc., which is the material retained on sieve no. 4, and consists of crushed rock. It shall be clean, hard, tough and free from deleterious substance.
b) **Fine Sand Materials**

Shall consist of that portion of the total aggregate/fines passes no.4 sieve, such as sand, silty sand…etc. The fill materials shall consist of the combination of coarse and fine sand and conform to the following grading:

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>1/2 &quot;</th>
<th>...3/8&quot;</th>
<th># 4</th>
<th>...# 10</th>
<th># 30</th>
<th>...# 60</th>
<th># 200</th>
</tr>
</thead>
<tbody>
<tr>
<td>%</td>
<td>90-100</td>
<td>80-90</td>
<td>58-72</td>
<td>42-50</td>
<td>28-38</td>
<td>8-18</td>
<td>2-5</td>
</tr>
<tr>
<td>Pass</td>
<td>100</td>
<td>90-100</td>
<td>65-85</td>
<td>50-75</td>
<td>30-60</td>
<td>20-40</td>
<td>10-25</td>
</tr>
</tbody>
</table>

The fine sand shall conform to the following grading:

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th># 4</th>
<th># 30</th>
<th># 60</th>
<th># 200</th>
</tr>
</thead>
<tbody>
<tr>
<td>%</td>
<td>100</td>
<td>80-100</td>
<td>30-50</td>
<td>4-8</td>
</tr>
<tr>
<td>Pass</td>
<td>100</td>
<td>90-100</td>
<td>40-90</td>
<td>5-15</td>
</tr>
</tbody>
</table>

In addition, shall conform to the following physical requirements:

- Minimum CBR: 35 %..Coarse materials, Kurkar
- 25 %..Fine sand, Sand

**2.10. Disposal of Surplus Material**

All surplus excavated material not used in backfilling or leveling shall be loaded and transported elsewhere on the Site as required by the Engineer or, if not required on the Site, shall be loaded and carted away from the Site to a dump to be selected by the Contractor and approved by the Municipality at the Contractor's own expense.

All rubbish arising from the Works shall be cleared away and removed from the Site as it accumulates according to the Engineer's instructions and also on completion of the Works.
SECTION 3: CONCRETE WORK

3.1 General

All materials shall be subject to such tests as the Engineer may direct and provision for such tests shall be included in the price for such materials inserted in the Bill of Quantities or Schedule of Rates unless otherwise provided for. In case such tests required by the Engineer, an independent and officially authorized lab shall carry out such tests and sampling.

Properly representative samples of all materials to be used in the works shall be submitted by the Contractor for the Engineer's approval when required.

Where tests are required by the Engineer, the Contractor shall take samples and send to a firm experienced in analysis of the material. Reports shall be submitted to the Engineer. The Contractor shall bear all expenses consequent to the provision, taking and cartage, etc. of samples, in addition to the costs of performing the tests and reporting the results.

The Engineer reserves the right to reject any material which, in his opinion is objectionable in any respect, notwithstanding its apparent compliance with the relevant Standards. Any such rejected material shall be removed from the site at the Contractor's expense at once.

3.2 Formwork for Concrete

The Contractor shall supply, design, erect, strike and remove the formwork and be entirely responsible for its stability and safety so that it will carry the fresh concrete and all incidental loadings and preserve it from damage and distortion during its placing, vibration, ramming, setting and curing. It shall be so constructed as to leave the finished concrete to the dimensions shown on the Drawings and of a material capable of providing the surface finish specified. In any event, the maximum permissible deflection under all loads shall not exceed l/480 of the free span according to ACI.

For any kind of concrete works ready mix concrete should be used.

Formwork shall be of timber and / or metal and shall include all temporary concrete moulds and their supports. Bolts to be used for fixing the formwork shall be approved by the Engineer before starring the work.

For concrete surfaces, which are to remain, exposed wrought formwork shall be used. Wrought formwork shall be of timber or steel framing lined with 12mm thick smooth-faced plywood or an equal lining approved by the Engineer, or of metal, suitable to obtain a fair face finish on the concrete. All external angles or fair faced in-site concrete shall have chamfers formed with 15x15mm (5/8"x5/8") wrought hardwood angle fillets planted in the angles of the formwork, unless larger chamfers are shown on the drawings.

Formwork ready to receive concrete shall be thoroughly clean and the internal faces properly painted with approved shutter oil or other preparation. Joints shall be tight to prevent leakage.

Wherever required and prior to placing of the reinforcement the internal surfaces of all formwork shall be treated with an approved mould oil.

All formwork shall be inspected and approved by the Engineer prior to concreting. This approval, however, does not relieve the Contractor of any of his responsibilities.

The striking of all formwork shall be carried out with the greatest of care to avoid damage to concrete.

The formwork to vertical surfaces such as walls, columns and sides of beams may be removed in accordance with the table below although care must be taken to avoid damage to the concrete, especially to arrases and features.

Minimum periods in days for striking other formwork should be in accordance with the following table, or as directed by the Engineer.
Ordinary Portland Cement Concrete

<table>
<thead>
<tr>
<th>Slabs</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>(props left under)</td>
<td></td>
</tr>
<tr>
<td>Beam soffits</td>
<td>7</td>
</tr>
<tr>
<td>(props left under)</td>
<td></td>
</tr>
<tr>
<td>Props to slabs</td>
<td>7</td>
</tr>
<tr>
<td>Props to beams</td>
<td>16</td>
</tr>
<tr>
<td>Vertical surfaces as walls, columns and sides of beams.</td>
<td>1</td>
</tr>
</tbody>
</table>

Formwork, shuttering, props, or any other means of temporary or semi-permanent support shall not be removed from the concrete until the concrete is sufficiently strong to carry safely the load (dead and temporary).

The Contractor shall inform the Engineer when he is ready to strike the formwork, or remove any form of temporary support, and shall obtain his written consent before proceeding.

The times given for the removal of props are based on the assumption that the total live plus dead weight to be supported at the time of removal is not more than one half of the total design load.

For horizontal members where the loading is to be a higher proportion of the total design load these times may need to be increased.

The Contractor shall be responsible for any damage to the concrete work caused by or arising from the removal and striking of the forms and supports. Any advice, permission or approval by the Engineer relative to the removal and striking of forms and supports shall not relieve the Contractor from this responsibility.

Any work showing signs of damage through premature loading is to be entirely reconstructed at the Contractor's expense.

The Contractor shall confirm positions and details of all
(a) Permanent fixings
(b) Pipes and conduit
(c) Holes and chases
to ensure that alterations are not made without the knowledge and approval of the Engineer.

The Contractor shall fix inserts or box out as required to correct positions before placing concrete, and shall form all holes and chases. He shall not cut hardened concrete without approval.

**Quality Assurance**

Concrete formwork shall be constructed/erected by the Trade Contractor in accordance with ACI 347 and applicable construction safety regulations at the place of work.

**Reference Standards**

ACI-347 Recommended Practice for Concrete Formwork.

**Reinforcement for Concrete**

<table>
<thead>
<tr>
<th>Grade</th>
<th>Minimum Yield Strength</th>
</tr>
</thead>
<tbody>
<tr>
<td>High Yield Steel</td>
<td>414.6MPa</td>
</tr>
<tr>
<td>Mild Steel</td>
<td>278.0MPa</td>
</tr>
</tbody>
</table>

a. Reinforcing Steel: High yield deformed weld able steel bars, BS 4449 and BS 4461.

b. Welded Steel Wire Fabric: Deformed type, BS. 4493; in flat sheets.
QUALITY REQUIREMENTS

a. Steel reinforcement shall be hot rolled high strength high bond, Grade 414, complying with requirements of BS 4449, BS. 4461, and BS 8110, deformed bars.

b. Steel fabric mesh shall comply with BS 4483.

In case any other type of reinforcement is required, it shall comply with the requirements of the Particular Specification.

All reinforcement shall be free from rust and mill scale and any coating such as oil, clay, paint etc which might impair the bond with the concrete.

Manufacturer's test certificates for all classes of reinforcement shall be supplied when required. Specimens sufficient for three tensile tests and three cold-bending tests per ten tons of bars or fraction thereof and for each different size of bar shall be sampled under the supervision of the Engineer. Testing shall be in accordance with BS 4449 or other approved standard and batches shall be rejected if the average results for each batch are not in accordance with the specification. All tests should be made on the Contractor's expense.

All steel is to be totally free from dirt, paint, loose rust or scale when in position ready for concreting.

The Contractor shall cut and bend bars to BS 4466 and to schedule provided unless otherwise instructed by the Engineer.

Lengthening of bars by welding, and rebinding of incorrectly bent bars will not be permitted, except where requested by the Engineer.

All bars will be cut and bent cold using approved machines.

The Contractor shall provide on site facilities for hand bending to deal with minor adjustments.

Unless otherwise allowed for in the particular specification splices in reinforcing bars shall be formed by lapping. Such laps in bars in any member shall be staggered. Except as otherwise indicated on the drawings the minimum overlap of lapped splices shall be 50 bar diameters or 400mm whichever is greater.

The steel is to be fixed in position exactly as indicated; taking in to consideration the seismic requirements and the bars are to be securely wired together with 1.6 or 1.4mm soft iron wire or approved spring steel clips wherever necessary to prevent any displacement during concreting.

Spacers, chairs and the like, temporary or permanent, are to be used as required to ensure that the steel has the exact amount of cover indicated. No permanent spacers may show on a surface where a fair faced concrete finish or a brushed aggregate finish are required. Type of spacers shall be approved by the Engineer before starting the work.

Unless otherwise indicated, the minimum cover to the reinforcing bars is to be as listed below, or equal to the diameter of the bar, whichever is greater.

<table>
<thead>
<tr>
<th>Position</th>
<th>Minimum cover - mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main bars in internal faces of columns and beams</td>
<td>25</td>
</tr>
<tr>
<td>Main bars in external faces of columns and beams</td>
<td>30</td>
</tr>
<tr>
<td>Main bars in floor slabs and soffits of roof slabs</td>
<td>20</td>
</tr>
<tr>
<td>Main bars in top of roof slabs</td>
<td>20</td>
</tr>
<tr>
<td>Outermost bars in internal faces of walls</td>
<td>20</td>
</tr>
<tr>
<td>Outermost bars in external faces of walls</td>
<td>25</td>
</tr>
</tbody>
</table>
Bars in top of ground slabs... 20
Bars near faces in contact with soil 40
The placing of all reinforcement will be checked by the Engineer and in no case is concrete to be poured around any steel that has not been passed by him. The Contractor is to ensure that no steel is displaced from its position during the placement of concrete and until the concrete is set.
The insertion of bars into or removal of bars from concrete already placed will not be permitted. Reinforcement temporarily left projecting from the concrete at the joints shall not be bent without the prior approval of the Engineer.
Secondary reinforced concrete members for which no reinforcement details are given in the drawings or the Particular Specifications shall have a minimum ratio of reinforcement area to concrete area of 0.33 %.

3.3 Concreting

Cement
The cement used shall be Portland cement conforming in all respects to ASTM Standard Specification C150, type 1, or to BS 12, unless otherwise required, bags shall contain 50kg net + 1%.
If cements other than the above are required they shall be covered fully by the Particular Specification.
The Contractor shall at all times furnish the Manufacturer's statement of the above Standard Specifications together with the date of manufacture, certified by an independent agency in the country of origin approved by the Engineer.
The cement shall be delivered to the site by the Contractor in the original sealed and branded bags or containers of the manufacturer in batches not exceeding 100 tons and shall be stored in a proper manner off the ground to prevent deterioration. Each batch shall be stacked separately and used in the order of delivery. No cement shall be used which has been manufactured more than twelve months prior to its proposed use on site.
All cements whether stored in bulk, bags, or containers in warehouses or on site shall be sampled for testing according to ASTM C183 (Methods of Sampling Hydraulic Cements). Test samples over and above those specified shall be taken at any time if so requested by the Engineer. Testing of cement shall be in accordance with the methods required by ASTM C150 and C175 or BS 12 or any other accepted by the Engineer.

Aggregates
This specification covers fine and coarse aggregates other than lightweight aggregates for use in the production of concrete.
When lightweight aggregates are required they shall be defined in the Particular Specification.
The aggregates shall be crushed gravel or stone and shall comply with BS 882 for graded or single size aggregate and shall be obtained from any quarry in the mountains approved by the Engineer. For convenience part of Clause 5 of BS 882 (grading) including Tables 1, 2 and 3 are reproduced herein.
Coarse aggregate: the grading of coarse aggregate, when analyzed by the method given for sieve analysis in BS 812 shall be within the limits given in Table 1.
Fine aggregate: the grading of a fine aggregate, when analyzed by the method of sieve analysis described in BS 812, shall be within the limits of one of the grading zones given in Table 2, except that a total tolerance of up to 5 per cent may be applied to the percentages under-lined. This tolerance may be split up; for example, it could be 1 per cent on each of three sieves and 2 per cent on another, or 4 per cent on one sieve and 1 per cent on another.
The fine aggregate shall be described as fine aggregate of the grading zone into which it falls, e.g. BS 882, Grading Zone 1.
NOTE: It is intended that individual zones should not be specified in contract documents relating to concrete but that the concrete mixes should be modified to make the best use of the materials readily available.
If approved by the Engineer. Single-sized aggregate to BS 882 Table 1 may only be used for reinforced concrete when combined in two or more sizes to provide a well-graded mixture approved by the Engineer.
Sampling and testing of aggregates shall be as required by BS 882 and in accordance with BS 812 'Methods for Sampling and Testing of Mineral Aggregates, Sands and Fillers'. All sampling shall be done by or under the supervision of the Engineer.

The combined percentage of sulphates and chlorides by weight in coarse and fine aggregates shall not exceed 0.05 per cent (500ppm) of the combined weight of total aggregates.

Just before use the aggregate will be washed down with potable water to reduce the content of sulphates, chlorides and other extraneous material.

Table 1: Coarse Aggregate

<table>
<thead>
<tr>
<th>BS 410 Test Sieve</th>
<th>Nominal size of Graded aggregate</th>
<th>Percentage by weight passing BS sieves</th>
</tr>
</thead>
<tbody>
<tr>
<td>mm</td>
<td>400mm to 5mm</td>
<td></td>
</tr>
<tr>
<td></td>
<td>200mm to 5mm</td>
<td></td>
</tr>
<tr>
<td></td>
<td>14mm to 5mm</td>
<td></td>
</tr>
<tr>
<td></td>
<td>63mm</td>
<td></td>
</tr>
<tr>
<td></td>
<td>40mm</td>
<td></td>
</tr>
<tr>
<td></td>
<td>20mm</td>
<td></td>
</tr>
<tr>
<td></td>
<td>14mm</td>
<td></td>
</tr>
<tr>
<td></td>
<td>14mm</td>
<td></td>
</tr>
<tr>
<td>75.0</td>
<td>100</td>
<td>--</td>
</tr>
<tr>
<td>63.0</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>37.5</td>
<td>95-100</td>
<td>100</td>
</tr>
<tr>
<td>20.0</td>
<td>35-70</td>
<td>63-100</td>
</tr>
<tr>
<td>14.0</td>
<td>--</td>
<td>90-100</td>
</tr>
<tr>
<td>10.0</td>
<td>10-40</td>
<td>30-60</td>
</tr>
<tr>
<td>5.0</td>
<td>0-5</td>
<td>0-10</td>
</tr>
<tr>
<td>2.36</td>
<td>--</td>
<td>--</td>
</tr>
</tbody>
</table>

Table 2: Fine Aggregate

<table>
<thead>
<tr>
<th>BS 410.Test Sieve</th>
<th>Percentage by weight passing BS sieves</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Grading..........Zone 1</td>
</tr>
<tr>
<td>mm</td>
<td></td>
</tr>
<tr>
<td>10.00</td>
<td>100</td>
</tr>
<tr>
<td>5.00</td>
<td>90-100</td>
</tr>
<tr>
<td>2.36</td>
<td>60-95</td>
</tr>
<tr>
<td>1.18</td>
<td>30-70</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>microns</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>600</td>
<td>15-34</td>
</tr>
<tr>
<td>300</td>
<td>5-20</td>
</tr>
<tr>
<td>150</td>
<td>0-10</td>
</tr>
</tbody>
</table>

Handling Aggregates

The choice and preparation of sites for stockpiling of aggregates, the number and sizes of stockpiles and the methods adopted to prevent segregation of component sizes shall be agreed with the Engineer.

Coarse aggregate shall be stockpiled in three separate grading: 38-19mm, 19-10mm, and 10-5 mm. When aggregates of different grading are stockpiled close together the stockpiles shall be separated by bulkheads.

Stockpiles are to be on concrete or other hard surface sufficiently sloped so that water is not retained in the base of the stockpiles.
All aggregates are to be handled from the stockpile in such a manner as to secure a typical grading of the material, care being taken to avoid crushing the aggregates and contamination with extraneous matter.

Aggregates need not be stockpiled when a crushing-screening plant is used in tandem with a batching plant properly equipped with several bins for different sized aggregates having the appropriate weighing scales at such bin such that a mix of the desired gradation is obtained consistently and the whole operation is conducted to the satisfaction of the Engineer.

Water

Unless otherwise authorized in writing by the Engineer, only water from potable supply system may be used for mixing concrete and other products containing cement.

Similarly only potable water may be used for curing concrete and cement products during the first 24 hours after pouring. Later, fresh water, or other water containing not more than 4750 ppm dissolved solids of which not more than 1000 ppm may be chlorides, may be used for curing.

No additives of any kind shall be used in the concrete without the express approval in writing of the Engineer.

Quality of Concrete

Concrete shall be a mixture of cement. Aggregates and water as covered respectively by 4.01 to 4.23 above.

Where air-entrainment is required, the method to be used shall be specified in the Particular Specification.

The mix proportions, workability and strengths of the various types of concrete shall conform to Table 4.

The terms contained in Table 4 are defined as follows: WATER/CEMENT RATIO: the term water/cement ratio means the ratio by weight of the water to the cement in the mix, expressed as a decimal fraction. The water is that which is free to combine with the cement in the mix. This includes free water in the aggregate but excludes water absorbed or to be absorbed by the aggregate. The aggregate for this purpose shall be taken in a saturated surface-dry condition.

The absorption of the aggregates shall be determined in accordance with Section 4 of BS 812 or any other method approved by the Engineer.

The strengths specified are for ordinary Portland cement to BS 12 or Type 1 Cement to ASTM C150; if other types of cement are specified, the required strength shall be defined in the Particular Specification.
Table 3: Mix Proportions, Workability and Strength
Grades of Concrete

<table>
<thead>
<tr>
<th>Grade</th>
<th>Minimum Works cube Strength,.kg/cm²</th>
<th>Max. Agg, mm</th>
<th>Limits of agg./Cement ration by weight</th>
<th>Use of concrete if not otherwise specified</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>At 7 days</td>
<td>At 28 days</td>
<td>Max.</td>
<td>Min.</td>
</tr>
<tr>
<td>(A)</td>
<td>150</td>
<td>200</td>
<td>20</td>
<td>7:1</td>
</tr>
<tr>
<td>C-200</td>
<td></td>
<td></td>
<td></td>
<td>5:1 RC structures in general</td>
</tr>
<tr>
<td>(B)</td>
<td>175</td>
<td>250</td>
<td>20</td>
<td>5.5:1</td>
</tr>
<tr>
<td>C-250</td>
<td></td>
<td></td>
<td></td>
<td>4:1 High load columns</td>
</tr>
<tr>
<td>(C)</td>
<td>200</td>
<td>300</td>
<td>20</td>
<td>5:1</td>
</tr>
<tr>
<td>C-300</td>
<td></td>
<td></td>
<td></td>
<td>3:1 High load foundations</td>
</tr>
<tr>
<td>(D)</td>
<td>100</td>
<td>150</td>
<td>20</td>
<td>10:1</td>
</tr>
<tr>
<td>C-150</td>
<td></td>
<td></td>
<td></td>
<td>8:1 Blinding layer under RC Found.</td>
</tr>
<tr>
<td>(E)</td>
<td>75</td>
<td>100</td>
<td>20</td>
<td>14:1</td>
</tr>
<tr>
<td>C-100</td>
<td></td>
<td></td>
<td></td>
<td>12:1 Mass lean</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Concrete filling</td>
</tr>
</tbody>
</table>

Table 4: Mix Proportions, Workability and Strength Standard Mixes

<table>
<thead>
<tr>
<th>Grade of Concrete</th>
<th>Minimum works Cube Strength Kg/cm²</th>
<th>Weight of dry sand per 50 kg of cement</th>
<th>Weight of dry sand per 50 k of cement</th>
<th>Workability</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>7 days</td>
<td>28 days</td>
<td>Low</td>
<td>Med.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>20mm max. size</td>
<td>37mm max. size</td>
</tr>
<tr>
<td></td>
<td>kg</td>
<td>kg</td>
<td>kg</td>
<td>kg</td>
</tr>
<tr>
<td>C-200</td>
<td>150</td>
<td>200</td>
<td>91</td>
<td>193</td>
</tr>
<tr>
<td>C-250</td>
<td>175</td>
<td>250</td>
<td>80</td>
<td>170</td>
</tr>
<tr>
<td>C-300</td>
<td>200</td>
<td>300</td>
<td>68</td>
<td>147</td>
</tr>
</tbody>
</table>

Table 5: Mix Proportions, Workability and Strength Workability

<table>
<thead>
<tr>
<th>Degree of Workability</th>
<th>20 mm Max. size aggregate</th>
<th>37 mm Max. size aggregate</th>
<th>Use for which Concrete is suitable</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Slump mm</td>
<td>Compacting Factor</td>
<td>Slump mm</td>
</tr>
<tr>
<td>Low</td>
<td>13-25</td>
<td>0.82-0.88</td>
<td>13-50</td>
</tr>
<tr>
<td>Medium</td>
<td>25-50</td>
<td>0.88-0.94</td>
<td>50-101</td>
</tr>
<tr>
<td>High</td>
<td>50-127</td>
<td>0.94-0.97</td>
<td>101-117</td>
</tr>
</tbody>
</table>

In case cylinders are used for determination of concrete compressive strength in accordance with ASTM C 39, the corresponding cube strength shall be obtained by using a multiplication factor of 1.2.
AGGREGATE/CEMENT RATIO: the term aggregate/cement ratio means the ratio by weight of aggregate to cement in the mix. For this purpose, the aggregate is taken in a saturated surface-dry condition as for the water/cement ratio above.

FINE/TOTAL AGGREGATE RATIO: the term fine/total aggregate ratio means the ratio by weight of the fine aggregate to the total aggregate in the mix expressed as a percentage. For this purpose, the aggregate is also taken in a saturated surface-dry condition as for the water/cement ratio above.

VOLUME OF AIR ENTRAINED: the air content expressed as a percentage by volume of concrete shall be determined by ASTM C231, 'Air Content of Freshly Mixed Concrete by the Pressure Method'. At least one test for each 120 cubic meters of concrete shall be made.

SLUMP: the slump of the freshly mixed concrete shall be determined in accordance with Part 2 of BS 1881 or ASTM C143. At least one morning and one afternoon test shall be made and whenever directed by the Engineer.

STRENGTH OF CONCRETE: Preliminary Test Cubes shall be taken from the trial mixes designed to select the job mix and shall be made and tested in accordance with Parts 3 and 4 of BS 1881.

SAMPLING FOR COMPLIANCE TESTING: Works Test Cubes shall be those used for control during construction and shall be made and tested in accordance with BS 5328 PART 4:1990.

### Recommended Minimum Rates Sampling

<table>
<thead>
<tr>
<th>Average Rate o Sampling One Sample (6 cubes) per</th>
<th>Maximum quantity of concrete at risk under any one decision</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 m³ or .10 batches</td>
<td>40 m³</td>
</tr>
<tr>
<td>20 m³ or .20 batches</td>
<td>80 m³</td>
</tr>
<tr>
<td>50 m³ or .50 batches</td>
<td>200 m³</td>
</tr>
</tbody>
</table>

The Contractor when tendering having knowledge of the source and types of cement, aggregate, plant and method of placing he intends to use shall allow for the aggregate/cement ratio and water/cement ratio which he considers will achieve the strength requirements specified and will produce a workability which will enable the concrete to be properly compacted to its full depth and finished to the dimensions and within the tolerances shown on the Drawings and required by the Particular Specification. In any event the aggregate/cement ratio and the water/cement ratio shall not exceed the upper limits specified in Table 4 for each type of concrete. Furthermore, the quantity of cement per cubic meter of concrete shall in no case be less than the minimum specified in Table 4.

As soon as possible after signature of the Contract, the Contractor shall prepare such trial mixes as required to satisfy the Engineer that the specified concrete strengths will be obtained using the materials and mix proportions in accordance with the above clauses. The proportion of cement shall be increased if necessary to obtain the strengths required.

From each trial mix, six Preliminary Test Cubes shall be made and tested at 7 days and four at 28 days, the test at 7 days being intended to give and early indication of possible variation from the required strength. If the difference between the highest and lowest test results from any one trial mix is more than 15 per cent of the average of the strength test results, the test is to be discarded and a further trial mix made, unless all test results so obtained are above the required strength. Separate trial mixes are required for each type of concrete. The trial mix or mixes agreed by the Engineer shall be designated job mixes and used as a basis for actual concrete production.

### Batching and Mixing of Concrete

All concrete shall be matched by weight and mixed mechanically.

Concrete may either be batched and mixed on site or outside the site and transported thereto.

When mixed outside the site and transported to it, batching and mixing shall be in accordance with ASTM Specification C94, 'Standard Specification for Ready-Mixed Concrete'.
When mixed on site, batching and mixing shall be as follows:

**BATCHING BY WEIGHT:** The cement and each size of aggregate shall be measured by weight. The water may be measured by weight or volume. The weight-batching machines used shall be of a type approved by the Engineer and shall be kept in good condition while in use on the Works. Checks are to be made as required by the Engineer to determine that the weighing devices are registering correctly.

**BATCHING AGGREGATE BY VOLUME:** When batching aggregates by volume is allowed as and when required, the cement shall be batched by weight and the water by weight or volume. Each size of aggregate shall be measured in metallic containers the depth of which is at least equal to their greatest width. The containers shall be of such shape that their volume can be easily checked by measurement.

**MIXING CONCRETE:** the location of the batching and mixing plant shall be agreed with the Engineer. The amount of concrete mixed in any one batch is not to exceed the rated capacity of the mixer. The whole of the batch is to be removed before materials for a fresh batch enter the drum.

On cessation of work, including all stoppages exceeding 20 minutes, the mixers and all handling plant shall be washed with clean mixing water. If old concrete deposits remain in the mixer drum, they shall be rotated with clean aggregate and water prior to production of new concrete.

Concrete mixed as above is not to be modified by the addition of water or in any other manner to facilitate handling or for any other reason.

**Work In Cold or Hot Weather**

Concrete is not to be mixed or placed at a shade air temperature below 2 deg. C on a rising thermometer or at a shade air temperature below 3 deg. C on a falling thermometer.

When the shade air temperature is 37 deg. C and rising, special precautions shall be taken during concreting operations, such as shading of the aggregates and plant, cooling of the mixing water or other methods approved by the Engineer, so that the temperatures of the concrete when placed shall not be in excess of 39 deg. C.

Fresh concrete placed at these temperatures shall be shaded from the direct rays of the sun to the satisfaction of the Engineer for a period of at least 24 hours.

**Placing**

Concrete shall be conveyed from the mixer to its final position in any suitable manner, provided there is no segregation, loss of ingredients or contamination.

It shall be placed in its final position before initial setting takes place and within 20 minutes of the addition of the water to the mixer without using any additives. Water is not aloud, only by the instructions of the Engineer in the manufacturer specifications of such additives must be handed over to the Engineer to be approved before using it.

The order of placing concrete shall be such as to prevent water from collecting at the ends, corners and along the faces of forms. It shall not be placed in large quantities at a given point and allowed to run or be worked over a long distance in the form.

Whenever possible concrete shall be placed and compacted in even layers with each batch adjoining the previous one.

The thickness of the layers shall be between 150 and 300mm for reinforced concrete and up to 450mm for plain (non-reinforced) concrete, the thickness depending on the width of forms, the amount of reinforcement and the need to place each layer before the previous one stiffens.

Concrete shall not be allowed to drop freely for more than 2 meters. To convey the concrete as near as possible to its final position, drop chutes of rubber or metal shall be used for small sections and bottom dump buckets or other suitable vessels for large sections.

Concrete shall be carefully compacted when placed to ensure a dense and uniform mass free from air holes and cavities. Concrete type "A", "B" & "C" shall be compacted by vibration, whereas type 'D' and 'E' concrete may be vibrated or rammed, tamped and rodded. Vibration shall be performed by mechanical
or electro-mechanical vibrators. The vibrators shall be of the plunger (poker) type for insertion in the concrete: except that plate type vibrators (external) shall be used if requested by the Engineer.

The plunger (poker) type vibrators shall have a diameter compatible with the lowest spacing of reinforcement, a sufficiently high frequency and be properly handled by experienced personnel.

They shall be immersed at regular intervals close enough to vibrate all of the concrete, but not too close to affect previously vibrated and partially set concrete.

Each immersion shall continue until shortly after air bubbles cease to appear on the surface of the concrete, but shall not last more than 30 seconds. The vibrators shall be withdrawn gradually and vertically to ensure that no air pockets are formed.

When external vibrators are used as directed by the Engineer, they shall be clamped to the forms whenever possible to avoid large impact during handling, and the forms shall be so constructed as to withstand the additional vibrations.

All vibrations, compaction and finishing operations shall be completed within 15 minutes from the time of placing the concrete in its final position. Until it has hardened sufficiently to carry weight without distortion, workers shall not be allowed to walk over freshly placed concrete.

Concrete shall be cured for at least seven days and as required by the Engineer. Curing shall be effected by the direct application of water to the surface of the concrete or by other approved curing methods or curing compounds applied in accordance with the manufacturer's specifications. In case the application of such curing compounds is delayed for any reason, the concrete shall be kept moist until the application is made.

Timber formwork covering the concrete shall be moistened with water at frequent intervals to keep it from drying during the curing period. Metal formwork exposed to the sun must be shaded from its direct rays, painted white or otherwise protected during the curing period.
3.4.  **Formed Finishes**

1. **Basic Finish**

   **General requirements:**
   
   (a) Produce an even finish with a sheet material.
   
   (b) Arrange panels in a regular pattern.
   
   (c) Blowholes not more than about 10mm in diameter will be permitted but otherwise surface is to be free from voids, honeycombing and other large defects.
   
   (d) Variation in colour resulting from the use of an impervious form lining will be permitted, but the surface is to be free from discoloration due to contamination or grout leakage.

   The finish will be left as struck, making good or small defects will normally be permitted but only after inspection by the Engineer. All blowholes shall be filled with a matching mortar to an approved sample unless otherwise instructed by the Engineer. All faces shall be protected from damage, especially arrisses.

   All faces shall be protected from rust marks and other surface disfigurements. Form tie holes shall be filled with a matching mortar to an approved sample accepted by the Engineer.

2. **Fair Faced Finish:**

   Concrete surface which are described as fair face finished shall be finished free from honeycombing and excessive air holes, fines and projections arising from defective mixing, placing of formwork, and shall, if necessary, be filled with mortar and rubbed with fine carborundum stone all works to be approved of engineer. The finish shall be integral with the body of the concrete and shall not be obtained by means of an applied rendering.

   The quality of the surface of concrete exposed to view shall be smooth and consistent throughout the project and the following methods shall be adopted to obtain the required fancy. The trade Contractor may submit alternative proposals for the approval of the Design Professional if he so desires.

   Formwork for fair faced concrete shall be provide with regular joints to achieved the satisfaction on the job finished, be either of steel, fibrous glass reinforced plastic or exterior grade plywood not less than 16mm before placing, pouring the concrete.

   All surplus oil on form surface and any oil on reinforcing steel shall be removed.

**Approval by the Design Professional to Fair Faced Finishes.**

1. Trade Contractor shall submit for approval of the Design Professional a sample panel not less than 60cm x 120cm to demonstrate the quality of the exposed concrete to be produced by forms, at his own expense.

2. The quality of the finished work shall be measured against the quality of the approved sample panel and the work of inferior quality shall be repaired or replaced as directed by the Design Professional without any additional cost.

3. The quality of the finished surfaces shall be of uniform color and consistency throughout the project. Should there be any inconsistency in color or texture in any of the finished surfaces the Design Professional may order the repair or the demolition of a portion of concrete work and its reconstruction at the Trade Contractor’s own expense.

4. Construction Joints, in special cases of weather conditions and if approved by the Design Professional shall be studied in detail ahead of time and the joints shall be grooved in a predetermined pattern approved by the Design Professional.

**General Requirements:**

a) Produce a smooth even finish with an impervious sheet metal.

b) Make panels as large as is practicable and arrange to approval.

c) Blowhole not more than about 5mm in diameter will be permitted but otherwise surface is to be free from voids, honey combing and other defects.

d) Variation in color resulting from the use of an impervious form lining will be permitted, but the surface is to be free from discoloration due to contamination or grout leakage.
e) Concrete cover spacers shall be used only if approved.
f) Sample on site has to be provided of 1 by 2m.

The finish is to be left as struck. Making good will not normally be permitted. All form tie holes are to be filled with a matching mortar to an approved sample. Wire form ties shall not be used. With Approval and instruction of the Engineer.

**Quality Control Testing Etc.**

Prior to commencing the work the contractor shall make available on site the following minimum approved equipment kept in good condition at all times:
- Six Cube moulds.
- Slump cones.
- Thermometer.
- Any other accessories as required by the Engineer.

All samples and testing shall be done in the presence of the Engineer or his authorized representative either on site or in an approved testing laboratory in the area.

The frequency of testing shall be as noted in the clauses of this section and whenever required by the Engineer.

The works Test Cubes shall be made as follows for types of concrete (A), (B), and (C):
- (a) At least three times weekly per mixing plant.
- (b) At least once for three individual parts of the structure.
- (c) At least once per 100 cubic meters of Concrete or fraction thereof.

For types (D), and (E) concrete the rate shall be once per each 100 cubic meters or fraction thereof.

At least six cubes shall be made at one time. Two of the six cubes are to be tested at seven (7) days. The remaining four cubes are to be tested at 28 days, and their average strength must not fall below the minimum strength specified for each type of concrete and the lowest test result shall not be more than 20% below the average of the four cubes.

When the result of 7-day test is unsatisfactory, the Contractor may elect to remove and replace the defective concrete without waiting for the 28-day test. If the result of the 28-day test is unsatisfactory all concreting shall be stopped at the Contractors expense and shall not proceed further without the written permission of the Engineer.

The Contractor shall then, in accordance with the instructions of the Engineer, remove cores and test same or conduct in-situ tests in accordance with CP 144 from or on suspect portions of the works, under the supervision of the Engineer.

Concrete judged by the Engineer to be defective shall be forthwith cut out, removed and replaced at the Contractors own expense.

In the event of strengths consistently higher than those specified being obtained, a reduction in the number of tests may be authorized by the Engineer.

**Position of Reinforcement**

The actual concrete cover to all steel at any point should not be smaller than the required nominal cover by more than 5mm.

The effective depth of fully or nearly fully stressed tensile reinforcement should not be less than that given on the drawings by an amount exceeding 5 percent of the effective depth of the section being considered or 5mm whichever is the greater.

**Ready mixed concrete**

Ready - mixed concrete as defined in BS 1926, batched off the site will be used with agreement of the Engineer and shall comply with all requirements of the Contract. The quality and strength of cements shall be determined by site tests. No test results supplied by Ready-Mix Supplier shall be accepted as proof of the quality and strength of the concrete.
The concrete shall be carried in purpose made agitators operating continuously, or in truck mixers. The concrete shall be compacted and in its final position within 1 hour of the introduction of cement to the aggregate or as agreed by the Engineer. The time of such introduction shall be recorded on the Delivery Note together with the weight of the constituents of each mix.

When truck mixed concrete is used, water shall be added under supervision either at the site or at the central batching plant as agreed by the Engineer but in no circumstances shall water be added in transit.

Unless otherwise agreed by the Engineer truck mixer units and their mixing and discharge performance shall comply with the requirements of BS 4251. Mixing shall continue for the number and at the rate of revolutions recommended in accordance with BS 4251 or, in the absence of the manufacturer's instructions, mixing shall continue for not less than 100 revolutions at a rate of not less than 7 revolutions per minute.

Prior to any ready mixed concrete being ordered, the Contractor shall submit to the Engineer details of the supplier and shall arrange for the Engineer to inspect the supplier's works if required.

Truck-mixer units shall be maintained and operated strictly in accordance with the manufacturer's recommendations.
SECTION 4: NATURAL STONE WORKS

4.1. GENERAL

The stone materials shall be class A according to the Jordanian Technical specifications and shall be local manufactured and to obtain the following Physical and mechanical properties:

1. Absorption
The percentage of absorption shall not exceed 3 % according to ASTM – C97.

2. Specific Gravity.
Minimum specific Gravity of stone shall be 2.56 according to ASTM- C97.

3. Modulus of Rupture
Shall not be less than 6.9 N/mm2 according to ASTM-C99.

4. Abrasion Resistance
For all stone types shall not be less than 10% according to ASTM- C241.

Anchors: Two of each type to be incorporated in the work.
Submit samples of other materials specified herein upon request by the Engineer.

Samples:
Submit two sets of stone, full size units as selected by the engineer to the project site, in sufficient number to indicate the full range of color, texture and finish. One of each of the duplicate samples approved by the engineer will be retained by him at the project site, the other being returned to the stone supplier for his guidance. Color and type of the stone dressing are as mentioned above.

1. The following physical data on proposed stone shall be submitted by the supplier:
2. Analysis of mineral composition
3. Analysis of chemical composition.
4. Thermal sufficient of expansion.
5. Absorption.
7. Modulus of Rupture
8. Abrasion Resistance.
9. Samples of other materials specified here in shall be submitted upon request by the engineer.

References
National Standards referenced her in are included establishing recognized quality only. Equivalent quality and testing standards will be acceptable subject to their timely submission, review and acceptance by the engineer.

4.2. MOCK UP

1. Furnish and install a typical stone wall, application required for the project at area designated by the Engineer. The panel shall be constructed for Engineer's approval showing 2.0m long x 1.5m high for wall installation. Wall installation shall include a corner condition indicating a jamb, sill, lintel and coping stones, etc., as shall be instructed by the Supervising Engineer.

2. All work shall include setting and jointing of all stone including final cleaning as specified here in for the actual work and as required for approval Construct as many mock-ups until approval by the Engineer has obtained.

3. The approved mock-up shall constitute the quality of work to be expected throughout the entire project, and shall remain in place for visual inspection until no longer needed as directed by the Engineer. The removal and disposition of the mock-ups shall be done by the Contractor at his expense without additional cost to the owner.
GUARANTEE / WARRANTY
Attention is directed to the provisions of the CONDITIONS OF THE CONTRACT regarding guarantees / warranties for the Work.
All warranties / guarantees to be issued by the Supplier, Manufacturers and sub-contractors shall be counter-signed by Main Contractor and both of them will be liable for repair / replace the items / works, etc., during the warrantee / guarantee period.

Standards : applicable provisions of the following standard publications shall apply throughout the work :
- Jordanian General Specifications.
- Jordanian Technical Specifications.
- Bs 882 Aggregate for Mortar.
- Bs 12 – Portland cement.

REFERENCES
National standards referenced herein are included to establish recognized quality only. Equivalent quality and testing standards will be acceptable subject to their timely submission, review and acceptance by the Engineer.

QUALIFICATIONS
A. Supplier / Fabricator: A firm having an adequate supply of the specified type of stone and an annual rated production capacity to deliver the stone to the project site on schedule within a time limit established by the Engineer, as required, to assure no delay in the progress and completion of the Work.
B. Installer: A qualified stone layer with a minimum of five years successful experience in the erection of stonework.

DESIGN CRITERIA
A. The method of erecting, installing and anchoring of all atone work shown on the Drawings is diagrammatic only, and is not to be used for the purpose of bidding or construction. It shall be the responsibility of the contractor to design and guarantee the mechanical fixation of the stone to the concrete structure, the permanent anchorage, and the watertight sealing of all stone work. The installation shall be designed to allow for expansion, contraction and differential deflection of supporting floors of the building structure. All fastenings into stone, such as plates, bolts, anchors, shelf angles, inserts, etc. are to be galvanized steel.
B. Design and calculations for stone anchor system shall be based on a minimum safety factor of five for aspects related to stone strength and anchor strength in masonry or concrete.
C. Allowable stresses in stainless steel anchor elements shall not exceed the following:
   1. Tension, bending 0.6 Fy
   2. Shear.... 0.4 Fy
D. Anchor stone elements to withstand a total temperature variation of 125 degrees F.

DELIVERY, STORAGE & HANDLING
1. Packing and Loading: Finished stone shall be carefully packed and loaded for shipment using all reasonable and customary precautions against damage in transit no material which may cause staining or discoloration shall be used for blocking or packing.
2. Site Storage: Upon receipt at the building site or storage yard, the stone shall be stacked on timber or platforms at least 100mm above the ground, and extreme care shall be taken to prevent staining during storage. If storage is to be for a prolonged period, polyethylene or other suitable plastic film shall be placed between any wood and finished surfaces, and shall be used also as an overall protective covering.
3. Defective Stone: Any piece of stone showing flaws, cracks, or imperfections such as vents, sand and clay holes, shelly bars, shakes, mottle, seams or starts upon receipt at the storage yard, or at the building site, shall be discarded and removed from the work site, at the contractor's own expense.
ENVIRONMENTAL REQUIREMENTS
The following environmental requirements are applicable to stone set in mortar, and when caulking stone joints with sealant:

1. During freezing or near freezing weather provide equipment and cover to maintain a minimum of 4 degrees C and to protect stone work completed or in progress.
2. At end of working day, or during rainy weather, cover stone work exposed to weather with waterproof coverings, securely anchored.
3. Maintain materials and surrounding air to a minimum 10 degrees C prior to, during and 48 hours after completion of work.

4.3. PRODUCTS

STONE MATERIALS AND FABRICATION

General
1. Stone shall be of good quality, sound, free from cracks and defects, seams or starts which may impair its structural integrity, durability, appearance or function. Colour, texture and finish shall be within the range of samples approved by the Engineer.
2. All stone shall be obtained from quarries having adequate capacity and facility to meet the specified requirements. Cutting and finishing shall be performed by using approved equipment to process the material promptly on order and in strict accordance with the specifications. Evidence to this effect shall be provided by the contractor's.
3. Stone rejected for noncompliance with the submitted samples or the requirements of this specification shall be replaced with material acceptable to the Engineer. Replacement shall be prompt and at the Contractor's own expense. Inspection of stone by the Engineer shall not relieve the contractor of his responsibilities to perform all work in accordance with the Documents.

STONE SCHEDULE
Refer to the Drawings for locations, sizes and herein. All stone work shall be carried out and executed in accordance with the classifications of class " Special refer to clause 1.06, item A/1.

Stone Type Application/ Thickness / Finish

Application: Exterior and Interior – Special Shapes include, but not limited to:
- Rebated and Splayed sills-Splayed copings with rounded edges – Splayed and mitered copings.
- Corner stones – Quoins
- Splayed coping quoins
- Other, all as shown and / or noted in the drawings and in the Book of Details (Jordanian Code)

Thickness: As noted on the relevant details / drawings.

Finish: Mosamsam, Mattabeh and Tubza dressing, as noted on the drawings and details.

Stone Finish
The finish of stone shall be according to the drawings that show size, and thickness. All stone work shall be carried out and executed in accordance with the classification of class (A) according to the Jordanian Specifications.
Matabeh finish # 12 will be used for WHITE ASEERA stone and applied as follows:
- Thickness 50mm thick.
- Height of courses As shown in drawings.
- Finish Matabeh dressing without Zamleh.
- Backing 150mm reinforced concrete.

STONE FABRICATION – GENERAL:
1. Fabrication of stone shall be in strict accordance with approved shop drawings for fabrication, and with this specification.
2. To the maximum extent possible, fabrication and assembly of stone shall be executed in the shop. Work that is not shop assembled shall be shop fitted.
3. All work shall be of the highest quality, in accordance with the best trade practices, and performed by skilled workmen. All materials and workmanship shall conform to the highest industry standards.
4. Use no materials, equipment, or practices that may adversely affect the functioning, appearance, or durability of the stone work or work trades.

DIMENSIONS
1. Cut all stone work accurately to shape and dimensions shown on the final approved shop drawings. Exposed plans surfaces shall be true. Bed and joint surfaces shall be dressed straight and at right angles to the faces, unless otherwise shown. Exposed arise lines shall be sharp and true. Patching of stone will not be permitted.
2. Do all necessary cutting for anchors, support plates, shelf angles, and dowels, etc.

BEDS AND JOINTS
Stone beds and joints surfaces shall be cut square from the face for the entire thickness of stones. Stone shall be bedded and jointed including the various expansion joints dimensions as shown on the approved shop drawings.

BACKS OF PIECES
Backs of all pieces of stone receiving no concrete backing shall be sawn to approximately true planes with a maximum variation of 1.5mm in thickness from that indicated on the approved shop drawings.

EXTERIOR & INTERIOR SPECIAL SHAPES
All specially shaped pieces of stones shall be constant in profile throughout their length, in strict conformity with details shown on approved shop drawings.

INCIDENTAL CUTTING & DRILLING
1. Provide holes, grooves, sinkages and recesses, etc., as applicable, for anchors, plates, bolts, shelf anchor supports, inserts, etc., other cutting and drilling shall be provided only when specifically shown on the approved shop drawings.
2. Holes for lifting will not be permitted on any stone element with a thickness of 51mm or less.
3. No cutting or drilling will not be permitted on exposed surfaces

4.4. MORTAR MATERIALS AND ACCESSORIES

Cement
1. Cement for Setting Mortar: Non – Staining Portland Cement conforming to ASTM C150, Type I except containing not more 0.03% water soluble alkali. Turkish cement will not be permitted.

Grey nonfattening cement may be used for pointing mortar if the colour of pointing mortar, as selected by the Supervising Engineer, does not require white Portland Cement.
Water
Water shall be potable, clean and fresh from public water system.

Sand
Well graded non-staining masonry sand conforming to ASTM C1 44. Use white Silica sand pointing mortar. No other Sand shall be permitted for mortar or grout unless otherwise tested and approved by the Engineer.

Lime
Approved brand of plastic hydrated, such as New England 4x, conforming to ASTM C207, Type "S"

Integral Waterproofing
Integral liquid waterproofed for concrete and mortar, manufactured by an approved manufacturer and conforming to ASTM C494.

Integral Color
Super permanent, manufactured by an approved manufacturer and conforming to BS 1014.

Mortar Plasticizer
As manufactured by an approved manufacturer and conforming to BS 4887.

4.5. STONE ANCHORAGE – MATERIALS

General
All stone anchorage in contact with stone shall be fabricated from approved galvanized steel.

Gravity anchors
Wherever possible and appropriate stone shall be supported by gravity anchors. The Type, location, and number of gravity anchors shall be determined by calculations, recommended practices of the BST.

Lateral Anchors
The type, location and number of lateral anchors shall be determined by calculations, applicable codes, and recommended practices of the BSI.

Dovetail Anchor Slots
Fabricate from not less than 6 ga. Galvanized steel. Provide dovetail anchor slots with filler strips

Anchorage Tolerances
Stone anchors shall be sufficiently adjustable to overcome expected variations in the building frame and in the stone itself, and in both in combination.

4.6. EXECUTION

Conditions at Site
1. The Contractor shall, prior to proceeding with the stone installation, examine all surfaces and parts of the structure to receive stone work, and notify the supervising Engineer in writing of any conditions detrimental to the proper and timely completion of the work. Do not proceed with installation until such conditions have been corrected and are acceptable to the Engineer.
2. Verify all measurements and dimensions coordinate the installation of inserts for this work and coordinate and schedule this work with the work of other trades. Give particular attention to the location and size of cutouts required to accommodate mechanical, electrical, and other work or adjoining construction, in accordance with the reviewed shop drawings for such trade.
Stone Installation:

1. **Anchors, Brackets and Angles:** Securely fix in place all supporting anchors, inserts, brackets, angles and other items requiring building into concrete, provide location drawings in sufficient time so as not to delay job progress.

2. **Preparation for stone Installation:** Clean stone prior to setting, leaving edges and surface free from dirt and foreign materials. Do not use wire brushes or implements which mark or damage exposed surfaces, unless otherwise approved by the Engineer.

**Mortar And Grout Proportioning – By Volume**

1. **General**
   Mortar and grout proportioning shall be prepared and tested by the contractor, and in addition the contractor shall allow for preparing and testing the mortar and grout mixes included within this section to meet the Engineer's satisfaction and approval.

2. **Setting Mortar for Stone**
   1. Portland Cement: 1 part
   2. Hydrated lime: 0.0-0.25 part
   3. Sand: 3 parts
   4. Plasticizer
   5. Integral water proofer

3. **Pointing Mortar:**
   1. White Portland cement: 1 part
   2. Sand: 1-1/2 parts
   3. Add color additive to acquire the color of mortar approved by the supervising Engineer.
   4. Add water proofer

   Add integral waterproofing admixture to setting and pointing mortar in the quantity and manner recommended by the manufacturer.

   Generally, only approved mortar plasticizer shall be used in all mortars, unless otherwise instructed by the Supervising Engineer.

4. **Wall Grout**
   Fine grout shall be mixed in the following proportions by volume all in accordance with ASTM C476:
   1. Portland Cement: 1 part
   2. Hydrated Lime: 0.1 part
   3. Sand: 2.25-3 parts

   Coarse grout, where required, shall be mixed in the following proportions by volume, all in accordance with ASTM C479:

   \[ \begin{align*}
   a & : & \text{Portland Cement} & - & 1 \text{ part} \\
   b & : & \text{Hydrated Lime} & - & 0.1 \text{ part} \\
   c & : & \text{Fine Aggregate} & - & 2.25 \text{ parts} \\
   d & : & \text{Coarse Aggregate} & - & 1-2 \text{ parts}
   \end{align*} \]

   Use sufficient water to produce a fluid, pourable consistency.

**Mortar and Grout Mixing**

1. Mortar and grout shall be machine mixed. Cement and hydrated lime may be batched by the bag. Sand preferably shall be batched by weight, but subject to the approval of the Supervising Engineer may on certain small operations be batched by volume in suitably calibrated containers, provided proper allowance is made for weight per cubic foot, contained moisture, bulking and consolidation, shovel measurement shall not be used.

2. Workability or consistency of mortar on the board shall be sufficiently wet to be worked under the trowel. Water for tempering shall be available on the scaffold at all times. Mortar and grout which has
begun to "set" shall be discarded. Mortar and grout which has stiffened due to evaporation shall be re-tempered to restore its workability. Tempering of mortar and grout at the mixer shall not be permitted.

4. Setting of Exterior and Interior Wall Stone

1. All setting shall be done in accordance with the approved shop drawings. All work shall set in a rigid and substantial manner, straight and plumb, with all horizontal lines level and all vertical lines plumb, unless otherwise shown on the Drawings. Similar abutting profiles shall accurately intersect and be in true alignment. All joints shall be uniform and shall be of the size and detail shown on the approved Shop Drawings.

2. Except as otherwise indicated and as herein specified. All anchoring devices shall be accurately set and adjusted. Holes and slots for anchoring devices shall be filled completely with mortar. Each stone shall be anchored securely in place. Joints noted to receive sealant shall be left void. If such joints cannot be sealed shortly after erection, they shall be taped or otherwise temporarily sealed in a manner as approved by the Engineer.

3. All exterior stone joints shall be 5mm wide unless otherwise indicated.

4. As setting stone joints, the work shall be fastened securely to take care of dead loads, wind loads and forces, and erection stresses. All units of stones shall have suitable temporary braces, shores, and stays to hold them in position until permanently secured. All bolts and nuts shall be drawn tight and the bolt threads shall be nicked to prevent the nuts from backing off.

5. All welding, where required, shall be done in accordance with the requirements of the Engineer, the current edition of the "Standard Code for Arc and Gas Welding in Building Construction" of the American Welding Society (AWS Code).

6. The definitions of all terms herein related to welds, welding, and oxygen cutting shall be interpreted in accordance with the "Standard Definitions, Welding, and Cutting", of the current edition of the American Society.

7. Cavities behind facing stones shall be filled with fine and/or course grout, as specifically shown on the approved shop drawings and as specified herein.

8. Stone elements indicated to be set with mortar joints shall be set with two cushions per stone in every horizontal joint. Stone shall be set in full horizontal mortar beds and joints raked out to a depth of 19 mm before mortar has set. The face surfaces shall not be smeared with the mortar forced out of joints or that used in pointing. No hammering, rolling or turning of stones will be allowed on the wall. Precautions shall be taken to prevent seepage of moisture, through or from the exposed surfaces.

9. Build in anchors and supports all as shown on the approved shop Drawings.

10. Allow stone units to set overnight and then completely fill joints with pointing mortar. Joints shall be toolled flush. During the tooling of the joints, enlarge any voids or holes and completely fill with mortar. Surfaces of stone shall be cleaned using sponge and water to remove mortar spills from face of stone.

11. The setting of patched, chipped, cracked, broken, stained or defective stones shall not be permitted.

Protection

Stone shall at all times be protected from drippings, welding spatter and damage by other trades during construction. Where necessary or directed, substantial non-staining wooden or other approved covering shall be placed to protect the work. Heavy polyethylene film shall be used between stone and wood. Maintain all protection until remit final cleaning of stone work.

Cleaning

Clean soiled surfaces using non-acidic solution of type, which will not harm stone, mortar joint materials, or adjacent surfaces. A non-metallic tools shall be used in cleaning operations
Final Inspection

Finished surfaces shall show no objectionable visual distinction in jointing, bedding, plane, colour, texture, pattern, and finish. All stones which in the opinion of the Engineer do not provide the required uniformity shall be relocated, or removed and replaced with new stone units to the satisfaction of the Engineer and at the contractor's own expense.

All defective stones shall be replaced with new stones units, except that minor damages may be repaired when approved by the Engineer. Repairs, when approved, shall be completed to the satisfaction of the Engineer. When the repairs to stone are unsatisfactory to the Engineer, the stone shall be replaced with new stone. All repairs and all replacements of defective and unsatisfactorily repaired stone shall be performed at the Contractor's own expense.
SECTION 5: BLOCKWORK

5.1 Manufacture

Generally the blocks used shall be of local manufacture made with concrete in approved vibrated pressure machines. The fine aggregate to be used for blocks shall be clean and sharp approved sand. It shall be chemically and structurally stable and shall comply with the Table of Gradings given hereunder. The cement, coarse aggregate and water to be used for blocks shall comply with the requirements given for Concrete Works, and the methods of measuring and mixing the material shall be the same. The following Mixing Table shall be strictly adhered to in all cases. Water/cement ratio shall be strictly governed to produce a mix of nil - slump.

Mixing Table
Nominal Mix (all by volume)
1 part Cement, 2 parts Fine Aggregate and 5 parts Coarse Aggregate

Table of Grading

(a) Fine aggregate

<table>
<thead>
<tr>
<th>BS 410 Sieve No</th>
<th>Approximate size: mm</th>
<th>Percentage (by weight) Passing BS sieve</th>
</tr>
</thead>
<tbody>
<tr>
<td>--</td>
<td>10.00</td>
<td>100</td>
</tr>
<tr>
<td>--</td>
<td>5.00</td>
<td>90-100</td>
</tr>
<tr>
<td>7</td>
<td>2.36</td>
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<td>14</td>
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<td>52</td>
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<td>8-30</td>
</tr>
<tr>
<td>100</td>
<td>0.15</td>
<td>0-10</td>
</tr>
</tbody>
</table>

b) Coarse aggregate 10mm single size aggregate.

The blocks shall be hard, sound, square and clean with sharp well defined arrises and shall, unless previously approved by the Engineer, be a work size of (400 x 200 x 200mm) with properly formed half blocks for bonding.

Hollow blocks, where required, shall be similar quality and overall size to solid blocks, and shall be of local manufacture made with concrete as described above in approved vibrated pressure machines. The design of the cavities and webs shall be submitted to the Engineer for approval before manufacture. The thickness of the membranes or solid portions of hollow blocks shall be not less than (30 mm) each and the combined thickness of the solid portion shall exceed one third of the total thickness in either horizontal direction (Light weight lime - blocks can be used according to drawings, bills of quantities and Engineer’s approval).

Double wall with thermal insulation polystyrene board 3cm thick according to the drawing and details.

Arrises shall be sharp and true; blocks which have damaged arrises are not to be used in the works and shall be discarded at the expense of the Contractor.

Immediately after molding the blocks shall be placed on clean, level, non-absorbent pallets. Blocks shall not be removed from the pallets until inspected and approved by the Engineer. Blocks shall be cured by being kept thoroughly wet by means of water sprinklers or other approved means for a period determined by the Engineer but in all cases for not less than three days. Blocks must not be left on earth or sand during the curing process. Blocks shall be stacked in honeycomb fashion. Solid stacking will not be permitted.

The average crushing strength of solid or hollow blocks shall be not less than 35 kg/cm of gross area (average of 12 blocks).
5.2 Mortars

The sand to be used for mortar shall be clean and sharp. It shall be chemically and structurally stable and shall comply with the Table of Gradings below. The lime if used for mortar shall be hydrated lime complying with BS 890.

Where colored mortars are required these shall be obtained either by the use of colored cement or by addition of pigments complying with BS 1014.

The cement and water to be used for mortar shall comply with the requirements given under Concrete Works Section, and the methods of measuring and mixing shall be the same. The following Mixing Table shall be strictly adhered to in all cases.

Mixing Table

<table>
<thead>
<tr>
<th>Nominal Mix</th>
<th>Cement Kilos</th>
<th>Sand m3</th>
<th>Lime (Dry Hydrate) Kilos</th>
</tr>
</thead>
<tbody>
<tr>
<td>1:4</td>
<td>360</td>
<td>1.00</td>
<td>as approved by the Engineer</td>
</tr>
</tbody>
</table>

Table of Grading

<table>
<thead>
<tr>
<th>BS 410 Sieve No</th>
<th>Approximate size: mm</th>
<th>Sand Passing through Sieve: percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>--</td>
<td>3</td>
<td>95-100</td>
</tr>
<tr>
<td>7</td>
<td>2.4</td>
<td>80-100</td>
</tr>
<tr>
<td>14</td>
<td>0.2</td>
<td>60-100</td>
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<tr>
<td>25</td>
<td>0.6</td>
<td>30-100</td>
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<tr>
<td>52</td>
<td>0.3</td>
<td>5-65</td>
</tr>
<tr>
<td>100</td>
<td>0.15</td>
<td>0-15</td>
</tr>
<tr>
<td>200</td>
<td>0.08</td>
<td>0-5</td>
</tr>
</tbody>
</table>

Note: the above figures represent the limits of percentages (by weight) passing sieves of the sizes mentioned.

The mortar generally shall be cement and sand (1:4) mix.

Where plasticizer is added to the mortar the following mixes shall be used:
(a) Building mortar - cement and sand (1:6) and
(b) Mortar for pointing - cement and sand (according to plasticizer manufacturer recommendation)

The plasticizer shall be used strictly in accordance with the manufacturer's instructions, and subject to the Engineer's approval.

All mortars shall be used before the initial set has begun. Mortar shall not be remixed after the initial set has taken place. The full description given under Plaster Work Section, shall apply also to the measuring, mixing etc. of mortar for blockwork.

5.3 Construction

All blockwork shall be set out and built to the dimensions shown on the Drawings.

Walls shall be carried up regularly without leaving any part more than one meter lower than another unless the permission of the Engineer is first obtained. Work which is left at different levels shall be racked back. In the case of cavity walls, both thicknesses shall not be carried up more than about 400 mm.

The courses of blockwork shall be properly leveled. The perpendicular joints shall be properly lined and quoins, jambs and other angles plumbed as the work proceeds.
All walls shall be thoroughly bonded in accordance with the best constructional practice and as directed by the Engineer. Broken blocks shall not be used except where required for bond (if approved by the Engineer).

All concrete blocks shall be soaked with water before being used and the tops of walls left off shall be wetted before work is resumed. The faces of walls shall be kept clean and free from mortar droppings and splashes.

All blocks shall be properly spread with mortar before being laid and all joints shall be thoroughly flushed up solid through the full thickness of the wall at each course as the work proceeds.

For block walls the gauge shall be ten courses to 2100 mm.

Walls to be left un-plastered shall have a fair face consisting of selected blocks pointed with a neat weathered or flush joint as the work proceeds using the same mortar mix as for jointing.

Walls to be plastered shall have the horizontal joints raked out to depth of 8 mm to form a key.

Blockwork shall be bonded to concrete columns and the like with 200 x 60 x 6mm nonferrous metal ties cast in concrete and subsequently bent down, ragged and built into every 2 courses of blockwork. Gunning ties to concrete will not be permitted (other ways of bond must be approved by the Engineer).
**SECTION 6: ROOFING, WATERPROOFING AND THERMAL INSULATION**

6.1. **ROOFING**

6.1.1. **Corrugated Steel Roofs**

All corrugated galvanized steel sheeting (whether fixed to wood or steel framing) shall be of 23 or 24 gauge fixed with a minimum of 50mm end laps and with a minimum of one corrugation side lap.

When instructed to have a one corrugation side lap, the sheets shall have a cover of not less than 20mm and all the lapped sides shall be turned downwards. Where practicable the exposed lapped sides shall be arranged to face away from the prevailing wind. When instructed to have a one and a half corrugations side lap the sheets shall be arranged alternatively with a cover of not less than 90mm, the first sheet being fixed with the lapped sides turned upwards away from the bearer and the cover sheet with the lapped sides turned downwards.

Sheets shall be secured to purlins at centers not exceeding 300mm by galvanized self parking screws (minimum 75mm long) with galvanized diamond shaped washers and lead sealing washers. All holes for bolts, self parking screws etc. shall be punched from the underside of the sheets and shall be on the crown of the corrugations.

Galvanized steel ridge capping shall be supplied and fixed to purlins as described above.

Hook bolts, self parking screws and washers shall generally comply with BS 1494.

6.1.2. **Screeds**

The provisions of Concrete Work section shall apply to the construction of solid reinforced concrete slab roofs and to hollow slab roofs. The actual finish will be specifically shown on the Drawings or in the Particular Specification.

Lightweight concrete screeds for obtaining falls or as an insulation layer shall be of approved type of foamed concrete. The materials shall be measured, applied and cured in accordance with the manufacturer's instructions and to the satisfaction of the Engineer. In all cases the finished screed shall be of an approved proprietary type with a density of not less than 400kg/m² to receive the applied roofing. Mixing shall take place using approved mechanical mixers.

Concrete screeds for obtaining falls shall be (1:3:6) mix.

All screeds shall be laid in bays not exceeding 10 square metres and formed between stop boards of the correct height and cut on each side to indicate the slope required in the roofing. The screed shall then be trowelled with a wooden float to true and accurate falls or cross falls up to the stop boards. A 10mm side gap shall be left between each screed bay for the full depth of the screed. The screeds shall be allowed to cure thoroughly to attain maximum shrinkage. Any cracks which appear due to shrinkage shall be made good. The gaps between bays shall then be filled in with cold bitumen.

Where the roof screeds are to be reinforced with one layer of galvanized wire mesh, this shall be supported on top of the base on spacers to ensure that it is maintained at between 10mm and 15mm below the top of the finished screeds. It shall be at least 100mm wide, securely wired together. It shall be stopped 20mm from the edge of each bay.
6.1.3. **Insulation**

When asphalt sheets are used on the top of the screeds, they shall have the following properties:

- Asphalt sheets shall be supplied in rolls of 1-1.2 m width and 4mm thick.
- Top surface shall have a layer of medium size white aggregates (2-3mm)

Applying asphalt sheets shall be made according to the manufacturer instructions.

Top surface of screeds shall be cleaned and a suitable prime should be sprayed before using asphalt sheets.

An overlap of 15-20cm shall be made on sheets.

Hot asphalt shall be sprayed before erecting the sheets, which should be heated (bottom side).

Sheets shall have at least 15cm vertical edges, all around the roof (a special groove should be made in the roof parapet to erect the vertical side of the sheets)

During erecting asphalt sheets, contractor shall prevent air pockets entrained under the sheets, which will be full flame applied.

6.1.4. **Tiling**

Tiled finishing to roofs shall be manufactured and laid as described in Section of (tiling works)

Tilted tiled skirting shall include a triangular fillet of screed material and pointing at top with polysulphide mastic.

6.1.5. **Expansion Joints**

The expansion joints shall generally be of 10mm thick fiberboard impregnated with bitumen accurately cut, with butt joints and fixed vertical and straight. The top 10mm of the joint shall be filled with a grey polyurethane gun grade sealant which confirms with BS 4254.

Expansion joints shall continue into the tilted tile, skirting and fillets.

6.1.6. **Felt Roofing**

Felt roofing, below tiling, shall be two-ply, tropical grade, fiber-based bituminous roofing felt weighing not less than 1.8kg /m2 and shall comply generally with BS 747 (Class 1 Type 16) and shall be executed by an approved specialist.

The felt shall be thoroughly bonded to the roof or screed and between layers. Care shall be taken to ensure that all surfaces upon which felt is to be laid are dry, smooth and clean.

The bonding shall be by means of bitumen (60 /70 penetration) applied hot as a continuous coating to an average thickness of not less than 1.5mm and not more than 2mm, to give a complete coat over the whole area at the rate of not less than 1.5kg /m2 and not more than 2.0kg /m2 for each bonding coat.

The felt shall be laid with 150mm side and end laps which shall be staggered.

The felt shall be carried up the walls etc., over fillets to from a skirting continuous with the roof covering.

The skirting shall be bonded to the fillets and walls and shall be not less that 150mm in vertical height.

Application of materials shall conform in all respects with the British Standard CP 144: Part 1, 'Roof Coverings, built-up bitumen felt', or any standards approved by the Engineer.

The felt shall be dressed and bonded into rainwater outlets and under flashings.

6.1.7. **Bitumen Roofing**

Where roof finishing is required to be of a bitumen and sand mix this shall be composed of a mix to the following proportion (by weight) :

* Bitumen 60 /70 penetration  13 %
* Filler (passing 200 sieve) 11 %
* Sand 76 %

Mixing shall be carried out in an approved machine until all materials are thoroughly mixed. The mixing temperature shall be between 163OC and 191OC and it shall be applied at a temperature sufficient to maintain the workability of the mix. The covering shall be laid in one coat to give a consolidated thickness of 20mm after rolling with a light hand roller. 150x150mm angle fillets shall be laid at edges of roofs against parapets etc., properly bonded to the roof covering and with top edges turned into joints of walls. The covering shall also be pressed into rainwater outlets and under flashings.

6.1.8. Asphalt

Asphalt roofing and tanking shall be executed by an approved specialist using mastic asphalt to BS 988. The asphalt shall be applied in the thickness and number of coats described in the in BOQ, with each successive coat breaking joints at least 300mm (12") and with properly formed angles, double angle fillets and fair edges. Joints of blockwork shall be raked out and all vertical surfaces hacked for key. Horizontal work shall be laid on a layer of stout sheathing felt.

6.1.9. Completion

On completion, all roofs etc. are to be left sound, water-tight and in clean condition before handing over.

6.2. Waterproofing and Thermal Insulation

6.2.1 Scope

These specifications cover, waterproofing, roofing and thermal insulation to be used for Underground structures, floors and roof decks required for the Works in accordance with the Drawings, Bills of Quantities and as directed in writing by the Engineer.

6.2.2 Preparation

All surfaces must be clean sound, and free from oil, grease and all loosely adherent materials. Wire brush, sand blast or grit blasting may be used to remove any surplus adhered to concrete and steel. The contractor must submit a request for all materials for Engineer approval.

6.2.3 Materials

1- Damp proofing

All substructures, floors of ground floor of kitchens, toilet and bathrooms have to be painted with a waterproofing liquid. Before application of primer and bituminous layers, angle fillets of concrete should be constructed at the wall boundary of the bathroom, toilet and kitchen with dimension of 7 cm x 7 cm and working mix cement & sand by 1:3. Thresholds of the same mix must be implemented at the bathroom, toilet and kitchen doors.
2- **Waterproofing of exterior walls**

This will be added to the exterior plastering of walls. It’s an integral concrete waterproofing compound that will reduce moisture absorption in the plastering mixture.

In case of buried masonry, the joints between courses should be ranked out to 0.5cm, and then the walls to be plastered with rich cement mortar 0.5cm thick by 1:1 cement –sand ratio.

The bitumen primer should be applied after the plastering is totally dried and left enough time as per instructions of the manufacturer. Two coats of hot bitumen 75/25 should be applied perpendicular to each other, unless otherwise indicated, so that any holes, cracks or any defects are not been noticed.

In case of concrete walls; any loose particles and steel ties should be removed and accordingly patched with special cementous material prior to application of the primer and bituminous coats as previously described.

3- **Waterproofing of the roof**

**Lightweight Concrete**

A sloping screed consisting of lightweight concrete screed shall conform to B.S.3797:

Lightweight aggregate for concrete. The lightweight aggregate shall be such a Vermiculite, Alveolite, etc…. aggregate of an exfoliated micaceous mineral aggregate incombustible and chemically inert, obtained from an approved manufacturer, graded and mixed in accordance with the manufacturer’s instructions.

The lightweight aggregate shall be delivered to the Site in the manufacturer’s sealed and branded containers which shall be clearly marked to show the grade of lightweight aggregate contained therein. They shall be stored in a covered shed with floor raised off the ground and bags stacked not more than 3.00 meters high.

Process of damp-proofing layers should not be started at least four days after curing of concrete screed finished and dried.

Cement angle fillets 10cm * 10 cm must to be executed at the boundary of roof parapet with cement & sand mix by 1:3

**Mixing Methods**

Mixing may be carried out by hand or by approved machine in accordance with the following procedures:

- **By Hand**

  The measured quantity of lightweight aggregate shall be poured out onto a clean dry level surface and sufficient water added only to give workability. Mixing shall be carried out until the water has been distributed amongst the lightweight aggregate. The cement shall be added and further mixing shall take place until all materials are uniformly distributed.

- **By Machine**

  The machine used for mixing shall be an approved countercurrent rotating paddle type mixer operating at the speed recommended by the manufacturer. The water shall be placed in the mixer followed by the lightweight aggregate and mixing shall continue until the water has been distributed amongst the lightweight aggregate. The cement shall then be added and further mixing shall take place until all the materials are uniformly distributed. It is extremely important to ensure that the mixing period is kept as short as possible in order to prevent compression of the lightweight aggregate. For this reason, ordinary concrete mixer of the revolving drum type is unsuitable and shall not be used.

If an approved mixing machine is not available, then the mixing shall be carried out by hand.
It is also important that the water content be kept to the minimum possible to allow for the proper hydration of the cement. Sloppy mixes shall not be used. An even consistency free from lumps and excess water is required. As a Site test for consistency, a handful of the mix when firmly gripped should just release water.

Placing of the lightweight concrete mix shall take place immediately after mixing. The lightweight concrete screed shall be laid to falls in alternate bays not exceeding 16.00 square meters in area to a minimum depth of 50mm. The lightweight concrete mix shall be carefully spread by means of a rake to a depth 12.5% greater than the finished thickness required and shall then be lightly troweled down to its finished thickness. The mix shall not be tamped, vibrated or compressed with heavy implements.

The lightweight concrete screed shall be cured by covering with damp Hessian for a period of seven days and during this time the screed shall not be subjected to traffic to any kind. After curing the lightweight concrete screed shall be protected by a layer of cement and sand (1:4) mix. This topping shall be well troweled in to ensure proper adhesion with the lightweight concrete screed and shall have a minimum finished thickness above the lightweight concrete screed of 30mm and shall be finished flat and true with a steel trowel.

The screed and topping shall be water cured with damp hessian for a period of 7 days then left for 4 days drying before receiving waterproofing system.

Alternatively, the cement and sand topping may, with the approval of the Engineer be applied immediately after troweling the lightweight concrete screed. Lightweight concrete screed, cement and sand topping shall not be laid during rain.

### 6.2.4 Waterproofing

An application of Plastomeric Bitumen-Polymer waterproofing sheets (APP) with splayed chips must be carried out after application of corresponding primer as instructed by the manufacturer. Membranes should not be less than 4mm in thickness or 4.5kg/m2.

Application process of the membranes must be done by torching them to the specified temperature prior to adhering to the roof deck. The pricing will include overlapping 10cm between sheets, upstands up to 15cm, dressing into storm water traps, etc.

Measurement of the membrane and underlay screeds will be for the horizontal projection of the deck unless otherwise described.

### 1- Workmanship

Prior to the beginning of the roofing works, the Engineer and the roofing superintendent shall proceed to the inspection and approval of the receiving surfaces, the upstands at roof edges, the drains, vent pipes and other venting devices, the construction joints etc.

The contractor will be notified in writing of all defects of the flat surfaces or details and work shall not be preceded until such defects have been corrected. One coat of primer is painted over the entire surface. Installation of the bituminous layers shall be carried out in conformity with the manufacturer’s specifications and using propane torch welding only.

Asphalt coatings shall be softened but not melted as to avoid superheating using a single nozzle torch of adequate size. Rolls shall overlap 75mm on sides and 150mm at ends. All inadequately welded seams will be refused. All superheated areas or parts will be refused and will require adequate repair in accordance with the degree of deterioration of the membrane.

Air blisters, wrinkles impact and tearing marks and protective granules pounding marks are not admissible. Should these defects occur, roofing works shall be carried out again.
2- Bituminous Flashings

A plain underlay bonded to the support with previously applied primer coating or welded to it with propane torch. This underlay shall be unrolled parallel to the upstanding element in one meter width extending 150mm onto the current surface underlay. Apply the current surface-finishing layer onto the flashing underlay and then recover with the flashing-finishing layer extending 200mm onto the current finished surface. This layer shall be welded with propane torch in full adherence that no air is entrapped between layers. Side and end laps shall be staggered over underlay seams and 75mm wide.

6.3 WATERSTOPS

General

Rubber water stops or PVC water stops shall be provided in the joints in concrete where shown on the Drawings. If not shown on the drawings the minimum width of the water stop shall be 200mm.

The Contractor shall submit with his Tender a detailed description of the water stop he intends to use, accompanied by a drawing showing the shape and size of the water stop, the name of the manufacture, and the methods to be installing and splicing the water stop, which shall be in accordance with the requirements detailed below.

The Contractor shall also furnish all labor and materials for making field splices in all water-stops. The Contractor shall take suitable precaution to support and protect the water-stops during the progress of the work and shall repair or replace any damaged water-stop.

All water-stops shall be stored in as cool a place as practicable, preferably at 21°C or less. Water-stops shall not be stored in the open or where they will be exposed to the direct rays of the sun. All water-stops shall be protected from oil or grease.

Rubber Water-stops

The rubber water-stop shall be fabricated from a high-grade, tread-type compound. The basic polymer shall be natural rubber or a synthetic rubber. The material shall be compounded and cured to have the following physical characteristics: yield strength 10.2 N/mm², elasticity of 400% at braking strain.

Installation

The water-stop shall be installed with approximately one-half of the width of the material embedded in the concrete on each side of the joint. Care shall be exercised in placing and vibrating the concrete about the water-stop to insure complete filling of the concrete forms under and about the water-stop, and to obtain a continuous bond between the concrete and the water-stop at all points around the periphery of the water-stop. In the event the water-stop is installed in the concrete on one side of a joint more than one month prior to the scheduled in date of placing the concrete on the other side of the joint, the exposed water-stop shall be covered or shaded to protect it from the direct rays of the sun during the exposure. Before placing the concrete on the other side of the joint the projecting half of the water-stop shall be carefully cleaned.

The contractor shall take suitable precaution to support and protect the water-stops during of the work and shall replace at this own cost all damaged or deteriorated water-stops.

6.4 THERMAL INSULATION

Criteria, design aspects, implementation methodology and relevant materials of the thermal insulation must be according to the Jordanian Code for Energy Efficient Building and using the supplementary Guidelines.
SECTION 7: PLASTER WORK

7.1 General
The British Standards (BS) govern the work covered in this section.

7.2 Materials
Portland cement, fine aggregate and water shall be as previously specified in Concrete Work section. The color pigments shall be of an approved manufacture, lime proof and non-fading.
The sand for plastering shall be clean fine sand and shall be chemically and structurally stable. The sand shall be sieved and graded in accordance with the Table of Grading given below.

Table of Grading

<table>
<thead>
<tr>
<th>BS 410 Sieve No.</th>
<th>Approximate Size. mm</th>
<th>Sand Passing Through Sieve Percentage:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>UNDERCOAT</td>
</tr>
<tr>
<td>7</td>
<td>2.4</td>
<td>95-100</td>
</tr>
<tr>
<td>14</td>
<td>1.2</td>
<td>80-95</td>
</tr>
<tr>
<td>25</td>
<td>0.6</td>
<td>30-55</td>
</tr>
<tr>
<td>52</td>
<td>0.3</td>
<td>5-50</td>
</tr>
<tr>
<td>100</td>
<td>0.15</td>
<td>0-10</td>
</tr>
</tbody>
</table>

Note: the above figures represent the limits of percentages (by weight) passing sieves of the sizes mentioned.

Imported lime shall be of the hydrate type complying with BS 890.
Bonding agents where required shall be of a type approved by the Engineer, and shall be used as recommended by the manufacturer.
The Contractor shall ensure that supplies of materials are sufficient to give consistent and uniform color to surface finishes which are not to be painted.
7.3. Mixing

The methods of measuring and mixing shall be as laid down under Concrete Work section, and the proportions shall be in accordance with the Mixing Table given below.

Mixing Table

<table>
<thead>
<tr>
<th>Nominal mix</th>
<th>Ratio</th>
<th>Cement. Kg</th>
<th>Fine Aggregate or Sand m³</th>
<th>(I) (dry hydrate) kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>1:5 cement</td>
<td>1:5:1</td>
<td>289</td>
<td>1.00</td>
<td>-</td>
</tr>
<tr>
<td>1:4 cement</td>
<td>1:4:2</td>
<td>361</td>
<td>1.00</td>
<td>-</td>
</tr>
<tr>
<td>1:3 cement</td>
<td>1:3:2</td>
<td>476</td>
<td>1.00</td>
<td>-</td>
</tr>
<tr>
<td>1:2 cement</td>
<td>1:2:2</td>
<td>577</td>
<td>1.00</td>
<td>-</td>
</tr>
<tr>
<td>1:2 cement</td>
<td>1:2:2</td>
<td>721</td>
<td>1.00</td>
<td>-</td>
</tr>
<tr>
<td>1:1 cement</td>
<td>1:1:1</td>
<td>1442</td>
<td>1.00</td>
<td>-</td>
</tr>
<tr>
<td>1:5 cement with 20% (I)</td>
<td>1:5:1</td>
<td>289</td>
<td>1.00</td>
<td>124</td>
</tr>
<tr>
<td>1:4 (I) with 10% cement</td>
<td>1:10:21/2</td>
<td>145</td>
<td>1.00</td>
<td>161</td>
</tr>
</tbody>
</table>

.... * I = Imported Lime

About the lime mortars gauged with cement, the addition just before use of the cement to small quantities of the lime/sand mix shall preferably take place in a mechanical mixer and mixing shall continue for such time as will ensure uniform distribution of materials and uniform colour and consistency. It is important to note that quantity of water used shall be carefully controlled.

7.4. Plastering and Similar In-Situ Finishing and Backings

All plastering shall be executed in a neat workmanlike manner. All faces except circular work shall be true and flat and angles shall be straight and level or plumb.

Plastering shall be neatly made good up to metal or wooden frames and skirting and around pipes or fittings. Angles shall be rounded to 5mm radius.

Surfaces of undercoats shall be well scratched to provide a key for finishing coats. Screed marks or making good on undercoats shall not show through the finishing coats.

Surfaces described as trowelled smooth shall be finished with a steel trowel to a smooth flat surface free from trowel marks.

Surfaces described as floated shall be finished with a wooden or felt float to a flat surface free from trowel marks.

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

Coating work shall not be started until all:

a) Required openings, chases or other apertures have been cut
b) Pipes, fixtures, fixing pads and plugs have been fixed
c) Making good has been completed.

The Contractor shall protect all existing work and approaches, with boards, dust sheets etc. All droppings onto finished work shall be cleaned off immediately.

The Contractor shall ensure that all plant and tools are kept clean and free from previous mixes.

The Contractor shall make good defective or damaged coatings before starting decoration works.

7.5 Preparation for Plaster, etc.

All surfaces to be plastered shall be clean and free from dust, loose mortar and all traces of salts. Projections and concrete fins shall be hacked off. Traces of mould oil, paint, grease, dust and other incompatible materials shall be removed by scrubbing with water containing detergent.
Where cement plaster is to be applied, the surfaces shall first be wetted and dashed with a mixture of Portland cement and sand (1:2) mix to form a key. This should be kept wet with a fine water spray until set, and allowed to harden before applying undercoat for a minimum of 3 days.

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

Bonding agents where required shall be applied in accordance with the manufacturer's instructions and must be approved by the Engineer.

Before plastering is commenced all junctions between differing materials shall be reinforced in accordance with clause 9.21.

### 7.6 Curing of Plaster, etc.

Each coat of plaster should be kept damp for the first three days. Care must be taken to prevent too rapid drying out during hot weather and in drying winds.

The Contractor shall therefore provide a protective covering of plastic or similar impervious sheeting which must be hung so that it is clear of the finished surface.

Any cracking, discoloration or other defects caused by inadequate protection shall be remedied at the Contractor's expense.

### 7.7 Uses of Plaster, etc.

The type, mix and thickness of plaster for each location shall be as stated in the Particular Specification or shown on the Drawings, and shall generally be selected from the Schedule of Plasters given in Table P1.

#### Table P1: Schedule of Plasters

<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>Render and Spray Cement Sand</th>
<th>Plain Face Cement and Sand</th>
<th>Gauged Plastering Lime and Sand with Cement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Thickness</td>
<td>Walls 13</td>
<td>15</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td>Ceilings 10</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Undercoats Thickness (mm)</td>
<td>Mix Surface 1:4 Floated</td>
<td>1:4 Scratched</td>
<td>1:10:2.5 Scratched</td>
</tr>
<tr>
<td></td>
<td>Walls 10 as required</td>
<td>as required</td>
<td>as required</td>
</tr>
<tr>
<td></td>
<td>Ceilings 7 as required</td>
<td>as required</td>
<td>as required</td>
</tr>
<tr>
<td>Finishing Thickness (mm)</td>
<td>Mix Surface 1:1 Sprayed</td>
<td>1:4 trowelled or floated</td>
<td>1:10:2.5 trowelled or floated</td>
</tr>
<tr>
<td></td>
<td>Walls 3 as required</td>
<td>as required</td>
<td>as required</td>
</tr>
<tr>
<td></td>
<td>Ceilings 3 as required</td>
<td>as required</td>
<td>as required</td>
</tr>
<tr>
<td>Remarks</td>
<td>External use</td>
<td>External or internal use may be applied in one coat to ceiling only if finished thickness is 12mm and the required surface finish is obtained</td>
<td>Internal use may be applied in one coat if finished thickness is 12mm and the required surface finish is obtained.</td>
</tr>
</tbody>
</table>

### 7.8 Application of Plaster, etc.

After preparation of the surfaces the undercoat shall be applied to the required thickness between screeds laid, ruled and plumbed as necessary. When nearly set the surface of the undercoat shall be scratched. The undercoat shall be allowed to set hard and shall be cured. Where plastering is applied in one coat or where roughcast is to be applied the scratching should be omitted.

The finishing coat shall be applied to the required thickness by means of a laying -on trowel and finished to give the required surface.
The surfaces shall be finished to a true plane to correct line and level, with all angles and corners to a right angle unless otherwise specified, and with walls and reveals plumb and square. The surfaces shall be finished to within 3 mm of a straight edge 1.80m long placed on face of plaster. Undercoat shall be worked well into the interstices of metal work to obtain maximum key. Each coat shall be applied firmly to achieve good adhesion, and ruled to an even surface. Each coat shall be applied to each wall and ceiling surface in one continuous operation. Each coat shall be applied at full thickness down to floor level or skirting lath. All undercoats shall be cross-scratched to provide key for next coat. Cement based undercoats shall be allowed to dry out thoroughly to ensure that drying shrinkage is substantially complete before applying subsequent coat. 50 mm each side of angle bead to be finished with neat Keene’s cement before plaster finishing coat is applied. Where angle beads are not specified, angles shall be formed with pencil round arris.

**Smooth Finish**
Finished with a steel laying trowel to an even surface.

**Wood Float or Plain Finish**
Finished with a dry wooden float as soon as wet sheen has disappeared from surface to give overall even texture.

**Rough Textured Finish**
Finished with a cork or carpet float to provide a rough but even open-textured surface.

**Scraped finish**
Finished with laying trowel to uniform thickness and after coat has set but before it is too hard, aggregate exposed by scraping surface of skin to approved texture.

**Rough Cast Finish**
Thrown on while wet with trowel or scooped to an even texture and left as cast.

**Dry Dash Finish**
Top coat of rendering finished to uniform thickness; while coating is plastic, aggregate thrown on to cover surface and particles pressed lightly into mortar to ensure adhesion.

**Sprayed Finish**
The sprayed finish shall be applied with an approved machine to give a finish of even texture and thickness. The sprayed finish shall be applied in three separate coats allowing time for drying between coats. Application in one continuous operation to build up a thick layer will not be permitted. The total finished thickness of the four sprayed coats shall not be less than 3 mm. The sprayed finish shall not be applied until all repairs and making good to the undercoat are completed. Rainwater pipes, fittings and the like shall first be fitted, then removed during the spraying process and refitted and jointed afterwards. Any plaster which adheres to other pipes, doors, windows and the like shall be carefully removed before it has set. Curing shall take place after the application of the fourth coat.

7.9 **Steel Mesh Lathing, Stops and Beads**

Steel mesh lathing shall be galvanized type weighing 1.6kg/m.

Steel rods for distancing shall be hot rolled mild steel round bars to BS 4449, diameter to approval, galvanized to BS 729 or bitumen coated.

Steel clout nails shall be to BS 1202: Part 1, Table 3, galvanized to BS 729.

Galvanized steel angle bead with 50 mm galvanized expanded metal mesh on both sides of bead.

Mesh lathing shall be fixed with the long way of the mesh at right angles to supports. In horizontal work it shall be fixed with all mesh strands sloping in the same direction.
In vertical work it shall be fixed with all mesh strands sloping inwards and downwards from face of coating.

Lathing shall be fixed from the center outwards so that it is taut.

Lathing shall not be lapped within 100mm of angles or curves.

Junctions of lathing shall be reinforced at corners with 75 x 75 mm angled plain mesh, fixed to rails with tying wire at not more than 100mm centers.

Ends of wire shall be bent away from face of coating.

Beads and stops shall be fixed plumb, square and true to line and level.

Metal angle beads shall be fixed to solid backgrounds with plaster dabs, and shall be fixed to timber supports with 28mm clout nail. Both types of fixing shall be on each side of angle at not more than 600mm centers.

At junctions between dissimilar solid backgrounds in the same plane and with the same coating, steel lathing shall be fixed with 38 mm clout nails or with staples. They shall be driven into drilled and plugged holes or into fixing bricks or plugs built in or cast in:

(a) At single junctions, lathing to be not less than 450mm wide, fixed each edge at 100 mm centers.
(b) At columns, lathing to extend not less than 150mm beyond each junction, fixed each edge and centrally at 100 mm center.

Side edges of lathing shall be lapped not less than 25mm, and secure with tying wire at not more than 100mm centers.

Ends of lathing shall be lapped 40mm at supports and 50mm between supports, and secured with tying wire at not more than 100m centers.

Lathing fixed to metal supports shall be fixed with hair-pin shaped tying wire ties at not more than 100mm centers, passed over the support with both ends through mesh, twisted tight, ends cut off and bent flat.

Concrete, blockwork or masonry backgrounds shall be drilled and plugged at not more than 100x400mm centers and the lathing shall be fixed with 38mm clout nails or wire staples driven at an angle to tauten the mesh.
SECTION 8: WALL AND FLOOR TILING WORKS

8.1 General

8.1.1 Section includes:

a. Ceramic and Terrazzo tile floor finish using the mortar bed application method. Approved Gravel bed under mortar for terrazzo tile, and for cement tiles.
b. Local marble tile stair treads using the mortar bed application method.
c. Interlock floor tile using the sand bed application.
d. Cements tiles.

8.1.2 References:

ANSI
TCA
ASTM
BS.

8.2 Materials:

Portland cement, fine aggregate and water shall be as previously specified in Concrete Work section. The marble chipping shall be of an approved quality in irregular pieces varying from 2 mm to 10 mm in size depending on the effect required. The pieces should preferably be roughly cubical in shape where flaky shaped pieces shall not be used.

The granite chipping shall be of an approved quality graded from 12 mm down with not more than 5 percent fine material passing a No.100 sieve.

Marble and granite aggregates shall comply generally with the Table of Grading. In connection with marble aggregates the percentages are approximate only. The actual grading should be selected to produce the surface effects required.

Table of Grading

<table>
<thead>
<tr>
<th>BS 410 Sieve No.</th>
<th>Approximate Size. mm</th>
<th>Percentage of Aggregate Passing Through Sieve</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>GRANITE</td>
</tr>
<tr>
<td>-</td>
<td>13</td>
<td>100</td>
</tr>
<tr>
<td>-</td>
<td>10</td>
<td>95-100</td>
</tr>
<tr>
<td>-</td>
<td>5</td>
<td>30-60</td>
</tr>
<tr>
<td>7</td>
<td>2.4</td>
<td>20-50</td>
</tr>
<tr>
<td>14</td>
<td>1.2</td>
<td>15-40</td>
</tr>
<tr>
<td>25</td>
<td>0.6</td>
<td>10-30</td>
</tr>
<tr>
<td>59</td>
<td>0.3</td>
<td>5-15</td>
</tr>
<tr>
<td>100</td>
<td>0.15</td>
<td>0-5</td>
</tr>
</tbody>
</table>

NOTE: the above figures represent the limits of percentages (by weight) passing sieves of the sizes mentioned.
8.3 Cement and Sand Tiles

Cement and sand tiles shall be formed with a (1:2) mix of white or colored cement, or in white cement with a colour pigment added, and sand applied as a facing not less than 7.5mm thick to a Portland cement and sand (1:5) mix backing.

The tiles shall be cast in heavy moulds under pressure to the proportions and sizes shown in the following table.

### Cement and Sand Tile Dimensions

<table>
<thead>
<tr>
<th>Size mm</th>
<th>Size tolerances mm</th>
<th>Minimum total thickness mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>200x200</td>
<td>0.5</td>
<td>20</td>
</tr>
<tr>
<td>250x250</td>
<td>0.5</td>
<td>25</td>
</tr>
<tr>
<td>300x300</td>
<td>1.0</td>
<td>25</td>
</tr>
<tr>
<td>400x400</td>
<td>1.0</td>
<td>30</td>
</tr>
<tr>
<td>Interlock tile (size vary)</td>
<td>1.0</td>
<td>60</td>
</tr>
</tbody>
</table>

Colored cement and sand skirting to match tiles, 100mm or 200mm with chamfered top edges shall be produced in the same way as the tiles using the same mixes.

All cement and sand tiles shall be cured by totally immersing them, after the initial set has taken place, in a tank of clean water for at least 24 hours.

Cement and sand tiles shall be laid and bedded direct onto a concrete sub-floor on a cement and sand (1:4) mix screed. This screed shall be 25mm thick in the case of 25mm tiles and 30mm thick in the case of 20mm tiles. The total thickness of cement and sand screed and tiles shall not exceed 50mm. All tiles shall be laid with square joints.

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

8.4 Terrazzo Tiles

Terrazzo tiles shall be formed with a (1:2 1/2) mix of white or colored cement or white cement with a colour pigment added and granular marble chippings applied as a facing not less than 5 mm thick to a Portland cement and sand (1:5) mix backing.

The tiles shall be cast in heavy metal moulds under pressure to the proportions and sizes shown in the following table.

### Terrazzo Tile Dimensions

<table>
<thead>
<tr>
<th>Size mm</th>
<th>Size tolerances mm</th>
<th>Minimum total thickness mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>200x200</td>
<td>0.5</td>
<td>20</td>
</tr>
<tr>
<td>250x250</td>
<td>0.5</td>
<td>25</td>
</tr>
<tr>
<td>300x300</td>
<td>1.0</td>
<td>25</td>
</tr>
<tr>
<td>400x400</td>
<td>1.0</td>
<td>30</td>
</tr>
</tbody>
</table>

Tiles shall be cured as for cement and sand tiles and then ground, filled and polished before distribution to site.

Grinding shall be done wet by means of a No. 80 carborundum stone. Filling shall be carried out with a neat cement grout of the same colour as the facing mix and this shall be worked into the surface with a wooden shaper to fill all voids and air holes.

Surplus grout shall be removed with a dry cloth. After a minimum period of 24 hours polishing shall be carried out wet by means of a No. 140 carborundum stone.
Terrazzo skirting 100mm high with chamfered top edges shall be produced in the same way as for tiles using the same mixes.

Terrazzo tiles shall be laid and bedded direct onto a proved gravel layer with a cement and sand (1:4) mix mortar. This mortar shall be 25mm thick in the case of 25mm tiles and 30mm thick in the case of 20mm tiles. The total thickness of the cement and sand screed and tiles shall not exceed 50 mm.

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

All terrazzo surfaces shall be polished on completion. Large areas such as floors shall be wet polished by means of approved machines using No. 140 carborundum wheel. Any surface too small for convenient machine polishing may be polished by hand using a No.140 carborundum stone and water. Care must be taken during any polishing operation not to damage any of angles or arrises.

Terrazzo covering to items such as sills, treads and risers to steps, skirting, etc., shall generally be applied in accordance with the foregoing specification except that the thickness of the facing shall be at least 10 mm (marble can be used if approved by the Engineer).

8.5. Marble Paving

Marble paving shall generally be 30 mm thick and the size, type and pattern shall be as stated in the Particular Specification and/or shown on the Drawings. The marble slabs shall be fixed solid on a bed of cement and sand (1:4) mix 30 mm thick with tight joints grouted in lime putty. A protective slurry of lime putty at least 3 mm thick shall be applied to the marble paving and subsequently cleaned off.

Treads shall be 30mm thick fixed solid on a bed of cement and sand (1:4) mix 30mm thick. Risers to stairs shall be 20mm thick fixed solid on a backing of cement and sand (1:4) mix 30 mm thick. Window sills shall be 40mm thick bedded hollow on plaster slabs. Skirting shall be 10mm thick, in lengths of about 1.5 meters, fixed solid on a backing of cement and to coincide with joints in adjacent paving. Rounded arrises, nosing and moldings shall be adequately protected by means of timber casings. Treads, risers, skirting and window sills shall be grouted and protected in a manner similar to paving.

The exposed faces and edges of all marble shall be polished smooth and be free from scratches or other defects. Concealed faces of marble shall be treated with shellac or bituminous paint.

8.6. Marble Lining

Marble lining to walls, columns and the like shall generally be 20 mm thick and the size, type and pattern shall be as stated in the Particular Specifications and/or as shown on the drawings. The marble slabs shall be cut square and true and shall be uniform in shape and thickness. Patterns and moldings shall be accurately formed in accordance with the Drawings.

Exposed edges and moldings shall be protected by means of timber casing or lime putty coating. The exposed edges and faces of all marble shall be polished smooth and shall be free from scratches or other defects.

8.7. Interlock tile – colored cement tile:

1. Interlock cement tile 6cm thick, first grad from certified factory.
2. Colour and shape to be approved from consultant.
3. Samples for lab testing.
4. Apply clean sand with minimum thickness 5cm
5. Lay tile according to the specification and drawings.
6. Paving on compacted base course layer not less than 20cm thick

8.8. Ceramic, Glazed and Quarry Tiling

Clay floor quarries and fittings shall be in accordance with BS 1286 type A and the thickness and size shall be as stated in the Particular Specification or on the Drawings.

Ceramic floor tiles and fittings shall be in accordance with BS 1286 type B, vitrified or fully vitrified and the thickness and size shall be as stated in the Particular Specification or on the Drawings.
Glazed ceramic floor tiling shall be of the type, thickness and size as stated in the Particular Specification or on the Drawings. The tiles shall be true to shape, flat and free from flaws, cracks and crazing and keyed on the reverse side and shall be of a manufacture approved by the Engineer. Bedding mortar shall be cement and sand all in accordance with the materials stated in Concrete Work and Blockwork sections. Any admixtures to the mortar must be approved before use.

Grout pointing shall be white or colored cement. Cement and sand mortar bed of not more than 20 mm or thickness of the tile shall be laid. Tiles shall be firmly tamped into mortar to form a level surface. The Contractor shall ensure that when fixing tiles with thin bed adhesive, the base to receive tiles is clean level and dry, with no loose and friable areas and surface dusting. Cement-based adhesive shall be prepared and used in accordance with the manufacturer’s recommendations to form a bed not more than 3 mm thick. Tiles shall be laid dry and tamped well down into the adhesive to ensure a proper bond with base and a level surface.

When bedding tiles on thick bed, semi-dry cement and sand (1:4) mortar bed shall be spread not less than 25 mm thick. Before the compacted bed has set a cement and sand slurry (1:1) about 3mm thick shall be spread over the surface. The tiles shall be laid dry and tamped into the slurry to form a level surface. Joints shall be even and not more than 3mm wide, in both directions. Joints shall be continuous both horizontally and vertically.

The tiles shall be grouted up with grey or colored cement mortar (1:1) worked well into joints when bed is sufficiently firm to prevent disturbances of the tiles; surplus grout shall be cleaned off from faces of tiles. Movement joints shall be provided not less than 6 mm wide where shown on the Drawings or as directed by the Engineer. Movement joints shall be carried through the depth of tile and bedding and partially filled with filling strip and finished flush with sealant to manufacturer’s recommendations joints should be made from silicone. Where tiling abuts against wood or metal frames or other tiling at angles and around pipes etc., it shall be carefully cut and fitted to form a close neat joint. Open irregular joints filled with cement and sand or plaster will not be permitted.

Tiles shall be cleaned off and polished at completion. Water shall not be allowed on new tiling until bedding and grouting have completely set. No traffic shall be allowed on the floor until 4 days after completion and then only light traffic for a further 10 days.

8.9. Glazed Ceramic Wall Tiling

Glazed ceramic wall tiles shall be in accordance with BS 1281 with or without cushioned edges and spacer lugs and shall be grey or colored as stated in the Particular Specification. Glazed ceramic tile fittings shall be rounded edge or angle bead type to match plain tiles. The tiles shall be true to shape, flat and free from flaws, cracks and crazing and keyed on the reverse side and shall be of a manufacture approved by the Engineer. Bedding mortar shall be cement and sand (1:3) all in accordance with the materials stated in Concrete Work and Blockwork sections. Any admixtures to the mortar must be approved before use.
Mastic adhesives shall be of an approved manufacture and shall comply with the performance requirements of CP 212: Part 1, if approved by the Engineer.

Grout pointing shall be neat grey or colored cement.

The Contractor shall ensure that the cement render backing is at least 14 days old, firmly bonded to its background, free from dust, with surfaces plumb and true to 3mm in any 1800 mm.

### 8.10. Fixing Tiles with Cement and Sand Mortar

The tiles shall be immersed in water for 6 hours or until saturated then stacked tightly together to drain with end tiles turned glaze outwards. Tiles shall be fixed as soon as surface water has drained.

The render coat shall be wetted sufficiently to prevent it absorbing water from the bedding coat.

Mortar bedding shall be applied to render background to an even thickness of approximately 10mm.

Each tile shall be buttered evenly with mortar and tapped firmly into position so that the bed is solid throughout.

Thickness of finished bed shall be not less than 6mm nor more than 12 mm.

Any necessary adjustment to tiles shall be made within ten minutes of fixing and tiles cleaned off after not less than two hours.

### 8.11. Fixing Tiles with Adhesive

The tiles shall be fixed in accordance with the recommendations of the adhesive manufacturer.

Adhesive shall be applied not more than 1sq.m at a time to avoid premature drying out.

Adhesive shall be applied as a continuous screed to a thickness of approximately 3mm on the surface to be tiled.

Dry tiles shall be pressed on to the adhesive and tapped firmly into position to ensure solid bedding without voids.

Any necessary adjustment to tiles shall be made immediately after bedding.

Tiles shall be cleaned off as soon as bedding is complete.

Joints shall be even and not more than 2mm wide using spacer lug tiles or spacer pegs.

Joints shall be continuous both horizontally and vertically.

Tiles shall be fixed to a finished surface that is plumb and true to 2 mm in any 2m.

Joints shall be grouted up not less than 24 hours after fixing tiles to porous surfaces and not less than 3 days after fixing to impervious surfaces.

Tiles shall be grouted by pressing mix firmly into joints, working in areas of not more than 1sq.m.

Surplus grout shall be cleaned off as the work proceeds.

Where tiling abuts against wood or metal frames or other tiling at angles and around pipes etc., it shall be carefully cut and fitted to form a close neat joint. Open irregular joints filled with cement and sand or plaster will not be permitted.

Tiles shall be cleaned off and polished on completion.

External tiling shall be protected from inclement weather until grouting is completely set.

No water is to be allowed on new tiling until bedding and grouting have completely set.

### 8.12. Protection

All floor, wall and ceiling finishes shall be protected from damage during subsequent work, and shall be thoroughly cleaned before handing over the works.
9.1 Timber

All softwood for carpentry and joinery work shall be well seasoned sound bright, free from shakes, large loose or dead knots, waney edges, warp, incipient decay, stained sapwood or other defects and shall be to the approval of the Engineer.

Only brass, galvanized or stainless screws will be allowed to use.

Timber for carpentry work shall be carefully sawn square and shall hold the full dimensions shown on the Drawings.

The hardwood for joinery work shall be to the approval of the Engineer, well seasoned, close grained and free from all defects. Hardwood for polishing or clear treatment shall be selected and kept clean.

Leafs, Shelves, drawers, sashes and partitions 17 mm thick of sandwich plywood covered on both sides and seen edged with (0.5 mm and 0.8 mm) thick Formica sheets internally and externally. All works shall be as per drawings and specifications.

Preservative treatment shall be approved by the Engineer. Environmentally-friendly preservatives.

The Contractor shall allow for all necessary cutting of timber to size and shape, for preparation of surfaces, for all fixings, for properly jointing and putting together including farming, gluing, doweling, screwing and mortising, for all cutting and waste, notching, sinking, scribing, mitres, ends, short lengths and any other sundry items of like nature and for priming all concealed surfaces of joinery. Aluminum primer shall be applied to concealed surfaces of all joinery timber.

All sizes and dimensions shown on the Drawings are finished sizes unless otherwise stated.

Timber for joinery work shall be finished work to the exact sizes shown on the Drawings with pencil rounded exposed arrises and no joinery shall be built in until inspected and approved by the Engineer.

All timber shall be properly seasoned and shall be planed square, straight and true and shall be free from the following defects:

- Sapwood slits, ring shakes and soft pith. Checks exceeding 1.5 mm wide.
- Checks exceeding 1.5 mm wide.
- Checks more than half the thickness of the timber in depth. Knots exceeding 20mm mean diameter.
- Knots exceeding half the width of the surface.
- Decayed or dead knots unless cut out and plugged.
- Loose knots or knot unless cut out and plugged.
- Pith pockets.
- Decay and insect attach including pinworm holes.

The whole of hardwood joinery shall be flush with timber surface and left clean and ready to receive any oiled or other finish.

Where screw fixings would show on the surface of hardwood, the heads shall be countersunk 6mm below timber surface and grain matched fillets not less than 6mm thick and traped and cut from matching timber shall be glued in and finished off flush with the face. This will apply equally to hardwood which is to be painted.

9.2 Moisture Content of Timber

The softwood generally shall have a maximum moisture content of 12%. The hardwood shall have a maximum moisture content of 10% and shall have been kiln dried. The whole of the timber for joinery work shall be properly stacked and protected from rain and ground moisture.
9.3 Plywood

The minimum thickness shall be 5mm.
Plywood face veneers shall be approved by the Engineer.
Plywood adhesives shall be approved by the Engineer.
The Contractor shall not be permitted to make up the required thickness by gluing together sheets of thinner plywood.

9.4 Timber Face Veneers

All timber face veneers that are exposed shall be selected to the approval of the Engineer and shall be hard, durable and capable of being finished easily to a smooth surface.
They shall be free from knots, worm and beetle holes, splits, glue stains, filling or inlaying of any kind, or defects.

9.5 Fixing and Jointing

Joinery work shall be carefully put together and properly jointed in accordance with best practice, all joints shall be glued and screwed or doweled. Any screws appearing on facework shall have the heads let in and pellated unless otherwise described. Softwood fixings shall be stout steel screws.
Where joinery is required to be put together and fixed with brass cups and screws, the cups for fixing hardwood joinery shall be cast brass cups with milled edges and shall be neatly let in to finish flush with the face of the work.
Nail lengths shall not be more than total thickness of sections to be joined less 5mm, but otherwise not less than twice the thickness of the section through which nails are driven.
Screw lengths shall be not more than total thickness of sections to be joined less 5mm, but otherwise not less than 1 times the thickness of the section through which screws are driven.
Proprietary plugs shall be approved by the Engineer.
Steel nails shall comply with BS 1202: Part 1.
Wood screws shall be brass complying with Bs 1210 with slotted countersunk heads.
Screw cups shall be brass complying with BS 1494: Part 2.
Synthetic resin gap-filling adhesives shall comply with BS 1204: Part 1, type WBP.
Synthetic resin close-contact adhesives shall comply with BS 1204: Part 2, type WBP.

9.6 Spacings And Additional Supports

Where no dimensions are specified or shown on Drawings, space battens, fillets, grounds studs etc., shall be used in accordance with the recommendations of the manufacture of the sheets and/or sections being fixed.
Where not shown on Drawings, additional supports shall be positioned and fixed for appliances, fixtures, edges of sheets etc., in accordance with the manufacturer's recommendations.
9.7 Doors

Door leaves with a polished finish are to be veneered as approved Hardwood veneered plywood factory finished and supplied with protective wrappings, and with all necessary preparation for ironmongery carried out.

All edges are to be lipped with hardwood and all beads and lippings are to match face veneers.

All doors whether light cored, solid cored and/or fire resisting shall conform to BS 459 and 476 and 4787 as appropriate with adequate blocking out for ironmongery etc.

Door frames shall be as shown on the Drawings all in wrought hardwood treated to match doors in accordance with door manufacturer's recommendations and should be manufactured and finished by the door manufacturer where possible.

Hardwood polished thresholds are to be provided to individual flat entrance doors. All other doors within flats should allow sufficient clearance for fitted carpets. The Contractor should ascertain requirements for clearance in all other positions from the Engineer.

9.8 Windows

Windows and fanlight sashes shall be framed to the size shown on the Drawings. Sashes hung folding shall have meeting beads screwed on. Glazing bars if required shall be of twice rebated section.

Aluminum windows (Best quality) will be used. Colour and type of section must be approved by the Engineer.

9.9 Fly screens

Fly screens to doors shall be framed and braced with rails styles and braces and filled in with aluminum mesh, 18x16 meshes per inch.

9.10 Frames

Frames to doors, windows and fly screens shall be provided and built in to the sizes shown on the Drawings or as directed by the Engineer.

Frames shall be securely tied to walls by means of steel or similar metal cramps, galvanized or dipped in bitumen and provided as follows:
(a). Door frames: three cramps to each side.
(b). Window frames: two or more cramps to each side according to size.
(c). Any other way approved by the Engineer (e.g. foam bond)

Doors, windows, etc. shall be carefully and accurately fitted to the frames to give a uniform clearance of not more than 3mm all round.

9.11 Architraves, Door Stops etc.

Architraves, door stops etc. shall be as shown on the Drawings and all properly mitred at intersections as approved by the Engineer.

Glazing beads where required shall be wrought splayed and rounded and shall be neatly mitred and fixed with small brads or lost-head nails.
**9.12 Fittings**

In connection with fittings such as wardrobes, cupboards, counters etc., the doors, frames, drawers, rails and framing etc. shall be properly and accurately framed together.

Before starting repetitive fabrication of any component, prototypes shall be prepared and approved. Unless components are specified to be built in, these shall not be made until all site dimensions have been checked.

Matching clearance holes shall be provided for all sizes of screw and matching pilot holes for screws of 6 gauges or more for screwing softwood.

Clearance and pilot holes to match screw sizes shall be provided for screwing hardwood.

Pilot holes shall be provided slightly less than half the diameter of the screw for screwing particle board.

All nail heads which will be visible in completed work shall be punched below timber surface.

**9.13 Finish**

All joinery which is to be polished, varnished or painted shall be finished smooth and clean by rubbing down with fine sandpaper.

**9.14 Protection**

All joinery shall be protected from damage during the course of the Works and on completion shall be to the Engineer's entire satisfaction. Before handing over the Contractor shall ensure that all doors, drawers, etc, work easily and shall make all necessary adjustments including those needed during the maintenance period.
SECTION 10: IRONMONGERY

10.1 Description

The Contractor shall provide and fix the ironmongery required by the Particular Specifications or shown on the Drawings complete, including all necessary screws, bolts, plugs and other fixings. The use of nails for fixing ironmongery shall not be permitted. The Contractor shall hand over all in a finished state and to the satisfaction of the Engineer. Any fitting must be heavy duty.

All ironmongery shall be of first quality and shall be obtained from an approved manufacturer. Butt hinges are to be aluminum alloy with silver anodized finish with double stainless steel washers, or as approved by the Engineer.

The Contractor shall be required to submit for approval samples of all items of ironmongery he proposes to use.

All doors shall be provided with an approved door stop plugged and screwed to the top wall mounted. All opening areas of aluminum work shall be provided with appropriate friction stays. The size, materials, finishes, type and quality of ironmongery shall be as described and shown on the Drawings.

Quality Assurances

Field Measurements: take field measurements prior to Preparation of shop drawings and fabrication, where Possible. Do not delay job progress; allow for timing and fitting where taking field measurements before fabrication might delay work.

Shop Assembly: Preassemble items in shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassemble and coordinated installation.

10.2. References

Applicable Publications: The following publications of the issues listed below, but referred to thereafter by basic designation only form a part of this Section.

1. Federal Specifications. Naval Publications and Forms Center. 5801 Tabor Avenue, Philadelphia. Pennsylvania 19120. USA, FF-W-92B Washers, Flat (Plain) and RR-G-861 E Grating, Metal, Bar Type (Floor, Except for Naval Vessels).
   A 27-83 Specifications for Steel Castings, Carbon, for General Application.
   A 53-82 Specification for Pipe, Steel, Black and Hot-Dipped, Zinc- Coated Welded and Seamless
   A 123-78 Specification of Zinc (Hot-Galvanized) Coatings on Products Fabricated from Rolled,
   Pressed, and Forged Steel Shapes, Plates, Bars, and Strip.
   A 153-82 Specification of Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
   A 569-72(79)...Specification of Steel, Carbon (0.15 Maximum, Percent), Hot Rolle Sheet and Strip,
   Commercial Quality.
Submittals
Submit items in accordance with the contract provision Product Data: Submit Manufacturer's specifications, anchor Details and installation instructions for products used in Miscellaneous metal fabrications, including paint products.

Shop Drawings: Submit shop drawings for fabrication and Erection of miscellaneous metal fabrications. Include plan, Elevations and details of sections and connections Show anchorage and accessory items. Provide templates for anchor and bolt installation in critical area. Where materials or fabrications are indicated to comply with certain requirement for design loading, include structural computations, material properties and other information needed for structural analysis.

10.3 Finish
The finish of the various items of ironmongery shall be as described as shown on the Drawings or as required and directed by the Engineer.

10.4 Fitting and Testing
All screws used for fixing ironmongery shall be of a suitable type, material, finish, size and shape to the satisfaction of the Engineer.

The hinges on which doors, windows, fly screen doors etc., are hung shall be carefully housed or let into the door, window, fly screen door etc., and to the frames.

All fittings shall be removed before commencing any painting operations and shall be re-assembled in place after all painting works are completed and approved by the Engineer.

All ironmongery shall be carefully wrapped and protected until completion of the work and any items or parts which are damaged or defaced or found to be defective shall be replaced at the Contractor's expense before handing over.

On completion of all locks, catches and similar items of ironmongery they shall be clearly labeled, with metal tags approximately 50x20mm and securely fixed to the keys and handed to the Engineer.

Door closers shall be fitted a maximum of two weeks before handover.

All floor and door springs are to be fully charged with oil and their operation checked to the satisfaction of the Engineer.

10.5 Standard Ironmongery for Internal Doors
Ironmongery is to be hard satin anodized aluminum alloy of best quality with matching screws fully matching and integrated. Where a supplier cannot offer the required ironmongery, the Contractor shall produce samples. All locks are to be provided with 2 keys on a key ring neatly labelled to indicate clearly the corresponding lock.

Any requirements for 'Master key' locking systems will be stated in the contract provision and Drawings.

All knob sets shall include the appropriate mortice latch or lock with a 70mm backset and with standard faceplates and roses unless otherwise noted.
SECTION 11: METAL WORKS

11.1 Cleanliness

All materials shall be free from scale, damage or defects. All welding, brazing or hot forging shall be carried out by approved processes.

Includes fixing complete to the structure heavy duty dowels and three points to be fixed from each side, architrave, door stopper, ironmongery, cylindrical locks handles (Wally or equal), 6 mm Glazing, gaskets, automatic closing piston, accessories, Hammer Finish painting in three coats in addition to two primer coats as per detailed drawings and Engineer's instructions.

Metalwork shall be approved by the Engineer before starting painting works.

HOLLOW METAL DOORS [AND PANELS]

Hollow metal doorframes shall be purpose made to the profiles and sizes shown on the drawings and obtained from an approved manufacturer. The doors shall be delivered to site complete with a factory applied anti-corrosive plastic coating, ties cast on to backs of frames for building in and rubber silencers on the locking stile.

The frames shall be stored in a clean, dry place, off the ground and protected from the weather.

The frames shall be free of all dents, bumps, splits, and cracks and any defective frames shall be made good or replaced at the Contractor's own expense.

Hollow metal doorframes shall be fixed and shown on the drawings all in accordance with the manufacturer's printed instructions and flushed up solid with plain concrete or cement mortar.

The rates for hollow metal door frames are to include for the supply and assembly of the complete unit including all necessary hole for fixing in walls in accordance with the manufacturer's printed instructions and plain concrete or mortar filling as shown on the drawings.

Galvanize metal work as specified and describe. and as manufactured.

11.2 Aluminum Doors

Extruded aluminum sections should be used as approved by the Engineer.

All visible surfaces of the sections shall be brilliantly polished prior to anodizing. The color of anodizing shall be as described in the Drawings and/or 8. Samples of colour shall be submitted for the Engineer's approval before work commences.

The sections shall be anodized to a minimum thickness of 25 microns. The supplier must submit necessary evidence to the satisfaction of the Engineer that the thickness of anodization is not less than 25 microns. In case of doubt the Engineer reserves the right to send sample pieces to independent testing laboratories, at the supplier's expense. If the testing laboratory report states that the thickness or quality of the anodization is deficient, the Employer may ask the supplier to treat the order as cancelled and the supplier in such a case shall indemnify the Employer of any/all losses incurred by the supplier.

All farms shall be made to fit the actual openings with a 5mm clearance all round. Discrepancies in overall width or height exceeding 5mm will not be allowed and the frames will be rejected in such cases. All small discrepancies shall have the gaps suitably backed and then filled with gun-applied mastic/sealant UV resistance as approved by the Engineer.

At all opening and doors and where there are louvered screens and approval of the Engineer, constructed following the principles and specifications as described elsewhere in this Specification.

Insect screens shall be in aluminum mesh, 18x16 meshes per inch. The gap between the insect screen and the shutter shall be covered with an adaptor PVC section.

For reference to window types see general arrangement drawings and elevations.
Tolerances are to be approved by the Engineer before manufacture. All ironmongery which is to have the same finish as the frames it is to be installed on shall be approved by the Engineer.

The Contractor shall provide shop drawings for aluminum doors which shall be submitted in quadruplicate to the Engineer for approval. Approval by the Engineer of the shop drawings shall not relieve the Contractor of his responsibilities under the Contract.

All assembly screws shall be in 18-8 stainless steel. Glazing sections shall be in special heat-resisting PVC and of channel type. Separate glazing sections on each side of the glass will not be permitted.

**Sliding Doors**
Weather-stripping - high density acrilan or wool weather - pile shall be used. There shall be double brushes at every contact between shutter and frame sections for complete insulation. These shall be present consistently throughout the unit between the inside and the outside and no portions without it are permitted.

The rollers for sliding shutters for doors shall be of an adjustable type. The adjusting screws shall be accessible in the assembled state of the shutters and a vertical adjustment of 7mm shall be possible.

All sections for sliding doors shall be of tubular shape and the cross-sectional dimensions of same shall be not less than 60x 40 mm.

The outer frame must be suitable for accommodating sliding fly screens as required or as directed by the Engineer.

The handle-latch set shall have all visible surfaces of anodized aluminum or similar non-rusting material to approval. The handle shall have a proper grip. A small projecting flange or a recess in the shutter sections shall not be accepted to serve as a handle. The latching mechanism shall not be surface mounted but shall be concealed within the sections.

**Side Hung Windows, Doors and Ventilators**
All windows and doors shall be weather-stripped with heat resistant PVC sections. The weather fighting action shall be achieved by a positive compressive action against the PVC section and shall not depend on an external contact with the PVC section. At every contact between two profiles two weather-stripped sections shall be provided for complete weather protection.

The bottom sections of hinged doors shall be capable of being adjusted vertically if necessary. The gap between the bottom section and the floor shall be covered with a pair of special flay-type PVC sections.

The shutter sections for windows and doors shall be of tubular type and shall be of overall size 57x45mm for windows and overall size 81x45mm for doors (including flanges).

The shutters of the windows and doors shall be assembled with concealed corners of high rigidity. Hinges shall be concealed within the sections.

Hinges shall be in anodized aluminum with stainless steel pins and nylon washers. Handles shall be in anodized aluminum and mounted with self-lubricating nylon washers.

A mortice cylinder rim automatic deadlock of high quality with double pin tumbler shall be used.

Windows shall have anodized aluminum handles and a latching mechanism securing the shutter to the frame both at the top and bottom.

The glazing vinyl shall be in heat resisting PVC and of channel type to the approval of the Engineer.
11.3 u-PVC Windows

- Material of windows Type PVC-U
- Specifications
  - 82 mm Frame Width.
  - $U_i$-Value for the Frame equals 0.134 Btu/(hr·ft²·F) (below/above/sides).
  - $\Psi$-Spacer (below/above/sides) equals 0.016 Btu/(hr·ft²·F).
  - $U_f$-Value for the Frame equals 0.133 Btu/(hr·ft²·F).
  - $U_cog$-Value Glass equals 0.088 Btu/(hr·ft²·F).
  - $U_w$-Value Window equals 0.114 Btu/(hr·ft²·F).
  - High insulation Heat and Sound resistance
  - Profiles shall be in compliance with EN 12608 standards.
  - Triple glazing 52mm glass thickness.
  - Windows, Air permeability, Permeability measurement, Leak tests, Pressure testing, testing conditions,
    Construction systems parts should be according to EN 1026
  - Windows. Water tightness. Test method should be according to EN 1027
  - Windows Resistance to wind load, Test method shall be according to EN 12211.

11.4 Sealing Joints

The Contractor shall ensure that joints are dry and shall remove all loose material, dust and grease.

Joints shall be prepared in accordance with sealant manufacturer's recommendations using recommended solvents and primers where necessary as approved by the Engineer.

Backing strips shall be inserted in all joints to be pointed with sealant.

When using backing strips, the Contractor shall not leave gaps and shall not reduce depth of joint for sealant to less than the minimum recommended by the manufacturer.

Cavities shall be filled with sealant /mastic joint has to be uv-resistance in accordance with the manufacturer's recommendations.

Joints between frames and walls have to be closed with pre –compressed polyutheane foam sealant

Sealant shall be tooled to form a smooth flat bed.

Excess sealant shall be removed from adjoining surfaces using cleaning materials recommended by the sealant manufacturer, and shall be left clean.

11.5 Expansion Joint Trims, etc.

The Contractor is to provide at all expansion joints in floors, roofs, ceilings, walls and columns extruded aluminum expansion joint cover systems as appropriate and as shown on the Drawings and fixed in accordance with their printed instructions including all necessary components and fixings.

11.6 Steel Pipe Railings and Handrails.

A. Fabricate Steel pipe railings and handrail to design, dimensions, and details indicated. Furnish railings and handrail members formed of the sized indicated conforming to ASTM A53, standard weight, galvanized.
B. Fabrication jointing of post, rail, and corners shall be by one of the following methods-
   1) Flush-type rail fittings of commercial standard welded and ground smooth with railing splice 
      locks secured with 10 mm hexagonal-recessed-head set screws.
   2) Mitered and welded joints made by fitting post to top rail and intermediate rail to post, mitering 
      corners, groove welding joints, and grinding smooth. Railing splices shall be butted and 
      reinforced by a tight-fitting interior sleeve not less that 152 mm (6 inches) long.
   3) Railings may be bent at corners in lieu of jointing, provide bends are made in suitable jigs and 
      that the pipe is not crushed.
   4) Furnish wall returns at ends of wall-mounted handrails.
   5) Close exposed ends of pipe by welding 5mm (3/16-inch) thick steel plate in place or by use of 
      prefabricated fittings.
   6) Furnish removable railing where indicated.
   7) Handrails shall be capable of withstanding a concentrated load of 91 Kg. (200 pounds) applied 
      at any point in any direction.
   8) Pipe 50mm dia. meter steel pipe welded joints.
   9) Posts 25mm diameter steel pipe; welded joints.
  10) Fitting Flanges fixed by screws.
  11) Mounting Adjustable flanges, with screws casting in concrete.
  12) Exposed Fasteners flush countersunk screws or bolts; consistent with design of railing.
  13) Splice Connectors Steel welding collars.
  14) Galvanized or stainless screws to be used

Floor joint covers shall be.5cm deep. Butt joints within continuing runs shall be a maximum of 6.00m 
apart and will be sealed during installation.

   Wall and ceiling joint covers shall be standard grey.

   Transition pieced at changes of direction and at joints between horizontal and vertical joint covers 
shall be factory fabricated.
11.7. FIRE RATED DOORS

11.7.1. GENERAL

One hour Fire rated doors, resistance to fire

SUBMITTALS
Product Data: Submit manufacturer’s product data.
Shop Drawings: submit shop drawings indicating locations, handling, sizes, elevations, materials and frames.
Certifications: Submit manufacturer’s certification stating that doors meet or exceed specified requirements (1 hour fire rating)

Quality Assurance
Certification of fire rated doors:

Delivery, Storage and Delivery
Deliver materials to site in manufacturer’s original, unopened containers and packaging, with labels clearly indicating manufacturer and materials.

Storage:
1. Store materials in a dry, ventilated area in doors, protected from damage and in accordance with manufacturer’s instructions.
2. Store doors in a clean, dry, well-ventilated building, in an area protected from damage and sunlight.
3. Store on flat, level surface.
4. Do not store directly on concrete
5. Do not subject doors to sudden changes in temperature or humidity.
6. Do not subject doors to sudden changes in temperature or humidity.
7. Relative Humidity: between 30 and 60 percent.

Handling
1. Protect doors during handling and installation to prevent damage
2. Do not drag doors across one another or other surfaces.
3. Handle doors with clean gloves to avoid smudging or staining.

11.7.2. PRODUCTS

2.1. Fire Rated Doors: -
Galvanized anti corrosion steel panels strengthened by welded horizontal and vertical stiffeners.
Firelock.
One fixed bolt on hinge side.
Three hinges.
Lower steel insert PVC covered color approved by the engineer.
Compressed fire resistance rock wool filling.
Intumescent strip on door rabbet.
Rubber sealing surrounding door.

2.2. Door finish: -
PVC coating in any color approved by the engineer.
2.3 Hardware:
Narrow security steel plates and handles in any color approved by the engineer.
Upper hydraulic door closer.
Optional panic lock/fire exit device.

11.7.3 EXECUTION

3.1 Examination
A. Inspect and verify frames are solidly anchored, allowing no deflection when door are installed.
B. Do not install doors in frame openings that are not plumb and level or are out of tolerance.
C. Notify the architect of conditions that would adversely affect the installation or subsequent utilization of the doors. Do not proceed with installation until unsatisfactory conditions are corrected.

3.2 Preparation
A. Acclimate doors to project conditions for 24 hours minimum before installation.
B. Do not remove labels from fire-rated doors.
C. Field finishing: Field finishes doors in accordance with door manufacturer’s instructions.

3.3 Installation
A. Install doors at locations indicated on the drawings and in accordance with manufacturer’s instructions.

Hinges:
B. Exterior Doors: Install 3 hinges on doors 7 feet tall or less, and 4 hinges on doors over 7 feet in height.
C. Interior Doors: Install 3 hinges on doors 7 feet 6 inches tall or less, and 4 hinges on doors over 7 feet 6 inches in height.
D. Install doorframe s as specified in wood doorframes.

3.4 Adjusting
Adjust and align doors for smooth operation without binding.
SECTION 12: PAINTING AND DECORATING

12.1 General

Every possible precaution shall be taken to keep down dust before and during painting processes. No paint shall be applied to surfaces structurally or superficially damp and all surfaces must be ascertained to be free from condensation, efflorescence etc. before the application of each coat.

Primed or undercoated woodwork and metalwork should not be left in an exposed or unsuitable situation for an undue period before completing the painting process. No exterior or exposed painting shall be carried out under adverse weather conditions, such as rain, extreme humidity, dust storms etc. Any external paints have to be UV –Resistance.

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

The contractor will be required to repaint at his own expense any work on which the paint is found to be incorrectly applied. The contractor shall be responsible for protecting from damage the paint work and all other work during and after painting operations including the provision of all necessary dust sheets, covers etc.

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

The number of coats stated in this specification is the minimum, and the Contractor must apply sufficient coats to achieve a proper even finish to the approval of the Engineer.

12.2 Materials

The decorating materials shall be obtained from approved manufacturers and shall be supplied in the manufacturers sealed and branded containers.

All materials must be thoroughly stirred before use, unless not recommended by the manufacturer.

All paints shall be environmentally friendly and for the use in internal rooms.

Details of mixing and application shall be in accordance with the specifications of the manufacturers concerned and to the approval of the Engineer.

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

Mordant solution shall be of approved manufacture.

Rust inhibitors shall be of approved manufacture.

Stopping for woodwork to receive clear finish shall be tinted to match surrounding woodwork, to the approval of the Engineer.

Stopping for internal woodwork, plywood, hardboard, and fiberboard, shall be linseed oil putty, tinted to match the colour of the undercoat.

Stopping for external woodwork shall be white lead paste and gold size well mixed.

Thinners shall be approved turpentine or white spirit.
Priming paints shall be:
(a) For woodwork: Leadless grey priming paint in accordance with the recommendations of the decorative coating manufacturer.
(b) For steelwork: red oxide priming paint.
(c) For galvanized, zinc or aluminum alloy surfaces: grey zinc chromate priming paint.
(d) For plaster, concrete and brickwork, ceiling boards etc.: alkali resisting priming paint in accordance with the recommendations of the decorative coating manufacturer.

Knotting shall be in accordance with BS 1336.

Undercoating shall be:
(a) Zinc oxide based undercoating paint;
(b) White lead based undercoating paint. Colors shall approximate to the finishing paint.
(c) Synthetic alkyd based undercoating in accordance with the recommendations of the decorative coating manufacturer.

Finishing paints shall be:
(a) Zinc oxide based oil paint:
(b) White lead based oil gloss finishing paint.
(c) Synthetic alkyd based finishing paint as approved by the Engineer.

Petrifying liquid shall be used undiluted as supplied by the manufacturer. A small quantity of water paint of the finishing colour may be mixed with the petrifying liquid.

Water paint shall be an approved brand of washable oil-bound water paint. Thinning shall be done with petrifying liquid or fresh water only.

Emulsion paint shall be of the Polyvinyl Acetate (PVA) type obtained from an approved manufacturer. The precise specification shall comply with the manufacturer's normal practice. In all cases thinning, shall be done with thinners supplied by the manufacturer or fresh water only.

Stain for woodwork shall be an approved brand of oil stain.

Polyurethane lacquer for woodwork shall be in accordance with the recommendation of the manufacturer.
Preparation Process

12.3 Internal Plaster, Fair Faced Concrete and Blockwork

Surfaces shall be allowed to dry out completely and cracks shall be cut out and made good with suitable hard plaster or cement and sand mix as appropriate, such repaired portions shall be allowed to dry out. No painting shall be carried out on plastering less than five weeks old.

Efflorescence shall be completely removed by rubbing down with dry coarse cloths followed by wiping down with damp cloths and allowed to dry. All surfaces shall be rubbed down with fine glass paper and brushed free of dust before applying any form of decoration.

Surfaces which are to receive water paint shall be treated with one coat of petrifying liquid applied by brush and allowed to dry for at least 24 hours before the application of water paint. A period of 24 hours or longer if necessary, shall be allowed between subsequent coats.

Fair faced concrete and/or cement and sand plastered surfaces which are to receive oil paint shall be given one thin coat of oil putty and allowed to dry for at least two days.

The surfaces shall then be rubbed down with fine glass paper and given a second thin coat of oil putty and when completely set The surfaces shall then be rubbed down with fine glass paper and given a second thin coat of oil putty and when completely set

All surfaces which are to receive oil paint shall be treated with one coat of alkali resisting priming paint applied by brush and allowed to completely harden.

12.4 Fiber Acoustic Boards etc.

Execution only by instructions and approval of the engineer in accordance with the recommendations of the manufacturer

SOFT BOARDS: where used externally or under humid conditions will receive one coat of priming paint and one coat of undercoat on back face and edges.

SOFT BOARDS: where used internally will receive one coat of priming paint and one coat of emulsion paint on back, face and edges.

HARD BOARD: composite panels will be treated in the same way as soft boards under humid conditions.

ACOUSTIC BOARDS: will be treated on the face in the same way as plaster, but the paint may be applied by spray; the backs and edges should not be treated.

12.5 Steelwork Including Windows, Louvers etc. Internally and Externally

Execution only by instructions and approval of the engineer in accordance with the recommendations of the manufacturer

If delivered galvanized, the surfaces shall be cleaned to remove grease and dirt before priming. Where rusting has occurred through damage to the galvanizing, such rust shall be removed by wire brushing back to clean metal and the galvanizing made good with a rust inhibiting agent.

The surface shall then be treated with one coat of mordant solution and one coat of zinc chromate priming paint.

If delivered primed, the surfaces shall be examined to ascertain that the priming paint is hard, firmly adhering and in good condition. If not satisfactory, the priming paint shall be removed and the surfaces cleaned to remove rust, and re-primed. If the condition of the priming paint is satisfactory, the surfaces
shall be cleaned to remove grease and dirt, minor damage to the priming paint being made good with red oxide priming paint after removal of rust.

If delivered unprimed and not galvanized, the surfaces shall be cleaned to remove grease and dirt, and wire brushed and scraped to remove all rust and scale before applying a red oxide priming paint.

Priming paint shall be brushed well into the surface and shall be allowed to dry and harden thoroughly before the application of subsequent coats.

Items of steelwork such as frames to roller shutters, covers to expansion joints etc., which are to be built into walls, shall first be primed.

12.6 Exposed Service Pipes

Copper and brass pipework shall have the surfaces slightly abraded with glass paper and white spirit or similar solvent and wiped clean. No priming paint will be necessary; the surfaces being finished in two coats of gloss paint.

Steel pipes will be treated as for steelwork with the exception that galvanized pipes are to be treated with a zinc-chromate priming paint.

Coated soil pipes shall be wiped clean and treated with two coats of knotting followed by priming paint as described below.

12.7 Woodwork Required to be Painted

Surfaces shall be cleaned to remove grease and dirt. The surface of teak shall be cleaned with white spirit to remove free oil. Tropical timber should be avoided. The preparation process shall then be:

(a) **KNOT**: all knots shall be treated with shellac knotting
(b) **PRIME**: one coat of primer shall be thoroughly applied by brush to all surfaces and when dry a further coat to be applied to end-grain surfaces.
(c) **STOP**: when priming paint is hard, all cracks, holes, open joints etc. shall be made good with hard stopping and all open grain surfaces filled smooth with linseed oil putty or an approved filler and rubbed down with fine glass paper.

No joinery shall be primed until it has been approved by the Engineer. Priming shall be carried out on the site and not in the factory.

Items of carpentry work which are to be built into walls etc. shall be first treated by twice coating with creosote or other approved preservative. And shall be environmentally friendly and for the use in internal rooms.

12.8 Woodwork required to be not stained

Surfaces shall be cleaned to remove grease and dirt. The wood shall then be stopped, filled and rubbed down. In the case of teak free oil shall be removed by cleaning with white spirit.

**Finishing Processes**

12.9 Internal Plaster

Where emulsion paint is specified three coats shall be applied by brush or sprayed in addition to any priming paint.
Where water paint is specified two coats shall be applied by brush or sprayed, in addition to the Petrifying liquid. The water paint shall be thinned to the consistency of thick cream.

Where oil paint is specified this shall be two or three coat work as detailed in the particular Specification, applied by roller or brush, but not by spray, to produce hard gloss, oil gloss, eggshell or flat finish as required.

The finishing coat of paint to walls and ceilings shall be applied after the completion and testing of the electrical installation. Any paint splashes on electrical fittings shall be carefully cleaned off.

**12.10 Fiber Boards etc.**

Both acoustic and plain soft or hard boards will be treated as for plaster, but the paint has to be applied by spray.

Water paint or emulsion paint shall be applied by brush to the specification of the manufacturers. Where a board is likely to be exposed to extreme humidity, i.e. kitchen and external corridors and covered ways, an oil paint shall be used on the face after fixing.

**12.11 Un-plastered Blockwork or Concrete**

As for internal plastered surfaces.

Externally a cement type paint may be used, and shall be applied keeping a constantly wet edge, in strict accordance with the manufacturer's instructions.

**12.12 Steelwork and Exposed Service Pipes**

Internally, apply one coat of hammer finished paint over two undercoats.

Non-ferrous pipes shall be finished in two coats of gloss paint.

Externally, apply two coats gloss paint over one undercoat.

**12.13 Woodwork Required to be Painted.**

Paints has to be avoided high maintenance and to apply the paint according to manufacturer recommendation.

**12.14 Woodwork Required to be Stained and Polyurethaned**

The woodwork, internally and externally, shall be stained as directed on site, rubbed down, brushed off, and treated with two coats of polyurethane.

**12.15 Protection of Factory Finished Work**

The contractor is to allow for protecting all factory finished doors, frames windows, suspended ceilings and the like at all times to ensure that factory finishes are not damaged and must make good or replace a defective component at his own expense.
SECTION 13: GLAZING

13.1 Sheet Glass
Sheet glass shall be flat-drawn clear sheet glass, of the substances shown below.

<table>
<thead>
<tr>
<th>Nominal Substance or thickness</th>
<th>Limits of thickness</th>
<th>Approximate Weight</th>
<th>Normal Maximum Size</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>mm</td>
<td>inch</td>
<td>lb/ft²</td>
</tr>
<tr>
<td>20oz</td>
<td>2.75-3.05</td>
<td>0.108-0.120</td>
<td>1 1/2</td>
</tr>
<tr>
<td>26oz</td>
<td>3.1-3.50</td>
<td>0.122-0.138</td>
<td>1 3/4</td>
</tr>
<tr>
<td>32oz</td>
<td>3.8-4.20</td>
<td>0.150-0.165</td>
<td>2</td>
</tr>
<tr>
<td>3/16 in</td>
<td>4.65-5.25</td>
<td>0.183-0.207</td>
<td>2 1/2</td>
</tr>
<tr>
<td>7/32 in</td>
<td>5.3-5.80</td>
<td>0.209-0.228</td>
<td>3</td>
</tr>
<tr>
<td>1/4 in</td>
<td>6.25-6.75</td>
<td>0.246-0.266</td>
<td>3 1/2</td>
</tr>
</tbody>
</table>

13.2 Plate Glass
Plate glass shall be cast, rolled or drawn glass ground and polished on both surfaces, of the thickness shown below.

Limits for Clear Plate Glass

<table>
<thead>
<tr>
<th>Nominal Substance or thickness</th>
<th>Limits of thickness</th>
<th>Approximate Weight</th>
<th>Normal Maximum Size</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>mm</td>
<td>inch</td>
<td>lb/ft²</td>
</tr>
<tr>
<td>3/16 in</td>
<td>3.97-5.56</td>
<td>0.156-0.219</td>
<td>2 1/2</td>
</tr>
<tr>
<td>1/4</td>
<td>5.56-7.94</td>
<td>0.219-0.312</td>
<td>3 1/4</td>
</tr>
<tr>
<td>3/8</td>
<td>9.13-10.72</td>
<td>0.359-0.422</td>
<td>5</td>
</tr>
<tr>
<td>1/2</td>
<td>11.91-13.49</td>
<td>0.469-0.531</td>
<td>6 1/2</td>
</tr>
</tbody>
</table>

13.3 Obscured Glass
Obscured glass shall be figured rolled glass, and of the thicknesses shown below.

<table>
<thead>
<tr>
<th>Nominal Substance or thickness</th>
<th>Limits of thickness</th>
<th>Approximate Weight</th>
<th>Normal Maximum Size</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>mm</td>
<td>inch</td>
<td>lb/ft²</td>
</tr>
<tr>
<td>1/8</td>
<td>2.94-4.4</td>
<td>0.116-0.173</td>
<td>1 1/2</td>
</tr>
<tr>
<td>3/16</td>
<td>4.5-6.1</td>
<td>0.177-0.240</td>
<td>2 1/2</td>
</tr>
<tr>
<td>1/4</td>
<td>6.0-7.0</td>
<td>0.237-0.276</td>
<td>3 1/2</td>
</tr>
</tbody>
</table>

13.4 Wired Glass
Wired glass shall be polished Georgian wired having both surfaces ground and polished and with square mesh inserted during rolling, of the thicknesses shown below.
Limits for Wired Glass

<table>
<thead>
<tr>
<th>Nominal thickness</th>
<th>Limits of thickness</th>
<th>Approximate Weight</th>
<th>Normal Maximum Size</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>mm</td>
<td>inch</td>
<td>lb/ft²</td>
</tr>
<tr>
<td>1/4</td>
<td>5.5-7.2</td>
<td>0.216-0.283</td>
<td>3 ½</td>
</tr>
</tbody>
</table>

13.5 Heat - Absorbing Glass

Heat - absorbing glass shall be floated glass substantially opaque to infra-red radiations of the thicknesses shown below.

Limits for Heat Absorbing Plate Glass

<table>
<thead>
<tr>
<th>Nominal thickness</th>
<th>Limits of thickness</th>
<th>Approximate Weight</th>
<th>Normal Maximum Size</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>mm</td>
<td>inch</td>
<td>lb/ft²</td>
</tr>
<tr>
<td>6mm</td>
<td>6</td>
<td>0.49</td>
<td>0.10</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Normal maximum size</td>
<td>4500 x 2500mm</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

13.6 Armourplate Glass

Armourplate glass shall be toughened safety glass made of heat treated polished plate of the thickness shown below.

Limits for Armourplate Glass

<table>
<thead>
<tr>
<th>Nominal thickness</th>
<th>Limits of thickness</th>
<th>Approximate Weight</th>
<th>Normal Maximum Size</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>mm</td>
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<td>5.56-7.94</td>
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</tr>
<tr>
<td>3/8</td>
<td>9.13-10.72</td>
<td>0.359-0.422</td>
<td>5</td>
</tr>
<tr>
<td>1/2</td>
<td>11.91-13.49</td>
<td>0.469-0.531</td>
<td>6 ½</td>
</tr>
</tbody>
</table>

13.7 Mirror Glass

Mirror glass shall be silvering Quality polished plate glass silvered on one side, copper-backed, varnished and painted of the thickness given in clause 2.02. Edges of mirrors shall be beveled.

13.8 Putty

Putty for glazing to metal shall be tropical grade metallic glazing quality and shall be approved.

13.9 Glazing Beads

Wooden glazing beads shall be of teak, splayed and rounded to the sizes shown in the Drawings and neatly metered and braded. No tropical timber shall be used.

Metal beads shall be supplied with metal windows and doors and these shall be sprung or screwed on according to design.
13.10 Glazing to Wood without Beads
The rebates shall be previously treated with one coat of priming paint and the bedding putty inserted. The glass shall be embedded in the putty and secured by sprigs. The front putty shall be inserted to form a triangular miter filling from the edge of the rebate to 2mm from the sight line. The bedding putty shall be trimmed off level with the sight line to form neat back putty. When the putty has hardened sufficiently the painting shall be carried out and care shall be taken to seal the joint between putty and glass by painting up to the sight line.

13.11 Glazing to Wood with Beads
The rebates shall be previously treated with one coat of priming paint and the bedding putty inserted. The glass shall be embedded in the putty and secured by the beads. The bedding putty shall be trimmed off level with the sight line to form neat back putty and the painting shall be carried out.

13.12 Glazing to Metal Without Beads
The rebate shall be previously treated either by rust proofing or priming as described elsewhere and the bedding putty inserted. The glass shall be embedded in the putty and secured by pegs or clips inserted in holes in the rebates.

The front putty shall be inserted to from a triangular mitred filling from the edge of the rebate to 2mm back from the sight line. The bedding putty shall be trimmed off level with the sight line to from a neat back putty. When the putty has hardened sufficiently the painting shall be carried out and care shall be taken to seal the joint between putty and glass by painting up to the sight line.

13.13 Glazing to Metal with Beads
The rebates shall be previously treated by rust proofing or priming as described elsewhere and the bedding putty inserted. The glass shall be embedded in the putty and secured by the Beads. The bedding putty shall be trimmed off level with the sight line to from neat back putty and painting shall be carried out.

13.14 Glazing without Putty
Where specified, wash leather, ribbon velvet, flannel, felt, of putty for internal glazing in conjunction with beads. The material should be fitted so that it covers all parts of the glass which will be covered by the rebate and bead.

13.15 Mirrors
Mirrors shall be fixed to walls with compressive spacers, fiber washers and chromium plated dome-headed screws, screwed into prepared plugs let into walls and set flush with surrounding wall finish.

Mirrors used as wardrobe doors or as wall linings are to be bedded with an approved mastic on a painted block - board backing not less than 12mm (1/2") thick to walls and 18mm (3/4") thick to doors. Glass sizes will be whole size to doors and minimum 900mm (3'0") wide to wall linings unless otherwise detailed, and backings continuous where possible.

Joints in backings must coincide with joints in mirrors.
13.16 Cleaning, etc
The Contractor shall replace all scratched, cracked or broken glass and clean all glazing on both sides and all mirrors before handing over.

13.17 Tempered Glass

1. **DEFINITIONS**
   Heat-treated glasses are classified as either fully tempered or heat strengthened. According to Federal Specification DD-G-1403B, fully tempered glass must have a surface compression of 10,000 psi or more or an edge compression of 9,700 psi or more. Heat-strength glass must have a surface compression between 3,500 and 10,000 psi, or an edge compression between 5,500 and 9,700 psi. The fracture characteristics of heat-strengthened glass vary widely from very much like annealed glass near the 3,500-psi level to similar to fully tempered glass at the 10,000-psi level.

2. **HEAT TREATMENT PRINCIPLE**
   Glass can fracture when its surfaces or edges are placed into tension. Under these conditions inherent surface or edge fissures may propagate into visible cracks. The basic principle employed in the heat treatment process is to create an initial condition of surface and edge compression. This condition is achieved by first heating the glass, then cooling the surfaces rapidly. This leaves the center glass thickness relatively hot compared to the surfaces. As the center thickness then cools, it forces the surfaces and edges into compression. Wind pressure, missile impact, thermal stresses or other applied loads must first overcome this compression before there is any possibility of fracture.

3. **STRENGTH**
   Under wind pressure, tempered glass is approximately four times as strong as annealed glass. It resists breakage by small missiles traveling approximately twice as fast as missiles which break annealed glass. Tempered glass is also able to resist temperature differences (200 °F - 300 °F) which would cause annealed glass to crack.

<table>
<thead>
<tr>
<th></th>
<th>Annealed Glass</th>
<th>Tempered Glass</th>
</tr>
</thead>
<tbody>
<tr>
<td>Typical Breaking Stress (large light 60 sec. load)</td>
<td>6,000 psi</td>
<td>24,000 psi</td>
</tr>
<tr>
<td>Typical Impact Velocity Causing Fracture (1/4&quot; light 5 gm missile, impact normal to surface)</td>
<td>30 ft/sec</td>
<td>60 ft/sec</td>
</tr>
</tbody>
</table>

4. **SAFETY**
   Fully tempered glass is used in many applications because of its safety characteristics. Safety comes from strength and from a unique fracture pattern. Strength, which effectively resists wind pressure and impact, provides safety in many applications. When fully tempered glass breaks the glass fractures into small, relatively harmless fragments. This phenomenon called "dicing," markedly reduces the likelihood of injury to people as there are no jagged edges or sharp shards.
   Fully tempered glass is a safety glazing material when manufactured to meet the requirements of the ANSI Z97.1 Standard and Federal Standard CPSC 16 CFR 1201. Federal Standard CPSC 16 CFR 1201, as well as state and local codes, require safety glazing material where the glazing might reasonably be exposed to human impact. This includes doors, tub and shower enclosures, side lights, and certain windows. Applicable building codes should be checked for specific information and requirements.

5. **USES FOR TEMPERED GLASS**
   Fully tempered glass is used traditionally in place of other glass products in applications requiring increased strength and reduced likelihood of injury in the event of breakage. The building industry, motor vehicle industry and certain manufacturing industries find tempered glass is effective and economical in a wide range of applications. Fully tempered glass can satisfy federal, state and local building code requirements for safety glazing in such applications as doors, side lights, shower and tub enclosure, and interior partitions. It is also used in storm doors, patio-door assemblies, and escalator and stairway balustrades. As a glazing product it is used in windows and in spandrel areas.
(for wind pressure, small missile impact and thermal stress resistance). Special building applications include sloped glazing, racquetball courts, skylights (see below), and solar panels. Any conditions or requirements imposed in the applicable safety glazing laws and building codes limiting such special uses should be determined prior to glazing.

The domestic motor vehicle industry employs tempered glass as side and rear windows in automobiles, trucks, and multi-purpose vehicles. Manufacturing industries use tempered glass in refrigerators, furniture, ovens, shelving, and fireplace screens. Tempered glass should not be used where building codes require wired glass for fire-spread resistance. Tempered glass should not be used, alone, where the objective is to provide security against forced entry or bullet passage. Combinations of annealed and tempered glass can be effective barriers against forced entry and bullet impact, if properly designed and constructed. When using tempered glass in fireplace screens, provisions must be made for expansion and edge insulation.

6. TEMPERED GLASS IN SLOPED GLAZING AND SKYLIGHTS

Because of its high resistance to thermal stresses and small missile impact, tempered glass is used in skylights and sloped glazing. On rare occasions when tempered glass in these applications fails, it may fail completely from the opening, individual fragments from tempered glass are relatively small and harmless. A number of these fragments may be loosely joined and fall in this manner. Such pieces do not have the sharp edges normally associated with broken glass but may have significant weight. Some building codes may require the use of screens under skylights. The use of screens may also be dictated by considering the risk of breakage and the resulting consequences.

7. HANDLING AND INSTALLATION

Tempered glass should receive the same care as annealed glass. Unfortunately, familiarity with the greatly improved strength of tempered glass may mislead people to exert less care in handling it. Careless handling and improper installation sometimes produce edge damage. Delayed breakage can ensue when edge-damaged tempered glass is subjected to a moderate thermal of mechanical stress. Full penetration of the compression layer will likely produce instantaneous total fragmentation of tempered glass. Hence, tempered glass cannot be cut or modified following heat treatment.

8. IMPERFECTIONS

Inclusions in glass originate from impurities in the batch or cullet, or are combined from furnace factories. Common forms of inclusions include aluminous stones, iron stones, and silicon. Nickel sulfide stones are uncommon, microscopic defects in glass, and may cause breakage. Delayed breakage may occur when a nickel sulfide stone is present near the center of the glass thickness. The tempering process rarely introduces imperfections into glass. The basic glass may contain bubbles, vents, chips, and inclusions which, if accepted or not revealed by inspection before tempering can cause breakage in the initial heating or final quench operations. If inclusions are not eliminated by self destruction during the tempering process, in rare cases they may lead to failure at a later time.

9. VISUAL APPEARANCE

Tempered glass possesses the basic optical qualities of annealed glass. The induced stress condition sometimes produces a slight bow in tempered glass lights. Tempered glass that has been manufactured in a vertical tempering oven contains small surface depressions resembling dimples along one edge. These marks are caused by the pointed metal tongs which support the glass during its passage through the oven. Glass which is passed horizontally through an oven may contain a very slight surface wave caused by contact with the rollers. The waviness can sometimes be detected when viewing reflected images from a large distance. Finally, the air quench nozzles discharge air in a fixed, reciprocating or rotating motion. The area of air quench can be seen through polarized glass as arrays of iridescent spots or lines. Under some lighting conditions these patterns can be seen in ordinary light.
SECTION 14: DRAINAGE

14.1 Scope

This Specification deals with the installation of the materials, fittings and equipment, the design and performance, the workmanship and the testing and commissioning of the below ground drainage.

This Specification is in addition to and will be read in conjunction with the Contract Drawings and relevant parts of the Contract Documents.

14.2 General

Works shall be constructed in accordance with BS CP 301: 1971 Building Drainage. The Contractor shall notify the Engineer of discrepancies between BS CP 301 and the working drawings and specifications.

Pipes and fittings shall be jointed and laid in accordance with the manufacturer's recommendations. The Contractor shall notify the Engineer of discrepancies between the manufacturer's recommendations and the design.

Unless otherwise stated, the provisions of the latest revised additions of relevant British Standards and Codes of Practice shall be held to be incorporated in the specification of materials and workmanship.

Drains shall be accurately laid, true to line and grade from point to point. Manholes shall be provided at changes of direction or gradient and at points of connection. Drain runs between manholes should be absolutely straight. Lines and falls shall be accurately set as shown on Drawings or as directed on Site.

Pipe work materials shall be as stated in the Particular Conditions or on the Drawings.

The Contractor shall perform all necessary excavation for drains, manholes, septic tanks, soak ways etc., and uphold sides, level or grade bottoms, return fill and ram and remove surplus spoil as directed.

The system shall be maintained in accordance with Clause 6 of CP 301.

14.3 Pipework

Excavation of any section of the work shall not start until a complete set of the pipes and components for that section is available.

The trench shall be as narrow as practicable but not less than the pipe diameter plus 300 mm from each side to permit adequate compaction of side fill. Adequate working space shall be left for pipe jointers and joint holes shall be formed where necessary.

The trench sides shall be kept vertical unless the approved use of a batter is unavoidable. In the latter case the sides of the trench shall be kept vertical up to 300 mm above the top of the pipe. If over width excavation occurs at or below this level the trench shall be reformed using concrete to 300 mm above the level of the top of the pipe or the Engineer’s approval shall be obtained for the proposed bedding for the wider trench condition.

Bedding material shall be
(a) Local korkar.
(b) Sand to BS 882 Zones 1 - 4.
Pipes and fittings shall be inspected before fixing, and defective items shall be rejected.

Pipes shall be laid with the socket ends against the flow and shall rest on a solid and even bearing for the full length of the barrel.

Trenches shall be back-filled only after drains have been tested to the satisfaction of the Engineer.

Flexible pipes including pitch fiber pipes, UVC pipes, steel pipes and tubes and ductile iron pipes shall be laid on a granular or sand bed. The trench shall be excavated below the invert level of the pipe to depth that will allow a minimum thickness of 200mm of Sand as bedding material which shall extend to the full width of the trench.

In rocky ground a minimum of 200mm of granular or sand bed shall be used.

The bedding material shall be well tamped down on the trench bottom which shall be free from hard or soft spots.

The finished bottom shall be true to line and gradient.

Rigid pipes including vitrified clayware, cement pipes, grey iron pipes and concrete pipes shall either be laid on a granular or sand bed or on a concrete base in the trench bottom. The type of base provided shall depend on the nature of the trench formation and the presence of ground water.

Where the nature of the ground is such as to allow the trench formation to be trimmed to provide a uniform and solid bearing, pipes shall be laid upon the formation. Socket and joint holes shall be as short as practicable and shall be scraped or cut into the formation.

Where because of the nature of the ground or the presence of ground water pipes cannot be laid directly on the trench formation, the trench shall be excavated below the invert level of the pipe to a depth to allow a minimum thickness of 200mm of granular bedding material which shall extend the full width of the trench. The bedding material, trench, etc., shall be as for flexible pipes.

Where pipes are to be laid with a concrete bed, bed and haunch or surrounds, the trench bottom shall be prepared as for the laying of pipes on a granular bed but with a layer of concrete at least 50mm thick. The pipes shall be supported clear of the trench bottom by blocks or cradles placed under the pipe and immediately behind each socket for short small pipes with a second block near the spigot end for long or large pipes.

The support should yield under load sufficiently to permit the barrel of the pipe to rest uniformly on its bed after the normal setting shrinkage of the concrete has occurred. The clearance under the barrel before placing the concrete should be not less than 100mm. The concrete bed or haunch should extend to 150mm on each side of the pipe.

Concrete shall not be laid until the drain has been approved by the Engineer.

Where rigid pipes with flexible joints are employed with a concrete bed, haunch or surround a simple constructional flexible joint shall be provided in the concrete at the face of a pipe joint at intervals of not more than 5 metres to reduce the natural rigidity of the concrete.

The first 300mm of filling above the top of pipes and the filling around the pipes shall be placed by hand over the pipe and compacted by hand in finished layers of 150mm to a maximum of 300mm and shall be selected material, carefully rammed around the pipes. The material shall be distributed equally to both sides of the pipe to buttress it to the sides of the trench. Subsequent filling shall be placed, rammed and watered if necessary in 300mm thick layers. Drains shall be kept free from earth, sand, surplus mortar and other obstructions during laying. Adequate cover shall be provided before using power compactors or heavy rollers.

Vitrified clay pipes and concrete pipes with more than 4.25 m of earth cover shall be laid on a 150mm thick bench of concrete and be haunched with concrete 150mm thick to at least the horizontal diameter of the pipe and above that level splayed tangentially to the extrados.
Where vitrified clay pipes and concrete pipes with more than 6 m of earth cover are used or where the pipes are laid in a heading or the cover is less than 1.2m if the pipes are laid in roads or 0.90 m elsewhere, the pipe shall be completely surrounded with concrete to a thickness of not less than 150mm.

The width of concrete beds shall be 150mm greater than the external diameter of the pipe on both sides.

Where drains run beneath buildings they shall be constructed of UPVC-SN8 pipe and shall be encased in concrete on bottom, top and both sides to a thickness of 150mm greater than the external diameter of the pipe and adequate flexibility in the pipeline shall be allowed.

The Engineer shall be consulted if pipes are to be laid with less than 600mm of cover or within 150mm of the underside of a concrete slab.

The head of every drainage system shall be ventilated and such ventilating pipes shall, where possible, be fixed against the outside face of an external wall unless otherwise shown on the Drawings and carried up to a height of 900mm above that part of the structure immediately adjacent to it. The ventilating pipe shall be fitted with a galvanized or copper wire balloon at the top.

Except where branches or other fittings occur, the top length of each ventilating stack shall consist of a complete length of pipe which shall be anchored 1.20 m from the top by means of wrought steel strap fixed as described elsewhere and painted to match the pipe. Any short length required to make up the length of the stack shall be fitted immediately below the top length.

14.4. UPVC Pipes and Fittings

UPVC-SN8 pipes and fittings shall comply with BS 4660.

All pipes and fittings on all soil, waste and vent pipes shall be in Un-plasticized Polyvinyl Chloride, with solvent weld cement joints, to pipes and fittings.

All branch waste and vent pipes from basins and sinks to stacks, floor gullies, collection boxes and manholes shall be in modified UPVC-SN4 with seal ring joints suitable to receive high temperature water discharge.

Fittings and coupling for use with UPVC pipes shall be jointed with solvent cement in accordance with manufacturer recommendations.

Fittings and coupling for use with UPVC pipes on movement joints shall be jointed with an incorporate synthetic rubber rings in accordance with the manufacturer recommendations.

Slip on cover plates shall be provided as a finish to pipe work, up to and including 50mm diameter, emerging from a wall in occupied areas other than service voids. Samples shall be first submitted to the Engineer for approval.

On pipe work up to and including 50 mm diameter union type fittings shall be provided to make up to outlets of basin, bath and sink wastes.

Access plates shall be fitted at the roof of each vertical stack at changes, to enable the complete disposal system to be internally cleaned and ridded.

Soil, waste and vent stacks above their highest branches shall be continued up words, at their full diameter, above roof level.
14.5 Safety

The Contractor shall provide, maintain and uphold safety measures adequate for the hazards of drainage works for all his employees. All safety measures taken by the Contractor should be approved by the Engineer. Such approval will not affect the full responsibility of the contractor toward the safety of all his employees, the supervision staff and any other third party existing on site.

The Contractor shall ensure that all timbering, shuttering, staging, strutting, ladders etc., used in drain trenches and pits are adequate for the duty involved.

14.6 Manholes

Manhole dimensions shall be as shown on Drawings.

Manholes shall be constructed from approved precast concrete rings.

Manholes, chambers, Septic tanks, disintegration and settling tanks and percolating pits shall be constructed in the positions and to the dimensions shown on the Drawings or as directed by the Engineer. The method of execution of all work in connection with these shall be as elsewhere described in the appropriate trades.

Manhole base slabs shall be according to drawings, and at least 150mm thick grade (A) concrete or as directed and approved by the Engineer.

Manhole cover slabs shall be a minimum of 150mm thick suitably reinforced grade (A) concrete, where also approved precast covers can be used.

Precast concrete manholes shall comply with BS 556.

Manhole sections shall be jointed using a cement and sand mortar, 1 : 2, proprietary bituminous or resin fillers. Where flexible fillers are used their shape, thickness and location in the joint shall be in accordance with the manufacturer’s recommendations. The remainder of the joint shall be filled with a cement and sand mortar 1 : 2, to prevent settlement of the sections with possible point contact and subsequent spalling of the concrete joint.

Precast concrete manholes used below water table level shall be surrounded with a minimum thickness of 150mm concrete which shall be not less than a 1:2:4 mix.

Sulphate resisting cements shall be used in concrete and mortar, or accepted epoxy paint should be made for all concrete and mortars facing the waste water.

Cast iron manhole covers and frames shall comply with BS 497 except that the bituminous based protective coating shall not flow or chip when exposed to temperatures in the range of 0OC to 76.7OC.

Manholes exceeding 1.00 meter deep internally shall have a minimum internal diameter of 80cm.

Where required the channels in manhole bottoms shall be constructed of glazed earthenware channels jointed in a similar manner to the pipes. Alternatively when so described the channels shall be formed in fine concrete finished smooth. The channels shall be semi circular in section and the concrete shall then be carried up vertically for a distance of 80mm at each side and sloped back at a minimum fall of 1: 10.

The benching shall be of fine concrete and shall be rendered over in cement and sand (1: 3) mix. Pipes entering manholes shall not project beyond the face of the internal rendering. The invert of the pipes and the channels shall be continuous. All benching surfaces should be painted by approved epoxy paint.
Covers and frames shall comply with the following:
GRADE A: Heavy duty covers suitable for heavy fast moving wheeled traffic (25 tons)
GRADE B: Medium duty covers suitable where heavy commercial vehicles would be exceptional (8 tons).
GRADE C: Light duty covers suitable for pedestrian traffic only (5 tons).

Manhole covers situated inside buildings or on verandahs shall be as follows:
(a) Double seal type cover and frame or
(b) Frame with ground - fit air tight cover manufactured for use inside buildings.

Manhole frames shall be bedded and pointed with cement and sand mortar and the rebates sealed with manhole grease.

Step irons shall be located and comply with BS CP 301, Clause 3.12.5.1.

Channels and benching shall comply with BS CP 301.

Where cast iron inspection chambers are shown on the Drawings these are to comply with BS 1130 using caulked joints and gasket sealed covers set in concrete block manholes benched to top of cover level. The manhole cover required can be single seal in lieu of double seal.
14.7 Septic Tanks (if applicable)

Septic tanks shall be sized and constructed of reinforced concrete for all sides with a block layer around the tank and according to drawings and specification mentioned in the BOQ as shown and constructed as stated in BS CP 302 unless otherwise stated.

External Walls of septic tanks shall be at least 300mm thick.

Where indicted on the drawings the Contractor shall provide an intercepting trap with cleaning arm and lever-locking stopper to be set in cement mortar in the intercepting manhole adjacent to the septic tank or inside the site boundary in the case of main drainage. The normal drop from inlet to outlet of trap shall be preserved. A fresh air inlet shall be taken to the intercepting manhole with 100mm cast iron drain pipes with an easy bend to a point just below ground level.

Septic tanks shall meet the requirements of the local Authority.

14.8 Soakaways

Soakaways shall be constructed in one of the following ways:
(a) Precast concrete rings to BS 556.
(b) 200mm (min) cast in situ concrete.

Cover and base slabs shall be at least 150mm thick Grade (A) reinforced concrete, or precast covers according to Specification and as directed and approved by the Engineer. Removable covers shall be as described for manhole covers.

Soakaways shall be of the sizes and in the positions shown on the Drawings or as directed on site by the Engineer.

Soakaways constructed in cast in situ concrete shall have walls of at least 200mm thicknesses.

Soakaways shall meet the requirements of the Local Authority.

14.9 Connections To Existing Manholes And Drains

When work is being undertaken on existing drains and manholes including the construction of new manholes, building in pipes, cutting through manhole walls, cutting out and reforming benching, completing pipe entries and making good the Contractor shall keep existing drains open to flow and reasonably free from debris at all times during the progress of works.

On completion, all work shall be in a watertight condition.
14.10 Cleaning, Protection and Testing Of Drains

The Contractor shall remove all silt and foreign matter from drains and manholes and leave the whole in a clean and workable condition.

In the event of delay between the laying of a drain and the placing of the first 300mm of backfilling over the top of the pipe, precautions shall be taken to protect the pipes from damage arising from differential exposure to sun or wind.

Lengths of drain, manholes and inspection chambers shall be capable of withstanding the test.

The test shall be applied after laying and before backfilling or placing concrete surround and bedding concrete.

Leakage of the section under test, including sweating, which causes a drop in the test water level shall be noted and the defective part of the work shall be rectified on the Contractor's own expenses.

The test shall be repeated after backfilling and any faults in the bedding or support of the pipe, inadequacies in design or accidental damage during or after backfilling, shall be noted and the defective part of the work shall be rectified on the Contractor's own expenses.

Whenever possible testing shall be carried out from manhole to manhole.

Testing shall not be started until at least 48 hours after completion of the last joint.

Tests before back filling:
(a) The section shall be filled with water and after about one hour test readings shall be taken.
(b) A test pressure of 1.2m head of water shall be applied at the high end of the section (but not let than 2.4m at the low end). Steeply graded mains shall be tested in sections.
(c) The loss of water over a period of 30 minutes shall be measured by adding water from a measuring vessel at regular intervals of 10 minutes and noting the quantity required to maintain the original water level in the standpipe.
(d) The average quantity of water added shall not exceed 0.06 liters per hour per 100 linear meters per millimeter of nominal bore of the drain.
(e) For sections of drain where the highest point is more than 1.2m below the water table the following infiltration test shall be undertaken.
(f) Inlets to the system shall be closed. Visual inspection at manholes or inspection chambers will reveal any flow the cause of which shall be investigated and the faults rectified.
(g) Tests for line, level and freedom from obstruction shall be applied by means of a mirror at one end of the drain and a lamp at the other.
(h) Final test: The water test shall be repeated in accordance with the requirements of the Local Authority or the Engineer.
(i) Tested have to be done only in company with the engineer.
SECTION 15:  
MECHANICAL WORKS & INSTALLATIONS

General

15.1 Layout

The Layout of the fitting and pipe work is approximate and diagrammatic only. The Contractor shall be responsible for laying out the fittings and equipment together with the service pipe work to satisfaction of the Engineer.

15.2 Pipe work and Fittings for Services

16.2.1. Piping
Each part of the piping systems shall be complete in all details and provided with all control valves and accessories necessary for satisfactory operation.

The drawings indicate generally the sizes of all main piping, and while the sizes are not to be decreased the Engineer reserves the right to change the runs and sizing of piping to accommodate conditions arising during construction.

All pipe work, valves, fittings etc. are to be as detailed for various services in the Schedules.

All piping shall be grouped wherever practical and shall be erected to present a neat appearance. Pipes shall be parallel to each other and parallel or at right angles to structural members of the building and shall give maximum possible headroom.

Pipe work shall generally be set around all columns and shall follow the contour of the building. Piping shall not pass in front of doorways or windows, nor be installed passing through ductwork or directly under electric light outlets.

Unless otherwise shown on the drawings or instructed on the site, all pipes shall have a minimum clearance of 75mm from floors and ceilings and 25mm from the finished face of walls or other surfaces.

All pipe drops shall be truly vertical, drain piping shall pitch down in direction of flow, and all pipework shall be installed with a continuous gradient to allow natural circulation, air venting and drainage. Levels are to be approved by the Engineer.

Run outs shall be graded in such a manner as to prevent air traps being formed within them when the mains expand or contract.

Pipes erected in plant rooms, vertical shafts or false ceiling spaces shall be arranged to provide maximum access, and generally all pipe work installed in voids, shafts or false ceilings and in other places where subsequent access is likely to be difficult and where ease of dismantling is not required, shall have welded joints.

Sufficient space is to be allowed for accessibility for servicing. No joints shall be formed in the thickness of walls, floors or ceilings.

Where pipes are to pass through reinforced concrete this must be ascertained before the concrete is cast and approval must be obtained for size of hole to be formed.

The Contractor is responsible for ascertaining the thickness of plaster and other wall finishes, skirting heights, sill lengths and floor finishes and routing pipe work to suit.
Where pipework is to be insulated, it shall be fitted in such a manner as to allow each pipe to be insulated the full circumference and also to allow the prescribed clearance, after insulation, between the insulation and walls, floors, ceilings, other pipes or the insulation on other pipes, to any other surfaces. Where pipes pass through or near walls, partitions or in chases, sufficient space must be left for the complete insulation treatment to be continued without interruption.

The Contractor shall be deemed to have included in his tender for work in setting pipes around all work and apparatus connected with other trades such as piers, wastes, drains, girders etc.

All reductions in sizes of horizontal piping shall be installed with eccentric fittings to maintain a level bottom.

Overflow and other warning pipes shall be fitted so that they discharge in obvious positions. Lightweight hinged weather flaps shall be provided which will close against wind pressure and open when discharging.

Pipe connections to equipment and valves shall be flanged for sizes 65 mm and above and with unions for other sizes, and shall be arranged for easy dismantling and removal.

All branches from mains shall be taken from the top of the main wherever practicable and shall be made in such a manner as to allow for expansion and contraction in both main and branch.

All sets, double sets and springs shall be formed on long lengths of tube with as large a radius as possible and shall be free from distortion.

The Contractor shall supply and install malleable iron unions for all pipes, up to and including 50 mm nominal bore to form removable joints at intervals of approximately 18 m and wherever difficulty in dismantling might occur.

All pipework shall be free of corrosion and without any signs of scaling pitting or excessive weathering, to the satisfaction of the Engineer.

Pipes stored on site shall be kept clean and off the ground and were possible stored under cover. Pipes corroded beyond normal "stock rust" conditions shall not be used.

The Contractor shall ensure that all tubes are free from internal obstructions. All burred and cut ends of pipes shall be well reamed and filed to ensure that the full bore of the pipes is maintained. The Contractor shall take special care to prevent dirt or rubbish entering the open ends of all pipework during storage and erection. Screwed iron caps or plugs or plastic caps shall be used for this purpose. Wood, rag, paper or other inadequate material will not be permitted. A valve fitted at an open pipe end shall not be considered adequate protection. Should any stoppage in the circulation occur after the various systems have been put into operation owing to non-compliance with these requirements the Contractor shall attend and rectify the matter at his own expense. Further information regarding flushing out of pipework system is given elsewhere in the Specification.

The Contractor will ensure that at no part of any one system does he include, either in contact or at a distance, dissimilar metals which will promote chemical or electro-chemical action, causing a weakening or failure of the service. This applies not only to the internal surfaces but also the external surfaces of all pipes, fittings, valves, plant, vessels, pumps and any other item of equipment in the installation.

Where pipes are held in vices, as when screwing, care shall be taken to ensure that the pipe surface is not damaged. Any pipework so damaged shall not be fitted.

The average depth of the inverts of mains below ground level shall be 60cm minimum. The Contractor shall mark out and accept the entire responsibility for the correct positioning of the
trenches required, both as regards line and level, and shall collaborate to the best of his ability with the Main Contractor in order to ensure adherence to the programme, and to avoid lengths of trench being opened up unnecessarily soon or remaining open unnecessarily long after the pipes have been satisfactorily tested. Depths of mains and branches must be approved by the Engineer.

Where piping is buried underground it shall be wrapped with PE (High density polyethylene protection insulation) of thickness 1.5mm factory applied. All wrapping shall be approved by the Engineer before the trench is filled in.

Any pipework which, in the opinion of the Engineer, does not conform as to material and workmanship with this specification shall be removed and fixed at the expense of the Contractor.

15.2.2 Joints
Reduction in pipe diameters shall be made by using one fitting only, be it reducing elbow, tee or coupling.

Where standard fittings are not available in the configuration required reductions to the run and branch connections shall be made with reducing sockets. Bushes will not be permitted.

Branch connections to mains may be employed where the sizes of the branch is two or more smaller than the size of the main. Generally sweep branches shall be made except for tees on headers, or where a sweep fitting would cause air to be trapped.

Upon completion welded joints shall be thoroughly cleaned with a stiff wire brush and screwed joints shall have jointing compound removed.

15.2.3 Plastic Piping
Plastic pipes shall be used only if approved by the Engineer (in all cases UPVC SN4&SN8 pipes must be used).

Cleaning fluids and solvent cements shall be suitable for use in the local ambient air conditions and operatives shall be fully trained in their use by attendance at an installation course organized by the manufacturers of the particular piping system.

15.2.4 Valves and Cocks
All valves and cocks for the services in which they are installed shall comply with the requirements of the appropriate Water Authority, and the Contractor shall include for any testing and stamping which the Authorities may require.

• Valves are to be provided as indicated and at all places necessary for the proper working, regulation, control and maintenance of the installation.

• Valves shall be either screwed or flanged in accordance with the Specification for the pipe work into which they are installed and as directed by the Engineer.

• Where flanged valves are specified, flanges are to correspond to appropriate BS specified in respect of the piping.

• Gate valves shall be used for shut-off purposes and globe valves shall be used for balancing purposes. All valves shall be designed for packing under pressure when fully open. Gate valves shall comply with BS 5154 or 5150. All valves must be approved by the Engineer.

• Taps and stop cocks shall comply with BS 1010 and shall be marked with the manufacturer's name or trade mark and the nominal size. All taps and stops cocks must be approved by the Engineer.

Valves shall be marked with the manufacturer's name or trade mark, the nominal size and the class number and must be approved by the Engineer.
Mixing valves shall comply with BS 1415 and shall be marked with the manufacturer’s name and trade mark and the nominal size, and must be approved by the Engineer.

15.3 Pipe installation

15.3.1 All piping shall be properly supported or suspended on stands, clamps, hangers, etc. of approved design. Supports shall be designed to permit free expansion and contractions while minimizing vibration. Pipes shall be anchored as directed by means of steel clamps securely fastened to the pipe and rigidly attached to the building structure.

Screw threads shall be cut clean and true and joints made tight without caulking. No bushing shall be used. Reducing fittings shall be used to change pipe size, and reductions to be made with eccentric reducers, short radius fittings shall not be used.

The drawings indicated generally the size and location of piping as designed for space conditions; ceilings heights and may not be changed until coordinated other contractors. If it is seemed necessary to modify the piping system, the contractor shall size the pipes on the basic of 3-6 fps. Velocity and re-check pump heads which are presently indicative and for purposes of an estimate.

Pipe work shall conform fully of the following requirements.
Piping shall be properly graded to secure easy circulation and prevent noise and water hammer. As much pitch as space conditions allow must be given. Capped dirt pockets to be installed at all risers heel, low points, and other places where dirt may accumulate must be provided. Allowance must be made for proper provision for expansion and contractions in all portions of pipe work to prevent undue strain in piping or machines. Expansion joints to be installed as directed by the engineer.

All fittings such as elbow, tees, bushes etc…shall be of best quality foreign made or local class “A” according local standard with smooth interior surfaces. Approved screw unions with bronze or steel bodies and ground brass taper or spherical joints shall be installed at traps instruments, etc… and where else directed to permit easy connection and disconnection.

Final connection to equipment and Fixtures shall be made in manner that will permit the complete removal of any fixtures or any piece of equipment without cutting of pipe line.

Each piece of pipe and each fitting shall be carefully inspected on the inside to see that there is no defective workmanship on the pipe or obstructions in the pipes or fitting. Joints in all screwed piping shall be made with red lead and boiled linseed oil completely covered the male threads.

Straight Elbows, bushing, long screws, or bull head tees shall not be installed, and all offsets shall be made with fittings. Pipes shall not be bent at any time.

Pipe work shall be installed in manner to allow for ease of air escape and system draining it shall be endeavored to obtain this naturally by gravity. However, where conditions do not permit it an automatic air vent shall be installed at all air pocket locations and drain gate valve shall be supplied and installed at all low points and risers legs.

<table>
<thead>
<tr>
<th>Service</th>
<th>Material Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Domestic hot and cold water</td>
<td>Steel Galvanized Schedule 40</td>
</tr>
<tr>
<td>Domestic water under ground</td>
<td>pex-pipe Cross linked polyethylene</td>
</tr>
<tr>
<td>Vent, feed, expansion</td>
<td>Steel Galvanized Schedule 40</td>
</tr>
<tr>
<td>Internal Drain</td>
<td>UPVC (SN4) Polyvinyl chloride resin</td>
</tr>
<tr>
<td>Sewage</td>
<td>UPVC (SN8)</td>
</tr>
<tr>
<td>Gas pipe</td>
<td>copper Type K</td>
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</tbody>
</table>
All piping black steel up to 11/4" shall be screwed and socketed with threaded fittings. All piping including 11/2" and above shall be welded or screwed and socketed. All steel welding elbow shall be of the long radius type except where space conditions do not allow. Joints shall be but welded single V type, elbow and fittings formed of welded cut pipe section will not be acceptable. No piping shall be hung from other piping and all hangers shall be of heavy construction suitable for the size of pipe being supported. All piping in the machine room shall provided with rubber in shear vibration eliminating.

1. Screwed Joints
Screwed joints on steel piping shall be clean threaded, pulled up tightly and made with approved jointing compound and long strand hemp. After joints have been formed, all surplus hemp should be cut away and the joints wiped clean. Alternatively, P.T.F.E. Taps may be used. Where galvanized piping is used, care shall be taken to ensure that threads are carefully cut, so that the number of exposed threads is minimized.

2. Flanged Joints
All flanged joints shall be flush and truly aligned and made with approved corrugated rings, compressed asbestos or composition joints. Flanges for connection to welded pipes shall be “slip on” or welding neck standard steel type made as indicated in the schedules. Flanges or unions shall be provided on straight runs at not greater than 12 meter intervals. Wherever possible, at piping connections to equipment, valves or other units requiring maintenance, servicing, or possible removal, the connecting joint shall be made by means of unions or flanges. Pressure rating or flanges shall match the pressure of the flanges on the equipment to which the pipe connected.

3. Unions
Unions are required on pipe 50 mm and under. Unions shall be ground taper joint type good for 8.37 Kg/sq. cm working pressure. Unions shall have bronze conical seats ground in. Flat unions shall not be used. Temperature midway between the high and low limits of normal service. Bellows expansion joints shall be provided with guides to ensure that all movement is taken up in the designed manner. The manufacturer’s recommendations shall be closely followed. Guides shall be secured rigidly and shall provide free movement for expansion without undue tolerance. Means for lubrication shall be provided where necessary.

4. Pipe Supports and Anchors
All supports for steel piping shall be ferrous. Supports for copper pipes shall be non-ferrous and chromium plated where chromium plated pipe is specified. Brackets or supports shall be set out so that they not obstruct the access to valves, flanges or other fittings requiring maintenance.

Supports for Steel Pipe-Works:
Piping at all equipment and control valves shall be supported to prevent strains or distortions in the connected equipment valves and control valves. Piping shall be supported to allow for removal of equipment valves and accessories with a minimum of dismantling and without requiring additional supports after these items are removed. All channels, angles, plates, clamps, etc, necessary for the fastening of hangers shall be furnished and fitted by the contractor. All hangers shall be properly sized for the pipe to be supported. Over-sized hangers shall not be permitted. Details of hangers and supports to be used by the contractor shall be submitted to the Engineer for approval before fitting. All hangers shall be provided with lock nuts and have provision for vertical adjustment pipes. Parallel groups of pipes shall be supported by trapeze type hangers of steel construction. Individual horizontal piping shall be supported by hangers consisting of malleable split rings with malleable iron sockets steel clevis type hangers, or roller hangers where specified or directed. Pipe standards with base flanges and adjustable type yokes shall be used for pipes supported from the floor. Vertical piping shall have wrought iron or steel clamps securely bolted on the piping with the end extensions bearing on the structure of the building.

Piping shall be anchored where required to localize expansion or to prevent strain on piping and branches. Anchors shall be entirely separate from hangers and shall be heavy forged or welded construction of approved design. Hangers for cold piping shall have hard wood inserts or high.
density insulation capable of withstanding the compression and allowing the hanger to support the pipe without any metal contact. No piping shall be hung from other piping and all hangers shall be of heavy construction suitable for the size of pipe being supported. All piping in the machine room shall be provided with rubber in shear vibration eliminating. Hanger.

5. Pipe Sleeves
All pipe openings through walls, partitions and slabs are to have sleeves having an interval diameter at least 1” larger than the outside diameter of the pipe or of the insulation passing through the sleeve. Pipes passing through external block work or concrete shall be provided with sleeves of galvanized standard weight steel pipe flush with walls and ceilings and extending one inch above finished floors. Pipes passing through internal partitions shall be provided with sleeves of gauge 22 galvanized sheet steel made flush with finished wall surfaces.

6. Flashing Sleeves
Flashing sleeves are to be provided where pipes pass through waterproof membranes. Flashing sleeves details are to be submitted to the Engineer for approval but generally they shall be provided with an integral flange set into the membrane. The associated pipe shall also have a flange and shield which shall extend beyond the insert and be sealed with approved mastic.

7. Pipe Insulation Protection Saddles
Insulation shields shall be used to protect the insulation on all pipes. Insulation protection saddles shall be welded to insulated hot pipes at roller supports. Wherever fiber-glass pipe insulation is installed, alternative high density insulation of equal thickness shall be installed in lieu thereof. Where hangers and insulation shields are installed the insulation shields shall bear only an insulation material which is of such density that it will not compress, crush or deform. Saddles shall consist of gauge 10 galvanized steel plates. The plate shall be curved to fit the contour of the insulation and shall cover the lower 180 deg. of the surface. Saddles shall be secure to the insulation by means of steel bands.

8. Strainers
Approved “self-cleaning” strainers shall be fitted in the section line of each pump and at the inlet connections to each feeder and make-up connections, and each automatic control valve of all apparatus of an automatic character, whose proper functioning would be interfered with by dirt on the seat or by scoring of the seat. All strainers shall be suitable for pressures as stipulated for the system concerned and are to be inspected and pressure tested at the works. All strainers shall be cast iron or bronze bodied of ample strength for the pressure to which they shall be subjected with suitable flanges or tapping to connect with the piping they serve. Strainers basket screens shall be stainless steel and shall be of ample strength to prevent collapsing the basket under shock loading. Each water strainer shall be provided with an approved valve dirt blow-out connection suitably piped to the nearest floor drain.

9. Automatic Air Vents
Wherever possible, all water pipe work system is to have open venting. At all high points in the system where this is not possible an automatic air vent shall be fitted and connected to the nearest drain. Air vents shall be of the float type. Sizes and working pressures shall be as indicated on the schedule, and/or in the bill of quantities. They shall be fitted with a suitable sized gate type lock shield valve.

10. Valves
Shut-off valves and balancing valves.
Gate valves shall be used for shut-off purposes and globe valves shall be used for balancing purposes. All valves shall be designed for packing under pressure when fully open. Shut-off valves shall be installed in both sides of all equipment.
Regulating valves shall be installed where indicated on the drawings and shall be of the Hattersley type P1373EC pattern or equal for screwed fitting or type 4733DR pattern or equal for flanged fitting.

11. Pipe work Underground Protection
Where pipe work is to be run underground it shall be wrapped with layer of PE (Polyethylene) applied by extrusion method 1.5 mm thickness wrapping from outside and fitting should be protected also.

12. **Union and Flanges**
Shall be provided on both sides of each piece of equipment. Also when required to facilitate removal of valve for repair. Union shall be provided for all piping 2” and smaller. Flanges shall be provided for all piping 2.5” and larger.

13. **Cleaning of pipe**
During constructions, the contractor shall properly cap all lines to prevent the entrance of sand, dirt, etc... All pipe, fittings, valve etc. shall be cleaned of grease, dirt, scale, and foreign material before installation. Before turning the project over to the owner prior to start-up of any mechanical equipment, all piping system shall be thoroughly cleaned following the hereinafter specified instructions. Piping shall be cleaned by operating system at normal operating pressure approximately 48 hours. At the end of the 48 hours’ period, contractor shall clean all strainers by removing baskets and flushing with clean water; Blowing down thru strainer blow down valve will not be acceptable.

14. **Testing**
The piping system shall be tested by accepted method and under 150 psi hydrostatic pressure. Test shall be maintained under inspection by consulting engineer for period of not less than 24 hours. If leaks develop test shall be repeated after leaks are corrected. No part of piping system shall be covered or concealed until it has been tested inspected and approved by engineer.

15.4 **Insulation**
All insulating materials required for general plumbing and equipment shall be furnished and installed according to this section of the specifications.
Insulation shall be installed in a smooth, clean, workmanlike manner and joints shall be tight and finished smooth.
All surfaces to be insulated shall be dry and free from loose scale, dirt, oil or water when insulation is applied.
Insulation shall be applied in such a manner that there will be no air circulation within the insulation or between the insulation and the surface to which it is applied.
Surface imperfections in the insulation such as clipped edges, small joints or cracks and small voids, or holes not over 25 sq.mm shall be filled with like insulating material or with insulating cement if approved by the Engineer.
Insulation for all services shall be continued through sleeves. The insulation on exposed risers shall extend through the floor.

15.5. **Domestic Water Services**
Generally water shall be supplied from the City Main and will connect either to the roof storage tanks or to the low level suction tanks. From the suction tanks water, shall be pumped up to the tanks at roof level. Connection can also be made directly to the water network in the building if it is available continuously.
The city water supply to building by φ1” inch size galvanized steel seam less sch. 40pipe wrapped from outside with layer of PE high density polyethylene insulated protection factory cover of thickness 1.5mm.
Laid underground with all necessary fitting and work from main city water supply pipe price. Completed with ф 1 inch water meter, shut of valve, check valve and strainer work include Fees for city municipality, sheet metal cabinet, excavation, back filling.

The price of tank completed with mechanical floater, connection for booster pump supply, drain valve and angle steel painted base of height 20 cm.

Where the rising main is installed in an open-to-sky void, it shall be in cast iron to BS 1211 with flanged joints or as directed by the Engineer.

All hot and cold water services shall be in galvanized steel sch.40.

The use of flexible connectors between services and sanitary fittings will NOT be permitted.

15.6. **Filter and Water Tanks**

All cold water storage tanks shall comply with the relevant British and local standards, and must be approved by the Engineer.

Drinking water tank of raw material linear low density polyethylene (food grade a drinking water) of white color and of capacity as indicated in P.O.Q the tank of cylindrical shape equipped with round screwed seated cover and supply with connection for city water supply building network supply pump water supply and rain pipe.

The price of tank completed with mechanical floater, connection for booster pump supply, drain valve and angle steel painted base of height 20 cm.

Tanks shall be fitted with a suitably sized ball valve and overflow

Before all pumps and control equipment and on the outlet from all tanks, a strainer shall be fitted.

The sizes of the tanks shall be as shown on the Drawings and noted on the schedules in the Particular Specification and the Contractor must allow in his rates for assembling, waterproofing, and providing holes, overflows and valves as required.

Alternatively, the Contractor may provide fiberglass tanks subject to their suitability for the project and the approval of the Engineer.

All tanks must be provided with strong covers and adequate access points for maintenance and cleaning.

15.7. **Tests at Site**

Pressure tests shall be applied to piping only before connection of equipment and appliances. In no case shall piping, equipment or appliances be subject to pressures exceeding their rating.

Tests shall be completed and approved before any insulation is applied or pipes, valves and fittings have been concealed. Tests shall be performed in the presence of and to the satisfaction of the Engineer. Any leaks or defects uncovered by the tests shall be repaired and the system re-tested at no additional cost to the Employer.

When the installation has been completed to the satisfaction of the Engineer, it shall be tested in the following manner:

(a) The entire system shall be slowly filled with water, allowing any trapped air to escape

(b) When all outlets are closed the system shall be checked for water tightness.

(c) Each outlet must be checked for rate of flow and correct operation.

15.8. **Cleaning**

The Contractor shall carefully clean out all cold water and hot water tanks, service pipes, sanitary fittings throughout, traps and wastes. The Contractor shall also overhaul and make good all flushing
valves, check regulating valves, check taps including re-washing as necessary and leave all
works in perfectly clean and working condition to the satisfaction of the Engineer.

15.9. **Sanitation and Rain Water Drainage**

The soil and waste system shall be installed in accordance with this Specification and bill of
quantities and must be approved by the Engineer.

Soil, waste and ventilation pipe work and fittings fixed in open-to-sky areas shall be in cast iron
or UPVC as shown on the Drawings or directed and approved by the Engineer.

Soil, waste and ventilation pipe work and fittings fixed in internal ducts shall be in un-plasticised
P.V.C. and according to manufacturer's specification and as approved by the Engineer.

Expansion joints and brackets shall be fixed in accordance with the manufacturer's
recommendations where required

Rain water pipes and fittings shall be as shown on the Drawings, Bill Of Quantities and as
directed by the Engineer.

15.10 **Testing**

Tests shall be carried out at the Engineer's request during installation in accordance with
manufacturer's specifications and to the approval of the Engineer.

**a) General**
The contractor shall submit to the engineer prior to the date of commencement of the tests his
proposed test procedure. The procedure method and points of measurement and the method of
calculation shall be approved by the engineer before any test is carried out.
The contractor shall supply skilled staff and all necessary instruments and carry out any test of any
kind on a piece of equipment, apparatus part of a system or on a complete system if the engineer
requests such a test for determining specified or guaranteed data, as given in the specifications.
Any damage resulting from the tests shall be repaired and/or damaged material replaced, all to
the satisfaction of the engineer at the expense of contractor.
In the event of any repair or any adjustment having to be made other than normal running
adjustment, the tests shall be void and shall be repeated after the adjustment or repairs have
been completed.
The tests shall not be made void due to circumstances beyond the contractor's control
All testing, balancing and final adjustment shall be in accordance with the provision of the
appliance B.S code of practice.

**b) Water Supply Systems**
All water supply piping shall be tested under hydrostatic pressure of not less than 1.5 times
(8Bar) working pressure psi, maintained for twelve hours. This test shall be applied to separate
lengths of pipe work before final connection of equipment and appliances but after all piping is
completed. Systems shall also be flushed. Test shall be completed and approved before pipes,
valves and fittings have been concealed. These systems shall be subject to a water test prior to
being covered and also tested for water tightness before backfilling. On any section of the pipe
under test, the head of water applied shall not be less than 3.00 meters and not greater than
6.00 meters. Tests shall be maintained for 20 minutes, and any defects shall be rectified and the
test reapplied to the complete satisfaction of the engineer.

**c) Drainage, Soil, Waste and Ventilation System**
These systems shall be subjected to a water test prior to being covered and also tested for water
tightness before backfilling. On any section of the pipe under test, the head of water applied shall not
be less than 3.00 meters and not greater than 6.00 meters. Tests shall be maintained for 20
minutes, and any defects shall be rectified and the test re-applied to the complete satisfaction of the engineer.

d) Final Testing
In addition to the above, final tests shall be carried out as directed by the engineer, just before final completion of the works and during the maintenance period.

15.11. Sanitary Fittings

15.11.1 General
Supply and install all sanitary fixtures shown on the drawings and as specified in these specifications.
Vitreous china fixtures shall be of the first quality with smooth glazed surfaces, free from wrap, cracks, checks, discoloration or other imperfections.
Fixtures shall be set in a neat, finished and uniform manner making the connection to all fixtures at right angles to the wall, unless otherwise directed by the engineer. Fixtures are not to be set until so directed by the Engineer.
Ample application of petroleum jelly shall be applied to all surfaces of exposed chromium plated piping, valves and fittings and stainless steel fixtures immediately after installation.
All fixtures shall be set, true, level, and finished in an approved and uniform manner.
Concealed brackets, hangers and plates shall have a shop coat of paint.
All necessary supports for fixtures shall be installed before plaster work.
All exposed piping and trim shall be chrome plated and fully protected during installation.
Strap or padded wrenches shall be used on chrome pipe fittings and valves.
All exposed metal parts in toilets rooms and bathrooms shall be chromium plated and fully protected during installation.
All valves in bathrooms, toilets and kitchens shall be chrome plated recessed type.
In the selection of the sanitary fixtures and their accessories, model numbers of manufacturer’s catalogues are given. A model numbers is given to describe the type and the shape of the item requested and does not in any way limit the supply to the model listed. Any item of different make judged by the engineer to be similar in quality and manufacture will be approved. Catalogues will be available at the engineer’s office for reference.
The location and disposition of all items shall be indicated on the relevant drawing
All sanitary fittings shall be of an approved quality obtained from an approved manufacturer. Sanitary fittings and their connections, services, wastes, overflows etc. shall be located as shown on the Drawings and shall be designed and installed to the satisfaction of the Engineer.
Details of the fittings are as shown in the Particular Specification and Drawings or as directed by the Engineer.
All sanitary fittings noted in the Particular Specification shall be properly assembled and the Contractor shall include for all waste fittings, traps, taps, plugs, chains, seats, handles, levers, fixings and brackets required to suit the installation.
All traps shall be of the correct size with a 3” deep seal and compression outlet connection.
When fixing washbasins (ceramic – with metal down pipes!), silicon or flexible putty is to be used. All washbasins are to be solidly affixed to the walls (using dowels, as appropriate).
15.11.2 Pipes and Fittings

Potable water main between city mains and water collector in floor water cabinet shall be galvanized steel sch. 40, heavy weight. Fittings shall be of seamless pipe with same characteristics as pipe.

Domestic cold and hot water pipes shall be sch. 40. All pipe fittings (elbow, tees, crosses, unions, reducers, etc...) shall be galvanized forged steel of the same quality and weight as the pipes. Pipes and fittings shall be suitable for threaded connections.

All drainage pipes 1 1/4" in diameter and larger shall be UPVC –SN4 (Polyvinyl chloride) of approved quality UAP-Plast.

All rain water pipes shall be UPVC-SN4 pipe. All fittings and accessories shall be of the same quality, and material of the pipe. All joints shall be rubber sealed stainless steel and plastic. Pipes and fittings shall be in accordance with latest JORDANIAN standards.

15.11.3 Local Regulations

All works shall be carried out to comply with the current local public health regulations, the latest BS 5572/BS 8301 and current local by-laws and shall be to the entire satisfaction of the Engineer.

15.12. Builders Work

Normally pipes will be fixed on the surface of walls and the Contractor shall perform all cutting and pinning for holder bats or plugging and screwing for pipe clips. Where pipes are required to be concealed in the walls etc., the contractor shall perform all cutting and subsequent making good. Pipes passing through walls and floors shall be sleeved with metal.

The expression 'Builders Work' shall mean work to be carried out by the Main Contractor under the direction of the Engineer in connection with the plumbing installation.

The Contractor shall prepare accurate drawings giving details of all holes, fixings, bases, and other builders work requirements and shall be responsible for their accuracy. The cost of any unnecessary work due to failure to comply with this condition will be charged to the Contractor and deducted from his account when making payment. The cost of preparing builders work drawings shall be included in the tender price.

If, in order to progress the contract, the Engineer has prepared certain details in connection with the builders work, the Contractor, when appointed, must immediately check these details against the architectural and structural drawings and if any additional work or alterations are required the Engineer must be advised immediately.

The following is a summary of the work to be carried out by the Main Contractor:

(a) Cutting and forming of holes for pipes or pipe fixings through walls, floors, ceilings, partitions, roofs etc., and making good after the work is sufficiently advanced.
(b) Building of concrete and/or brick ducts in floors, walls…etc.
(c) Formation of concrete bases, plinths etc. for plant and equipment.
(d) Building of manholes pits etc.
(e) Excavation, forming of trenches for services etc., and the filling in of same after the pipes are laid.
(f) Cutting or forming of chases, recesses etc. in floors, walls…etc. for pipes and fittings, and making good.
(g) Excavation for and laying of pipes and ducts.
(h) The building in of brackets and supporting bars or other form of pipes after fixing unless specified to the contrary.
(i) Painting of all pipes after fixing unless otherwise specified
(k) Providing and building in of sleeves through slabs and walls

Where pipes or fittings are fixed to concrete or woodwork by means of saddles or clips the Contractor shall himself execute the work necessary and shall include the cost of such work in the price given in the Form of Tender.


The contractor shall supply and install solar hot water heater of capacity as indicated in drawings /BOQ. The panels install on roof as indicated in the drawings while the cylinders will be placed on the Boiler Room, the following are the technical Specifications.

A- Solar Collectors
- High Efficiency Absorber titanium oxides selective treatment
- Bottom Rock Wool Insulation 50 mm, And Lateral Glass Wool 15 mm
- Solar Safety Glass Low Iron and High Optical Efficiency with 95% solar absorption
- High Robustness of frame designed according strict standard
- High resistance Glass to hail Tested according EN 12975-2.

B- cylinders
- Floor-standing vertical double-coil for the production of domestic hot water. Integrable with forced circulation solar system or high power heating system
- Capacity 2000 l
- Maximum working pressure 7 bar (according to EN12897-2006)
- Maximum working cylinder Temperature 95°C
- Solar coil surface 4.5m²
- Solar coil capacity 25L or more
- Operating coil pressure 10bar
- Upper coil capacity 20L
- Upper coil max. operating pressure 10bar
- Cylinder thermal dispersions less than 7 kwh/24h

System shall be completed with all fitting such as valves, union, safety valve, non-return valve and all piping necessary for connection to city water, cold water and hot water electrical cable connected to heater coil with adjustable thermostat and electrical switch with indicated lamp

15.14. Water Booster Pump

The contractor shall supply and install a BOOSTER centrifugal pumps as indicated on drawings and of capacities and ratings as indicated on drawings and bills of quantities. All pumps shall be centrifugal type single stage directly coupled to a squirrel cage, totally enclosed fan cooled induction motor by a flexible coupling.

Both pumps and motor shall be mounted on a common steel base frame which shall be securely fixed to a concrete base frame, suitable isolation pads must be provided for each pump. The pump shall have cast iron casing stainless steel shaft for cold water and good quality bronze impellers pump shall be fitted with pressure gauges on its discharge. The gauges shall be equipped with approved type cocks in order to take reading when required.

Each pump shall be fitted with a check valve on the discharge and an approved type strainer in the suction. Furthermore, each pump shall include with it two shut-off valves, two gate valve in suction and discharge. Pump speed shall not exceed 1450 R.P.M.

Each pump shall be driven by a constant speed motor and be provided with a suitable starter as specified under motor and starter clauses in the electrical specifications in this tender book. Each pump shall be guaranteed not less than the quantity of water against the circulating head given in the schedule when operating continuously without over-heating the motor or bearings.
15.16. Fans

16.16.1 General
Exhaust and return air fans shall be of approved quality and quite noise, supplied and installed by the contractor as shown on the drawings. The capacity, type and rating of the fans shall be as specified in the schedules. The fans motors and starters shall be in accordance with the specifications and electrical equipment.

16.16.2 Extractor Fans
The contractor shall supply and install as shown on the drawings a range of vent axia extractors or equivalent of ratings as indicated on the drawings.
Fan shall be either centrifugal or propeller type direct drive suitable for window or wall mounting.
Fans shall be designed to ensure lowest noise level and each shall be supplied with its starter or switch and weatherproof hood. Fans shall be constructed from non-corrodible materials. Fans shall be furnished with self acting louvers mounted on the face of fan.
The propeller will be strong and rigid giving large volumetric capacities and high efficiency, with non overloading characteristics and very quite operation.
The motor to be squirrel cage induced type suitable for continuous operation.
For wall mounted fan the motor to be attached to the fan ring by three arms of pressed steel.
Rubber inserts to prevent transmission of motor noise.
15.17 AIR-CONDITIONING SYSTEM

15.17.1 GENERAL

1. RELATED DOCUMENTS
   A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, apply to this Section.

2. SUMMARY
   A. The extent of VRF air-conditioners work is indicated by requirements of this section. Units are hereby defined to include, but not by way of limitation, refrigeration compressors, direct-expansion coils, filters, fans, and air-cooled condensers.
   B. The types of air-conditioning units required for project include the following:
      1. VRF SYSTEM.
      2. DX-COIL AIR HANDLING UNIT (DX-AHU).

3 SUBMITTALS
   A. Product Data: Include rated capacities; shipping, installed, and operating weights; furnished specialties; and accessories for each type of product indicated. Include performance data in terms of capacities, outlet velocities, static pressures, sound power characteristics, motor requirements, and electrical characteristics.
   B. Shop Drawings: Installation detail, piping connection detail, Diagram power, signal, and control wiring and differentiate between manufacturer-installed and field-installed wiring.
   C. Maintenance Data: Include Operation and maintenance manuals, including testing and commissioning procedure.

4 QUALITY ASSURANCE
   A. Manufacturers: Firms regularly engaged in manufacture of types, sizes and capacities required, whose products have been in satisfactory use in similar service for not less than 5 years
   B. The Agent or authorized dealer should be representing the manufacturer for not less than Five years and should be registered in Jordan for not less than 10 years, and should have not less than 5 years experience in selling, installing and maintaining VRF systems in Jordan. And the VRF System have been in satisfactory use in similar projects in Jordan of the same size or larger.
   C. Guarantee: Air conditioning units shall be the latest and newest model and latest technology for the manufacturer products and shall include a (5) five years full warranty on all parts and labor after acceptance by the Engineer and the owner. (cost of spare parts and labor deemed to be included in the contractor’s cost)
   D. Instruction of Personnel: At completion of the work, the Contractor shall furnish a competent service man to instruct Client's personnel in the proper operation and maintenance procedures to be followed. The instruction shall be given for a total of five (5) full working days; not including time spent trouble-shooting and adjusting the system as required by this Contract. At Client's option the instruction period may be postponed in part or in whole until a later period within the year following the completion of the Work.
   E. All VRF systems components and air handling units shall be manufactured in factories owned by the same brand name holder.
F. Provide manufacturer’s data certifying required performance for actual refrigerant pipes height and length.

G. Electrical Components, Devices, and Accessories: Listed and labeled to European norms by a testing agency acceptable to authorities having jurisdiction, and marked for intended use. All electrical connections shall be to NF 15-100.

H. All VRV/VRF Outdoor units and air handling units shall have a EUROVENT CERTIFICATION for performance.

5 WARRANTY

A. General Warranty: Special warranty specified in this article shall not deprive owner of other rights. Owner may have under other provisions of the contract documents and shall be in addition to, and run concurrent with, other warranties made by contractor under requirements of the contract documents.

B. Warranty Period three years from date of substantial operation

15.17.2 - PRODUCT

1. MANUFACTURERS

A. Available Manufacturers: Japan or European manufacturing origin, Subject to compliance with requirements, products that may be incorporated into the Work are:

1. Daikin (Japan-Europe)
2. Approved equal

2. GENERAL

A. The unit shall be a Variable Refrigerant Flow/Temperature inverter driven heat pump air conditioner, and shall be composed of multiple indoor units and an outdoor unit with a distributed refrigeration loop, electrical components and enclosing cabinets.

B. The indoor and outdoor units shall be properly assembled, internally piped and wired, tested and charged with R410 refrigerant.

C. All indoor units that will be connected to a system must be possible to be independently controlled depending on the requirements of each room. To be connected to the outdoor unit via wiring and refrigeration piping network. The wiring cables is not required to be shielded, but the installer will have to ensure that it will not be closer than 5cm to power cables.

D. System’s operation has to be based on pressure sensors and thermostats, which via a specially developed and designed integrated circuit will control the frequency of the motor (inverter) of the compressor by means of varying the compressor’s speed, thus changing refrigerant’s volume and temperature, this way and according to ambient temperature and building’s block load, will result in always delivering the necessary capacity while maintaining optimum efficiency.

E. Weather dependent variation of the refrigerant temperature – evaporating and/or condensing – will be an asset and will be most preferable, since it results in even greater energy savings and optimal seasonal efficiencies, as per all contemporary and latest directives and norms of the European Union.

F. It should be also possible to fix the evaporating temperature at different values in order to have the system operate with different Sensible Heat Factors. This way and depending on the indoor relative humidity the supply air temperature can vary (e.g. higher), thus increasing comfort levels through not so cold air supplied in the rooms. At the same time relative humidity levels can be maintained within the comfort zone according to international standards and guidelines.
3. INDOOR UNITS

Modern style, extremely quiet in operation, long-life washable filters, vibration free, large Surface area with HI-X Cu piping R 410A counter-flow design with profiled aluminum fins, Electronic expansion valve with stepping motor, 2000 steps for precise cooling unit
Adjustment between 0%- 100%.

Ducted Ceiling Unit:

According to the following specifications:

1. False ceiling duct connection unit.
2. DC Inverter fan with automatic static pressure judgment function. Ensures up to 20% reduction in the power consumption. And balanced flow distribution on the duct branches.
3. Variable external static pressure from 30 up to 120 Pa.
4. Possibility to change the external static pressure through wired remote control allows optimization of the supply air volume.
5. Height of the unit must not exceed 250 mm.
6. Radial fan, vibration-free and quiet running. Protected by a thermal contact.
7. Built-in drains pump as a standard up to 650 mm.
8. Fresh-air admixing can be admixed via a punched aperture.
9. Sound pressure not more than 40 dBA at high speed.
10. standard air filter: removes airborne dust particles to ensure a steady supply of clean air
11. Home leave operation saves energy during absence.
12. 3-step air flow control to improve the comfort level.
13. Possibility of bottom and rear suction (Return).
14. Microprocessor temperature control.

4 OUTDOOR UNIT

4.1 GENERAL

Outdoor units will have to be manufactured for operating with a three-phase power supply of 400 V / 50 Hz. and with full inverter compressor(s) per outdoor module for standard

The noise level - sound pressure - should not exceed 66 dB(A) under laboratory conditions, measured in a semi-anechoic chamber, at a horizontal distance of 1 meter from the unit and at 1.5 meters height from the base of the unit.

The outdoor unit must be suitable for outdoor installation. The shell/casing of the unit will have to be made of enameled stainless steel sheet, with polyester thermal powder coating (minimum 70μ) for high protection in environment near the seaside. The air-cooled heat exchanger of the outdoor unit will have to have undergone appropriate treatment for protection and long life efficient operation against atmospheric corrosion. Specifically, the

aluminum fins will be coated with a layer of acrylic resin and on top covered with a hydrophilic film or any other material which will provide minimum 5 to 6 times greater resistance to acid rain and salt corrosion (e.g. wind in coastal areas). The bottom of the unit will have a sheet of stainless steel for protection against oxidation.
In the outdoor unit there will be either one or two compressors in separate shells, so in case one fails it will not be necessary to replace both. Axial fan(s) DC inverter driven, air-cooled heat exchanger, piping, wiring and automation. The outdoor units will have factory-installed electronic expansion valves, oil separator, accumulator at the suction side of the compressor, high & low pressure sensors, DC inverter motors for the fan(s), protection thermostats, fuses, protection against overcurrent, protection for overloading of the inverter, liquid and gas stop valves and solenoid valves, timers and all the necessary sensors and protection equipment to ensure continuous, safe and smooth operation.

The outdoor unit - and consequently the whole system - will keep on operating even if one compressor is turned off (emergency operation). In case of a multi-outdoor unit system it will be possible to isolate one module, while the rest of the system will continue to operate even if delivering reduced capacity.

This way continuous air conditioning of the premises is ensured, until the cause ceases to exist.

All refrigerant piping connections should be soldered. Mechanical connections such as flanges, couplings or gaskets will not be accepted.

The system shall maintain smooth operation for up to 24 hours without any error even if there was a power cut-off on one indoor unit. The smooth operation shall have the option to be extended for more than 24 hours until the indoor unit is maintained back to its original condition.

The outdoor units will incorporate a "Soft Start" technology, to achieve a very low starting current in order to lower consumption, reduce power requirements of the electrical board and minimize the stress of individual parts of the outdoor unit (e.g. compressor's motor).

Taking into consideration that frost/ice build-up on the outdoor heat exchanger is mainly taking place at ambient temperatures ranging from -7°C to +7°C – depending also on humidity levels – the units should incorporate a special defrost function that will guarantee continuous comfort during defrost cycles. Defrost will have to take place regularly in order to increase efficiency of the system and protect the outdoor units from heat exchanger breaking down.

Defrost of the outdoor unit should happen by reversing the operation cycle. During the defrost the outdoor unit heat exchanger will be the condenser, by means of hot gas from the compressors' discharge will be used for the frost/ice melt down. In order to avoid cold drafts and also the absorption of heat from the rooms, the indoors will not be used as the evaporator during defrost. The outdoor unit must have a special heat exchanger that will be the evaporator during defrost. In case of multi-outdoor systems, the defrost of the outdoor heat exchanger will take place in a consecutive way, by means of defrosting completely each heat exchanger after the other. For single-module systems the most preferred technology for the special heat exchanger will the one of using a phase changing material. This material will provide the necessary heat for the defrost cycle, while ensuring that any residual capacity of the unit will be provided in the indoor units for continuous heating. The manufacturer will have to guarantee seamless operation and constant comfort levels during defrost at all ambient conditions.

Aforementioned defrost technology results in further increasing the seasonal efficiency of the system, since the indoor unit's coil, does not have to be reheated before the unit starts delivering the necessary capacity.

The systems will also feature a "Hot Start" function in heating to prevent cold drafts from the indoor units during the start-up period. During Hot Start the louver(s) of indoor units will have to be at horizontal position, while the indoor fan will operate at very low speed (LL: lower than the lowest that can be set by the local control).

The oil recovery from the piping network and the indoor units has to be achieved by the use of a microprocessor. The oil will be recovered at least once every eight hours, via a special oil recovery function, ensuring smooth operation of compressors constantly.
To avoid high start-up currents in multi-module systems, the outdoor units should start at different timings and with different sequence each time, in order also to make sure equitable operating hours, compressors’ strain and oil quantities in each module of the system.

Outdoor units should necessarily have a specific function and appropriate devices to prevent refrigerant in liquid phase to return to the compressor. This ensures the preservation of the proposed by the manufacturer density of the oil and therefore the adequate lubrication of the compressor. This function is increasing both the efficiency of the system and extends the lifespan of the compressor.

All outdoor units should have an auto-charge function for adding the necessary amount of refrigerant. This function is necessary for the systems to meet the standards and specifications set by the manufacturer. In addition, in the future it will be fast and accurate for the installer to check whether there is even a minor refrigerant leakage in the future. Operation with optimum quantity of refrigerant ensures efficient and economical system operation, while protecting the environment from the effects of global warming and at the same time meeting F-Gas directive requirements. It is needed to be possible to automatically check, all connections - electrical and piping - as well as sensors and valves in order to limit any human error or oversight.

In the outdoors units it is preferable to have a 7 segment decimal display, displaying detailed error codes, stage of a procedure or a function and operating data of the system. This will diminish human errors. For the commissioning of a system and in order to properly set all necessary data and values for the optimum operation of it, it is recommended for the starting-up the use of special software provided by the manufacturer of the system. The establishing of the values and the programming should be possible even offline.

4.2 COMPRESSOR

Compressors will have to be hermetically closed scroll type for greater reliability over time, with integrated motor and sound absorbing jacket. All of them will have to have a DC inverter driven motors will have the possibility to continuous change the frequency, resulting in changing the volumetric refrigerant flow from the compressor, in order to accurately and fast respond to the required load. The change in frequency should be done incrementally, but in enough steps so the change of delivered capacity can be approximated as linear. The minimum number of capacity steps will have to be no less than 100.

The motor windings will have to be specially constructed, in order to achieve the safe and smooth operation to avoid hazards due to the continuously changing of frequency and voltage. The compressors will be protected by an electrical crankcase heater to prevent oil condensation at low ambient temperatures.

The oil supply in the compressor will have to be on the high pressure side, ensuring optimum lubrication of all moving parts. Thereby it will not be required to have a separate lubrication system of all moving parts of the compressor, since the oil pipeline in the center of the crankshaft will be transported across the surface of the rotating parts in the direction from the center to the perimeter. This optimizes the performance of the compressor and minimizes stress and wear, extending its lifetime.
The compressors’ motors will have a cooling system using compressed gas, to avoid sudden changes in temperature resulting in significant stresses on winding and bearings. Compressors will alter the rotation speed linearly and proportionally consume energy in accordance in each room. The two DC inverter compressors will vary their speed separately in parallel and thus controlling the volumetric flow more accurately, with lower power consumption, resulting in higher efficiencies at all loads and connection ratios.

For protecting the compressor from frequent start-stops, there will be an appropriate timer.

### 4.3 FAN

The fan motor(s) of the outdoor unit will have to be DC inverter to further increase energy savings, to more accurately adjust the fan speed and reduce noise even more. The precise setting of the fan speed will result in precise control of system’s performance in accordance with the requirements of indoor and ambient conditions. The DC inverter fan motors will automatically adjust the rotation speed - thus the air flow - and have at least eight (8) different steps. Each fan will be separately controlled in order to further increase the accuracy on controlling the system.

The impeller will be made of plastic and with a special configuration to achieve greater air flow with quite low noise level. Outdoor units will have a protective cover to the fan against accidents and to avoid foreign objects entering the units. It will be special design and construction to minimize the external static pressure drop of the fan.

Fans will have a high external static pressure setting in order to reach at least 78 Pa. This will allow the installation / connection of duct(s) for greater flexibility during installation. In case of an outdoor unit with two fans, then each fan will have to be separately ducted.

### 4.4 CONTROL

Each indoor unit will be controller by wall mounted wired remote controllers. The length of the connecting wiring of the remote controller to the indoor unit could reach 500 meters. In this way it will be possible to install all local remote controllers at one given location.

The controller will have a high resolution LCD, which will indicate the various operating parameters of the controlled indoor unit(s), as well as possible error code. The user will be able to switch between simple and detailed mode, by means of displayed parameters. It will be highly preferred for the displayed information to be wording, instead of symbolic. The remote will have to be of contemporary design.

From the remote controller it will be possible to independently control the louvers of the indoor unit(s), if present. Any energy saving function and / or sensor related to indoors for increasing either efficiency and/or comfort, must also be possible to control by the remote controller.

The local remote controller will have an internal memory to store at least the last 9 error codes that happened. This way it will be easier to retrospectively conclude in the real cause of the problem.

It will be possible to connect, monitor and control at least sixteen (16) indoor units on one remote controller.

For each system it should be evident and clearly indicated which indoor unit is the one determining the operating mode (cooling / heating). Setting and changing this should be possible at any given moment - even after the first start up- by the user and without having to shut down the whole system of cut off the power supply indoors.

The controller will have a built-in room temperature sensor which in cooperation with the built room air temperature on the indoor unit will accurately control the operation of the unit, thus reaching the set point.
**DX-COIL AIR HANDLING UNIT (DX-AHU)**

**FEATURES OF THE CLOSURE PANELS**

A. The DX-AHU shall be a clean custom made upon capacity, air flow rate, ESP, fresh air intake, etc., provided with various air filter classes, heat exchanger (Optional), direct expansion coil inside.

B. The DX-AHU shall be compatible with both Heat Recovery (HR) VRF and Heat Pump (HP) VRF systems. The DX-AHU shall support individual control using the available Manufacturer Control Network Solutions (Control systems).

C. Selection software output must be submitted with equipment data sheets to show the coil capacity, Fans ESP, Filters classification, etc., and the selection software shall be EUROVENT CERTIFIED.

D. The DX-AHU shall be divided into factory assembled sections. Fans, coils or any other active part to be finished and run tested. Contained within the unit shall be all factory wiring, piping and fan motor. The unit shall have a self-diagnostic function, 3-minute time delay mechanism, and an auto restart function.

E. Unit Cabinet:

AHUs are to be installed outdoor. Therefore, it must be fitted with a protective roof in aluminum alloy.

It must be constructed according to the shape of the sections with specific folds, to ensure that no water can leak beneath the roof itself from section to section joints. It must also be built to avoid water stagnation and its lateral edges must be folded opportunely towards the inside to "envelop" the AHU both for safety purposes and in order to help the water drip down.

The cabinet shall be custom design in dimensions.

DX-AHU cabinet shall be divided into sections; each section should be supplied with all needed accessories, gaskets & adhesives for assembly.

The cabinet exterior structure shall be built from Aluminum frame with assembly hinges and covered by galvanized steel sheets or equivalent. Sheets shall be coated with single skin thermal coating for indoor installation or double skin thermal coating for outdoor installation.

The cabinet interior structure shall be supported by galvanized steel and will insulate by polyethylene plates.

Cabinet case shall have a maintenance access panel or more for each section with necessary accessories.

Cabinet base frame shall be galvanized or thermally coated, and able to handle each section weight specially in lifting case, also shall be drilled (Ø20-24mm) to be mount on kinetic isolators.
**Filters Section**

- Outside and return air shall be filtered by means of a mixing box contains custom class installed air filters rather single or multi stages one preventing from dust, molecules any other particles.
- Filter class to be suitable for the designed application upon standard specs.
- Filters shall be easy to install, cleaning and reinstall with suitable access panels.
- All the filters—regardless of their type - must be mounted on counter-frames with airtight seals and anchoring springs and must be easy to extract and inspect. Filters must always be removed from the dirty side (upstream of the filter).
- For each AHU, the contractor must provide a spare filter pack for each filter type.

**Return Fan Section**

- Fans shall consist of a multiple fan array system. Fans shall be sized such that if one fan fails, the remaining fans can be sped up to achieve the scheduled airflow at the scheduled total static pressure.

- Fan shall be an assembly with belt driven centrifugal fan by a single motor and with variable pulley pitch OR direct drive with High-performance radial impeller with circumferential diffuser mounted on an electronically commutated external-rotor.

- Fan shall be statically and dynamically balanced to run on a motor with permanently lubricated bearings, and to be mount to the cabinet by vibration isolators.

- Fan location should be proper for maintenance with enough space, access panels with glass window and service light inside the cabinet.

- Fan noise level shall be suitable for indoor / outdoor installation, a sound attenuator may require for duct works upon octave band calculations and installed duct works.

- A proper motor starter shall be provided.
F. Direct Expansion Coil Section (Standard)

- The coil shall be of nonferrous construction with slit fins on copper tubing.
- The tubing shall have inner grooves for high efficiency heat exchange.
- All tube joints shall be brazed with phos-copper or silver alloy.
- The coils shall be pressure tested at the factory at min. 40bar.
- Coil should be proper for R410a Refrigerant.
- A galvanized steel or aluminum condensate pan and drain shall be provided under the coil.
- The condensate shall be gravity drained from the fan coil.
- Both refrigerant lines to the Pre-Cool DX-coil shall be insulated.

G. Electrical Expansion Valves (EEV):

- Valves to be handle 40bar gas pressure.
- Fully controlled by a microprocessor unit, and logically connected to pressure sensor, refrigerant in/out temperature and on/off coil temperature sensors.
- EEV shall be installed in a multiple row regarding to DX coil circuits capacity.
- Valve shall be suitable to handle the rated DX-AHU circuit’s capacity.

H. Supply Air Fan Section

- Fans shall consist of a multiple fan array system. Fans shall be sized such that if one fan fails, the remaining fans can be sped up to achieve the scheduled airflow at the scheduled total static pressure.

- Fan shall be an assembly with belt driven centrifugal fan by a single motor and with variable pulley pitch OR direct drive with High-performance radial impeller with circumferential diffuser mounted on an electronically commutated external-rotor.

- Fan shall be statically and dynamically balanced to run on a motor with permanently lubricated bearings, and to be mount to the cabinet by vibration isolators.

- Fan location should be proper for maintenance with enough space, access panels with glass window and service light inside the cabinet.

- Fan noise level shall be suitable for indoor / outdoor installation, a sound attenuator may require for duct works upon octave band calculations and installed duct works.

- A proper motor starter shall be provided.

I. Electrical:

- The unit electrical power shall be 380/420 volts, 3 phase, 50Hz for both supply and return fans motor, and 220/240 volts, 1 phase, 50Hz for control unit and expansion valves

- The system shall be capable of satisfactory operation within voltage limits of 350-480 volts (400V/50Hz).
J. Controls:
This unit shall use controls provided by the manufacturer to perform functions necessary to operate the system. Please refer to Part 5 of this guide specification for details on controllers and other control options.

15.17.3 - EXECUTION

Control wiring:
A simple 2-wire non-shielded multiplex transmission system links each outdoor unit to multiple indoor units using one 2-wire, non-polar to simplify the wiring operation.

Pipes Connection:
Possibility of use either joints or headers. Connection sizes must be selected according to the system supplier recommendation.

Control:
Individual control for each indoor unit to be synchronized with the outdoor unit. Wired remote controller with digital display and function buttons. Equipped with real time clock to enable weekly and daily schedules. Possibility to be connected to a centralized controller or to a BMS system.

Pipes:
ACR type L seamless copper tubes according to ASTM B280 standards, with brazed, soldered, or flared joints. All copper tubes and fittings shall be properly sized and insulated according to the equipment manufacturer recommendations and specifications.

Table (1): Copper pipes sizes

<table>
<thead>
<tr>
<th>Pipe Outside Diameter</th>
<th>Pipe Wall Thickness</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.4</td>
<td>0.75</td>
</tr>
<tr>
<td>9.5</td>
<td>0.80</td>
</tr>
<tr>
<td>12.7</td>
<td>0.80</td>
</tr>
<tr>
<td>15.9</td>
<td>1.00</td>
</tr>
<tr>
<td>19.1</td>
<td>0.80</td>
</tr>
<tr>
<td>22.2</td>
<td>0.80</td>
</tr>
<tr>
<td>25.4</td>
<td>1.00</td>
</tr>
<tr>
<td>28.6</td>
<td>1.00</td>
</tr>
<tr>
<td>34.9</td>
<td>1.20</td>
</tr>
<tr>
<td>41.3</td>
<td>1.40</td>
</tr>
</tbody>
</table>

Installation:
Installation must be according to the system supplier recommendation.

Refrigerant: R-410A.

Origin: Japan / Europe.

Warranty: Three years.
**Local Distributer:** local installation running and operational experience for more than five years

### 3.1 INSTALLATION

A. Install unit’s level and plumb.

B. Install evaporator-fan components using manufacturer’s standard mounting devices securely fastened to building structure.

C. Install ground-mounted, compressor-condenser components on 100-mm-(4-inch) thick, reinforced concrete base; 100 mm (4 inches) larger on each side than unit.

D. Install ground-mounted, compressor-condenser components on polyethylene mounting base.

E. Install roof-mounted compressor-condenser components on equipment supports. Anchor units to supports with removable, cadmium-plated fasteners.

F. Install compressor-condenser components on restrained, spring isolators with a minimum static deflection of 25 mm (1 inch).

G. Connect pre charged refrigerant tubing to component’s quick-connect fittings. Install tubing to allow access to unit.

### 3.2 CONNECTIONS

A. Piping installation requirements are specified in other Division 15 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to unit to allow service and maintenance.

C. Unless otherwise indicated, connect piping with unions and shutoff valves to allow units to be disconnected without draining piping. Refer to piping system Sections for specific valve and specialty arrangements.

D. Tighten electrical connectors and terminals according to manufacturer’s published values. If manufacturer’s torque values are not indicated, use those specified in UL 486A and UL 486B.
3.3 FIELD QUALITY CONTROL

A. Installation Inspection: Engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including piping and electrical connections, and to prepare a written report of inspection.

B. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.

C. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation. Remove malfunctioning units, replace with new components, and retest.

D. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.4 COMMISSIONING

A. Engage a factory-authorized service representative to perform startup service.

B. Verify that units are installed and connected according to the Contract Documents and manufacturer.

C. Lubricate bearings, adjust belt tension, and change filters.

D. Perform startup checks according to manufacturer's written instructions and do the following:

1. Fill out manufacturer's checklists.

2. Check for unobstructed airflow over coils.

3. Check operation of condenser capacity-control device.

Verify that vibration isolation devices and flexible connectors dampen vibration transmission to structure.
16Electrical Works
Technical Specifications
ELECTRICAL WORKS

Preambles:

1. General:

1.1 Each section referred to in the bills of quantities shall be read in conjunction with the respective section and with all other sections of specifications.

1.2 The bills of quantities, specifications, schedules of equipment, drawings and all other contract documents are complementary to each other.

1.3 It is highly advisable that the contractor read the preamble prior to quoting his prices.

1.4 It should be understood that the unit rates of the bill of quantities items cover all needed materials, workmanship, equipment, accessories ... etc. needed to complete the work, regardless to whether they are stipulated in the items' description or not.

1.5 It is the responsibility of the contractor to check the locations and quantities of the materials and equipment's which should be executed in accordance with the contract drawings.

1.6 The unit rate of the materials and equipment - supplied by the contractor - should be as specified under each item concerned in the B.O.Q.

1.7 Manufacturers of equipment, materials and other accessories - supplied by the contractor - should be as specified in the list of approved manufacturers or equivalent.

1.8 Equivalent items should be equal in quality, standards, application and price.

1.9 Owner reserves the right to increase or decrease the quantity of works specified in the Bill of Quantities, regardless of the percentage of change in quantities, without any change in unit price or other terms.
PART 1 - GENERAL

ELECTRICAL SUB-CONTRACTOR

A. The electrical work shall be carried out by an electrical sub-contractor after SESAME Approval of the subcontractor technical expertise.

B. The electrical sub-contractor must have, during the entire duration of the Contract, qualified electrical engineer and electrical supervisor for ensuring proper execution and supervision of work. The electrical engineer should be licensed & registered with the Local Engineer’s Association and his name, qualifications and experience should be submitted for approval. The electrical engineer and supervisor should be available at site during all working hours.

C. The name of the electrical sub-contractor, details of his experience and his staff qualifications and experience shall be submitted by the tenderer with his tender in accordance with form shown hereinafter which shall be filled by the tenderer and his proposed sub-contractor.

1.01 SCOPE OF WORK

A. The Work included in these Specifications is for the complete Electrical Services for the Project. The Work described and included in this Specification is for the manufacture works, testing, supply, delivery to site, erection, connection, site testing, demonstrating, commissioning and maintaining for required duration, all equipment and installation as described in this Specifications and shown on Contract Drawings. Additionally, all equipment and installation shall conform to local authorities Specifications.

Any Works whether shown on the Drawings and/or described in the Specifications but which can reasonably be inferred as necessary for the completion and proper operation of the works will also form part of the extent of the Contract.

B. All Electrical Works complete in all respects shall be provided in accordance with the requirements of the Contract Documents. The scope of works shall include, but not be limited to the following:
1.02 A. RELATED SECTIONS

<table>
<thead>
<tr>
<th>SECTION</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>14200</td>
<td>Conveiance System</td>
</tr>
<tr>
<td>16000</td>
<td>Electrical Works</td>
</tr>
<tr>
<td>16010</td>
<td>General Provisions for Electrical Work</td>
</tr>
<tr>
<td>16110</td>
<td>Raceways</td>
</tr>
<tr>
<td>16120</td>
<td>Conduits</td>
</tr>
<tr>
<td>16200</td>
<td>Cables and Wires</td>
</tr>
<tr>
<td>16300</td>
<td>Supporting Devices</td>
</tr>
<tr>
<td>16400</td>
<td>Main Distribution Equipment</td>
</tr>
<tr>
<td>16500</td>
<td>Lighting</td>
</tr>
<tr>
<td>16640</td>
<td>Earthing</td>
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<tr>
<td>16670</td>
<td>Lightning Protection system</td>
</tr>
<tr>
<td>16720</td>
<td>Fire Detection and Alarm System</td>
</tr>
<tr>
<td>16760</td>
<td>Data System</td>
</tr>
<tr>
<td>16771</td>
<td>Public Address /Evacuation System</td>
</tr>
<tr>
<td></td>
<td>Audio Visual, Conference, Interpretation</td>
</tr>
<tr>
<td>16772</td>
<td>System</td>
</tr>
<tr>
<td>16960</td>
<td>Building Surveillance System (CCTV)</td>
</tr>
</tbody>
</table>

B. RELATED WORKS SPECIFIED ELSEWHERE

The following related service installations are specified in other divisions of the Specifications. The Contractor shall co-ordinate all his installation with the related works such as:
- Plumbing
- HVAC
- Fire Fighting
- Interior Finishes & Architectural Works
- Any other sub-contractor engaged for the project.
## 1.03 ELECTRICITY SUPPLY

A. All electrical equipment accessories and fittings shall be designed and manufactured to operate continuously in the electricity supply system having the following characteristics:

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voltage</td>
<td>415 Volts 6% 3Phase 4-Wire</td>
</tr>
<tr>
<td>Frequency</td>
<td>50 Hz 4%</td>
</tr>
<tr>
<td>Neutral</td>
<td>Solidly Earthed</td>
</tr>
<tr>
<td>Fault Level</td>
<td>31 MVA at 415 volts</td>
</tr>
<tr>
<td>Fault Duration</td>
<td>0.5 Seconds</td>
</tr>
</tbody>
</table>
1.04 STANDARDS

A. All works contained herein shall be subject in every respect to the approval of the Engineer.

The design manufacture installation and testing of all materials and equipment shall comply with the latest Local Authorities Specifications. Where no item is not specified by Local Authorities Specifications, relevant recommendation of the International Electrotechnical Commission (I.E.C.) and if this is not available then with the latest relevant British Standard Specification (B.S.S.) or other approved National Standards. Specifically, the following standards/regulations/codes shall be acceptable:

- IES/CIBSE Illumination codes
- CIE International Commission on Illumination
- Relevant British Standard Codes for Practice (BSCP)
- International Commission for Conformity Certification of Electrical Equipment (CEE)
- Specifications for Installation of Telephones, issued by the Ministry Of Telecommunication.
- The latest relevant recommendations of the committee ‘Consultant International Telephone and Telegraph (CCITT)
- Civil Defense Fire Department
- British Fire Officer’s Committee (FOC) Rules (Latest Edition)
- National Fire Protection Association (NFPA)

B. Standards for materials and the design of equipment are quoted throughout this specification and the Contractor shall produce copies of these Standards as required and instructed by the Engineer. If the Contractor offers equipment, which is not manufactured, in compliance with these Standards the equipment offered should be at least equal in performance and quality to that required by the relevant Standard.

C. In the event of the Contractor offering materials or equipment which differs from that described in this Specification, the Contractor shall include for all the costs involved in checking the design, any necessary redesign, drawings and the modifications to other equipment of the affected system.

D. While making an offer, the Tenderer should specify the name of the Manufacturer he intends to use for the supply of each equipment material/light fitting etc. In offering such material or equipment or light fitting he shall include with his tender the detailed information necessary to demonstrate quality. The presentation of such data shall take the form of a comparison sheet giving on one column the critical parameters required by the relevant Standard and/or equipment specified and an adjacent column giving the standards of the equipment offered in the Tender. Where manufacturers names are particularly specified for any item, the contractor must choose from the specified manufacturer(s).

E. The term “materials” as used in this Specification refers to any basic engineering equipment which forms part of the installation but which in itself does not form a unit which can be specified with an output performance.

F. Materials are related to a Standard whenever applicable and it is deemed that such reference, without further amplification, includes the whole of the current Standard. With the approval of the Engineer, alternative and equivalent National or International Standards may be used, but these must be declared and agreed at the time of Tendering.
G. All materials/equipment/light fittings manufacturers selected by the contractor shall have established local agents.

1.05 CAPACITIES AND DERATING FACTORS

The capacities and ratings of the equipment, electrical components and accessories shall be sufficient to give satisfactory service in the environments conditions stated herein before.

Sizes of electrical cables and wires shall be determined by suitably derating the current ratings of such cables and wires in accordance with the rating factors indicated in the I.E.E. Regulations. The attention of the Contractor is drawn to the fact that the application of derating factors for the higher ambient temperatures will not by itself render the equipment suitable for the climatic conditions of the site. Full considerations shall be given to the severe climatic conditions.
1.06 FUSING AND PROTECTION

A. The rating (in amperes) of circuit breakers, switch fuses and circuit ways of distribution boards given on diagrams or drawings are the maximum normal (operating) rating permissible for such circuit.

On completion of the installation it shall be the responsibility of the Contractor to set the overload protection appropriate to the actual loading on each circuit.

The Contractor shall be held liable to make good any damage resulting from overloading should it be discovered that overloads where improperly set or fused incorrectly rated.

Under no circumstances shall cartridge fuse carriers be bridged with loose fuse wire. In the event of such malpractice being discovered, the Contractor will be required to replace the whole assembly if such a fuse is blown.

1.07 RADIO INTERFERENCE SUPPRESSION

A. All electrical equipment shall be provided with suitable means of suppressing radio frequency interference fully in accordance with various requirements stipulated in relevant British Standards.

1.08 DIMENSIONS OF EQUIPMENT

A. The Contractor shall ensure that all plant and equipment included in his offer can be accommodated in the position shown on the drawings without structural alterations. The Engineer will not consider any claims for additional payments resulting from modifications arising from equipment of unsuitable dimensions being provided.

1.09 DRAWINGS

A. Refer to all other Architectural, Structural and Mechanical Drawings to verify all spaces and conditions affecting the electrical work and to ascertain the location and routes of all gas and water services, AC ducts, piping ...etc. so as to maintain adequate clearance between electrical and other services. The Drawings shall be available at the main contractor’s Office. In case of discrepancy the decision of the engineer shall be final.

B. **Shop Drawings**

1. Prepare and submit for approval, before commencing any portion of the Contract work, complete shop drawings, which shall show:

   - Exact routes of cables and ducts including sizes and details of installation.
   - Cable trays and ladders giving routes, sizes and details of supports and hangers.
   - Exact runs of conduits and trucking including sizes, draw boxes and junction boxes and the number and sizes of wires in each run.
   - Switch boards and distribution boards and control panels including location, layout, dimensions, fixing details, cabling and final connection arrangement.
- Proposed supports and hangers for cable trays, trunking, conduits, cables, light fittings …etc. including details of materials, finish, sizes and method of fixing to structure.

- The contractor shall submit sections and elevations as required by the Engineer to show details of installation showing plant, equipment, fixtures in true dimensions in relation to furniture and other elements in the concerned area.

2. Shop drawings shall be made to a scale not less than 1/100 or as required by the Engineer. A detailed duly updated record shall be kept by the Contractor of all service distribution routes and installation work during the Contract duly titled.

3. The shop drawings shall be coordinated with the work of all other Trades and shall where necessary show adjacent services to indicate satisfactory coordination. Where necessary or when requested by the Engineer, provide coordinated sections to a suitable scale to suit each condition. Drawings of other Trades which are not forming part of this Contract if required for coordination purposes will be issued to the Contractor by the Engineer.

D. Progress Drawings

1. Furnish and keep on the job site at all times, one complete and separate set of blackline prints of the Electrical Work on which shall be clearly, neatly and accurately noted, promptly as the work progress, all electrical changes, revisions and additions to work as actually installed. Wherever work is installed other than as shown on the drawings, such changes shall be noted.

2. Indicate daily progress on progress prints by coloring in the various parts of the Works as they are erected.

1.10 DISCREPANCIES

A. Before signing the contract, the Contractor should verify for himself any discrepancies between B.O.Q and the drawings. He may add in his offer any additional amounts that are required to meet the discrepancies. Under No circumstances he will be eligible for additional claims because such discrepancies
PART 2 – PRODUCT

2.01 MATERIALS

A. All equipment and materials used in the electrical installation work shall be new and of the highest quality. They shall be suitable for operation the standard voltage and frequency in the project.

B. Unless otherwise specified, all equipment and materials shall comply as a minimum with the latest relevant recommendations of the International Electrotechnical Commission (IEC). If these are not available for any equipment or material, then the latest relevant British Standard shall be followed.

C. If standards mentioned above contradict with this Specification, then the requirements of this Specification shall prevail.

D. Electrical equipment and material complying with other national standards may be considered for use in the work provided, the Contractor shall, at the time of submitting his offer, confirm in writing that such standards meet the requirements of IEC/BSS about characteristics, requirements and testing procedures as a minimum. The Contractor, if awarded the work on the basis, shall be required to substantiate this by producing all relevant data and test certificates and, if needed, by report from an approved inspecting and testing authority confirming that the results of the tests carried out on these equipment and materials meet the requirements of IEC/BSS as a minimum. Only after the production of such evidence and subsequent approval of the Engineer should the equipment and materials be delivered to site.

E. Submit to the Engineer full details and of all equipment and materials proposed for use and no material shall be ordered, delivered or constructed without a written approval from the Engineer. Any material or equipment, which is not approved but installed, shall be removed and reinstalled with approved one at the Contractor’s expense.

F. The details of equipment and materials shall include the following:
   1. Full technical specifications of equipment including construction, materials, degree of protection, characteristics, curves, diagrams, ratings, dimensions, fixing details, etc.
   2. Relevant sheets of manufacturer’s catalogues, specifications, technical data ...etc.
   3. Confirmation that equipment and materials offered complies fully with relevant Clauses of the Specification and, in case of deviation from the Specification, a schedule of deviations listing all points not conforming to the Specification.
   4. Short circuit study including all components shown on the Schematic Diagrams.

G. Submit, at the request of the Engineer, a sample of any equipment or material for further study before approval.

H. Manufacturers specified by name are not relieved of the responsibility for meeting Specification requirements and submittal for approval.

I. No order shall be placed by the Contractor for major material or equipment unless written approval of the Engineer has been obtained. The Contractor shall report monthly progress of the purchase orders to the Engineer submitting to him a copy of the orders.
PART 3 – EXECUTION

3.01 WORKMANNISHIP

A. The works shall be executed in a neat, substantial and workmanlike manner. All workmanship shall be strictly first class in every respect and shall be performed only by skilled workmen.

B. Whether or not shown on the Drawings, equipment shall be installed in such a manner that equipment, operating and control devices ...etc. are readily accessible for service and adequate access spaces are maintained.

C. Obtain detailed information from the manufacturers of equipment as to proper method of installation and connection of these equipment.

D. Should any portion of the Contract work which should reasonably and obviously be inferred as necessary for the complete, safe and satisfactory operation of the electrical installation as a whole, but not expressly described or specified, provide and execute such works as part of the Contract.

3.02 CONTRACTOR’S REPRESENTATIVE, STAFF AND WORKMEN

A. The Contractor shall keep permanently on the site, a competent Senior Electrical Engineer, having an experience of not less than 10 years, as his representative fully experienced and who has executed as Superintendent of electrical installation works of the type and scale similar or larger than this Project.

B. The Contractor shall submit to the Engineer the Schedule of Proposed Contractor’s Engineers Senior Draftsmen and Senior Foremen employed for this Project stating the names, nationalities, ages, qualifications and detailed experience before proceeding with the Works. The Contractor shall from time to time supply any further personnel in addition to those proposed and approved as may be necessary to ensure the satisfactory progress of the works.
3.03 IDENTIFICATION AND LABELLING

A. The components of all main and sub-main switch boards, all distribution boards, switches, isolators and other items of plant shall be clearly identified by means of labels secured to the external surfaces of the units designating the function of these units.

B. The labels shall be 2mm. “Trafalite” of minimum size 50 x 20mm with 5mm black lettering on white background fixed securely to front plates of distribution boards, switches, circuit breakers, isolators, starters, push buttons, lamps, instruments ...etc.

C. In addition to this each distribution board shall also be provided with circuit schedules fixed rigidly inside the door of the board and indicating the number, rating, type of load and location of each circuit in the board.

D. Each end of each cable shall be provided with identification labels lettered with feeder or circuit designation to the Engineer's instructions. The labels shall be permanently fixed in distribution boards, terminal boxes, isolators, etc.

E. Manufacturers name plates shall include manufacturer's name, model or type number, serial number and all applicable ratings clearly marked thereon. The name plates shall be placed in a conspicuous location on the equipment.

3.04 TESTING AND COMMISSIONING

A. On completion of the entire electrical installation work or any separate or distinct part thereof, notify the Engineer, in writing, that the completed part of the electrical work is ready for inspection. Before doing so, perform initial trial tests. Test, correct, adjust, balance, regulate, etc. the section concerned as necessary until required conditions are obtained.

B. The inspection of the Contract work shall be carried out in the presence of the Engineer and in accordance with the requirements of Section 'E' of the IEE 'Regulations for Electrical Equipment of Buildings' and shall comprise of but not be limited to:
1. Verification of polarity.
2. Effectiveness of earthing.
3. Insulation resistance test.
4. Test of ring circuit continuity.
5. Phase rotation.
6. Operation tests of relays, interlocks and any other protective and control device to ensure correct functioning.

The results and readings obtained shall be equal or better than the requirements of the IEE and the local authority’s regulations and these shall be recorded on forms like the ones described in the IEE regulations.
C. Supply all instruments and tools required for carrying out the tests.

D. In case that the above-mentioned tests are satisfactory and no errors or faults appeared in the installation, submit the necessary test forms duly filled, to the local authorities and to repeat, if necessary, the tests in the presence of the local authorities Inspector.

E. Follow-up and make all necessary arrangements with the local authorities for providing permanent electricity supply and telephone service. Also, provide all facilities and attendance to the local authorities for any other tests carried out before energizing the installation.

F. After the connection of the supply to the installation, commission all parts of the electrical installation covered by this Specification and demonstrate to the Engineer that the entire electrical installations are in perfect working order.

G. When equipment or services of a specialized nature are involved, and if it was found necessary, provide the services of a specialist from the manufacturer who shall be present at the time of testing and commissioning of this equipment. Include for all expenses incurred in this respect as no claim for additional payment will be entertained.

H. Acceptance certificate will not be issued until all testing and commissioning has been carried out to the satisfaction of the Engineer and local authorities. After local authority’s final approval microfilm of as-built drawing shall be given to the Engineer for permanent record.

I. An amount equal to 5% of the contract value for the Electrical, Communication and Electronic works will be retained till the completion of all commissioning. This amount is in addition to the 10% retention money, which will be release after the completion of 2 years of maintenance contract.

3.05 OPERATION AND MAINTENANCE MANUALS

A. Submit to the Engineer, at the same time of submitting “Record Drawings”, properly printed and bound copies of service manuals for the electrical installations to describe the various systems in the fullest details that permit application of proper maintenance, replacement of parts and awareness of system characteristics. These shall include the following:

1. Manufacturer’s technical catalogues, dimensional drawings and wiring diagrams for each type of equipment installed.

2. Operating instructions for various equipment and systems included in the installation work.

3. Maintenance manuals for all equipment and systems included in the installation work, which need regular and specialized maintenance.

4. Spare parts list with part numbers of various components of all equipment used in the installation work.
3.06 OPERATION AND MAINTENANCE DURING TWO YEAR MAINTENANCE PERIOD

A. Include for Operation and Maintenance including Preventive Maintenance during the two (2) year Maintenance Period.

B. Include all spare parts for replacements made necessary due to wear and tear of equipment, consumable parts, short life parts, oils, etc. and all maintenance tools and equipment required for proper operation and maintenance of the Works, the contractor should submit a list of spare parts to be included with his offer for each item.

C. Include for sufficient personnel’s to be on call for 24 hours 7 days a week

D. Include all routine and preventive scheduled maintenance as recommended by the equipment manufacturers to keep equipment in perfect operating condition.

E. Keep all records, logbooks, log sheets, maintenance job cards ...etc. in neat order to the satisfaction of the Engineer. All records, log books, and log sheets, charts, maintenance job cards, etc. shall become the property of the Employer.

F. Provide all necessary maintenance and operation staff experienced in both electrical and mechanical work such as engineers, foremen, operators, electricians, mechanics, helpers.... etc. for effective maintenance and operation of all systems. Submit to the Engineer for approval qualification details of all maintenance and operation staff.

G. During the Maintenance Period operate, control, maintain, replace and repair any part of plant or material within the Electrical Works Systems which may prove defective due to Contractor's design, erection, operation, performance, or workmanship, or prove defective from any act or omission that may develop from use in the Works or any section thereof.

H. Be responsible for training the Employer's personnel in the correct operation, control and maintenance of the Electrical Works Systems. Training shall be carried out by qualified commissioning and operating staff of the Contractor.

J. The foregoing Clauses are in addition to and in no way relieve the Contractor of his liabilities and obligations under the Contract.
3.07 GUARANTEE

A. Manufacturer's shall provide their standard guarantees for products furnished under this Contract. However, such guarantees shall be in addition to and not in lieu of all other liabilities which manufacturers and the Contractor may have by law or by other provisions of the Contract Documents.

B. All materials, items of equipment and workmanship furnished under this Contract shall carry standard warranty against all defects in materials and workmanship. Any fault due to defective or improper material, equipment, workmanship or Contractor's design which develop shall be made good, forthwith, by and at the expense of the Contractor, including all other damage done to areas, materials and other systems resulting from this failure.

C. Guarantee that all elements of the systems are of sufficient capacity to meet the specified performance requirements as set forth herein or as indicated.

3.08 SPARE PARTS

A. **Spare Parts during Two Years Maintenance Period:** Contractor shall provide all spare parts required during the two (2) years maintenance period at NO cost.

B. In special cases the spares have been listed in the sections. In all other cases manufacturer's recommended spares shall be provided.

*** END OF SECTION ***
PART 1 GENERAL

1.01 SECTION INCLUDES

A. Electrical identification to identify all electrical items for easy operation and maintenance including, but not limited to the following:

1. Nameplates and labels.
2. Wire markers.
5. Cable identification tags.
6. Cable warning tapes.
7. Cable markers.

1.02 RELATED SECTIONS
Section
A. 09900 Painting.
Section
B. 16050 Electrical Wiring, General.

1.03 REFERENCES

IEC 364 Electrical Installations
BS 7671 Electrical Wiring Regulation (IEE 16th)
IEC 391 Marking of Insulated Conductors
IEC 445 Equipment Terminals (Identification of Equipment Terminals and Terminations of Certain Designated Conductors).
IEC 446 Identification of Bare Conductors by Colors or Numerals.

1.04 SUBMITTALS
A. Submit for complete and detailed manufacturer's catalogues and data relating which shall include, but not limited to, the following:

1. Name of the manufacturer.
2. Country of origin.
3. Method of obtaining spare parts for maintenance and list of spare parts sufficient for a 2 years' period.
4. Technical performance of the equipment selected.
5. Dimensional details needed for installation and maintenance.
6. Delivery time from the date of orders.
7. Copies of test reports or certificates.
8. Control schematics and wiring diagrams.
B. Provide samples of proposed devices together with the above submittal for approval of the Engineer.

C. Manufacturer’s Instructions: Indicate application conditions and limitations of use stipulated by product Testing Agency and include instructions for storage, handling, protection, examination, preparation and installation of the product.

1.05 QUALITY ASSURANCE

A. Manufacturers: Firms regularly engaged in manufacture of items the types, sizes and ratings required, whose products have been in satisfactory use in similar service for not less than 5 years. Preference shall be given to local manufacturers and agents/suppliers.

B. Installer: Firms regularly engaged and qualified with at least 5 years of successful installation experience on projects with electrical installation work like that required for the project.

C. All items of Electrical Identification shall be complying with the requirements of BS and Local Standards Organization.
PART 2 PRODUCTS

2.01 NAMEPLATES AND LABELS

A. Nameplates and labels shall be engraved on a three-layer 2 trifoliate plate having minimum thickness of 2 mm, securely screwed to the housing and have black letters on white background in Arabic and English.

B. The name plates and labels shall be required for each electrical distribution board, control panels, equipment enclosures, substation equipment, disconnect switches and equipment cabinets.

C. Lettering shall be block capitals standing:
   1. 6 mm high for identifying individual equipment and loads.
   2. 10 mm high for identifying grouped equipment and loads.

D. Labels using embossed adhesive tape with 6mm white letters on black background or transparent adhesive tape with 6 mm black letters, as selected by the Engineer, shall be used for identification of individual wall switches, receptacles, low current outlets, speakers, control device stations, junction/pull boxes, electrical boxes and fittings, etc.

2.02 WIRE MARKERS

A. Wire markers shall be split sleeve or tubing type.

B. The wire markers shall be required for each conductor at panel board gutters, pull boxes, outlets, junction boxes and each load connection.

C. All power and lighting circuits, branch or feeder circuits and control circuits shall require wire markers.

2.03 COLOUR CODING OF RACEWAYS

A. Provide color bands with printed description of each system, minimum 75 mm wide for all cable trays/ladders and trunking runs. These color bands shall be applied at each electrical distribution/panel board, low current system control panels and junction box locations and at 15 m centers within an area.

B. Provide color bands with printed description of each system, minimum 25 mm wide for conduits up to 25 mm in diameter and one-half the conduit diameter for larger conduits, applied at panel and pull box locations, within each room, and at 6 m centers within an area.
C. Following color banding shall be used for the raceways of various electrical systems, however subject to final decision of the Engineer. Color bands for the electrical systems not described here shall be as agreed on site:

a. Lighting: gray.
c. Essential Power: black
d. Earthing: green.
e. Fire alarm: red.
f. Telephone: blue.
g. Sound: yellow.
h. Data: purple.
i. Television: rust.

2.04 CIRCUIT IDENTIFICATION CHARTS

A. Individual circuit identification charts shall be provided for all panelboards, distribution boards, control panels, etc. giving the following information as a minimum.

1. Circuit numbers
2. Phase
3. Load names with location.
5. Outgoing terminal numbers.
7. Sizes and types of incoming and outgoing cables.
8. Contacts location references of relays and other control devices (if any).

B. Charts shall be typed on A4 size sheets. They shall be enclosed in a clear plastic envelope and shall be securely fixed to the inside cover of the unit. Additional copies of the charts shall be included in the Operation and Maintenance Manuals.
2.05 CABLE IDENTIFICATION TAGS

A. All cables which exit from manholes, vaults, handholes, and transformer or switch enclosures shall be properly tagged or labeled. Tags shall be permanent, non-corrodible and clearly readable. Tags should include the information listed below for the various circuit categories:

- Primary Cables - 11 kV
- Feeder Name
- Voltage
- Phase (for single conductor cables)

B. Cable identification tags for wire and cable circuits shall be of an opaque nylon material arranged to include a marker plate, non-releasing nylon ties, and cable fastening tail. One side shall be roughened to hold black nylon permanent ink. Identification shall be permanent and waterproof. The holding device shall be designed to allow the fastening tail to pass around the cable through the holding device, and prevent removal of the tail without cutting it lose from the marker. Cable identification shall be inscribed in Arabic and English.

2.06 CABLE WARNING TAPES

A. For buried LV and HV cables use warning tapes per the standard practice of Electricity Supply Authority and applicable international standards.

B. Cable warning tapes shall be of polythene, not less than 150 mm wide and at least 0.25 mm thick. They shall be yellow in color for LV and MV cables and bear the continuously repeated legend – “CAUTION ELECTRIC CABLE BELOW” or similar in English and Arabic, in black letters not less than 30 mm high.

C. For buried low current/communication cables or duct banks, use warning tapes as per the standard practice of Local Telecom Supplier and applicable international standards.

2.07 CABLE MARKERS

A. Buried cables shall be permanently identified by concrete markers. The markers shall be 600 mm square x 100 mm thick with impressed character; they shall be made of grade 20 concrete, with 10 mm aggregate. The impressed characters shall be in English and Arabic and worded "HV CABLE" or "LV CABLE" as appropriate together with circuit details as required for proper identification. In addition, the word “JOINT” shall be added to above words, where applicable.

B. Except where cables are buried, located in switch rooms, in ducts and spaces designated solely for electrical services, or have orange over sheaths; they shall be identified by adhesive bands colored orange, complying with standards and codes of practice mentioned elsewhere in the Specifications. The bands shall be not less than 100 mm long, located at least once within each separate compartment through which cables pass and at intervals not exceeding 12 m.
C. Except where cables are buried or enclosed in conduit, trunking or ducting; they shall be permanently identified by discs. The discs shall be of laminated plastic materials with black character on white; character shall be not less than 3 mm high. The inscription shall indicate the nominal voltage, the designation of the load, the number and cross sectional area of cores and the rated voltage of the cable.

D. Cables identification discs shall be attached to the cables with ties. Disc shall be located within 500 mm of terminations and joints, at least once within each separate compartment through which the cable passes, and at intervals not exceeding 24 m, they shall coincide with the color bands.

2.08 EQUIPMENT WARNING/DANGER SIGNS
A. For external use, pressure sensitive danger signs shall be used. Dimensions shall be as approved by the Engineer. The signs shall be heavy duty vinyl with a self-adhesive backing which can be applied to curved or irregular surfaces. Danger signs shall be weather-resistant and shall not discolor or deteriorate with age.
B. Danger signs shall be inscribed with the equipment voltage level along with an internationally recognized danger sign.
C. Warning/Danger signs made of red plastic (vinyl) with white letters at least 25 mm high reading "DANGER High Voltage" shall be fixed to the entrance doors of all 11-kV switchgear and transformer rooms.
D. Warning/Danger signs made of red plastic (vinyl) with white letters at least 15 mm high reading "DANGER 380V" or "DANGER 220V" as appropriate, shall be fixed to the lids, covers or doors of any equipment which contains terminals or conductors connected to more than one phase of a low voltage supply.
E. All signs shall be in English and Arabic.

2.09 LANGUAGE
A. The Arabic and English languages shall be used for all labeling and charts.

PART 3 EXECUTION
3.01 PREPARATION
A. De-grease and clean surfaces to receive nameplates and labels.

3.02 INSTALLATION
A. Install warning and descriptive labels as follows:
1. Metallic surfaces using stainless steel or chromium plated bolts and/or self-tapping screws.
2. Concrete surfaces or masonry walls using and brass wood screws.
3. Timber surfaces using minimum 6 mm countersunk brass screws.
4. All insulated enclosures using an approved plastic welding adhesive.

B. The danger sign and identification number shall be affixed to the front or access doors of all transformers and switches. For equipment with two doors the danger sign shall be mounted on the left door with the identification number mounted on the right door. Both the danger sign and the identification number shall be centered 300 mm below the top edge of the doors and on the vertical centerline of each door.

C. On equipment with only one access door, the danger sign and the identification number shall be centered on the vertical centerline of the door, with the horizontal centerline of the danger sign 300 mm below the top edge of the door and the horizontal centerline of the identification number 250 mm below the danger sign centerline.

D. Locate cable markers at every point where cable(s) enter a building, substation, distribution/feeder pillar; at each joint, change of direction, road/pathway crossing, etc. Cable markers shall also be provided along the straight runs (route) of the cable(s) at the interval not exceeding 30 m.

*** END OF SECTION ***
PART 1 - GENERAL

1.01 GENERAL

A. Raceways shall include all bus ducts, cable ladders, trays and cable trunking with all associated accessories, supports and fixings used for the distribution of electric power in the buildings.

B. Raceways shall be of galvanized steel unless specifically indicated otherwise as per Specifications of local authorities: Non-Metallic Cable Trunking

C. In general, the raceways shall conform to the following specifications:
   Local authorities: Steel Cable Trunking
   Local authorities: Cable Trays & Racks

1.02 RELATED WORKS SPECIFIED ELSEWHERE

A. Section 16200 Cables & Wires
B. Section 16300 Supporting Devices

1.03 SIZE SELECTION

The size of the raceways shall be selected per local authorities' regulations taking into consideration required "2D" spacing between cables (Where D is the cable diameter of the larger cable or the space factor as applicable in case of cable trucking.

PART 2 - PRODUCTS

2.01 CABLE TRAYS

A. Cable trays shall be heavy duty, return flange, of 2mm gauge perforated type formed from sheet steel to B.S. 1449 - Part 1 and hot-dip galvanized after manufacture in accordance with B.S. 729.

B. Cable trays shall have a minimum thickness of 1.6mm for trays up to 300mm and 2mm for wider trays.

C. Cable trays shall be assembled complete with couplers, bends, tees, risers, reducers and all other accessories as required and these accessories shall be of the same material, thickness and finish as the trays. Manufacturer's standard accessories shall be used and site fabrication shall only be allowed where special sections are required subject to the approval of the Engineer.
C. Mushroom head steel roofing bolts and nuts to B.S. 1494 - Part 1 shall be used to fix adjacent sections of cable trays and/or accessories. Holes cut in trays for passage of cables shall be provided with grommets and cable tray finished to G.D.C.D. standard 23rd March 1979. Cable trays shall be cut only along a line of plain metal and not through perforations. All cut edges of trays shall be prepared with burrs and sharp edges removed prior to installation and any cutting and/or damage made good with rust proofing agent and zinc rich epoxy paint.

D. Cables shall be installed on trays in a single layer except where specified otherwise, leaving 25% of the tray width space for future use.

2.02 CABLE TRAY SUPPORTS AND RACKS

A. Cable trays shall be fixed by support channels and hanger rods or by cantilever brackets fixed to walls or columns. Fixings shall be disposed at regular intervals not exceeding 1.0m. Joints shall be positioned as close as practicable to the tray fixing or support. Mid-span joints shall be avoided. All screw bolts and nuts used for fixing shall be zinc plated to B.S. 1706 - Class B coatings. All the supporting angles, brackets, anchors, etc. shall be of hot dip galvanized. A minimum clear space of 25mm shall remain at the wall side.

B. Weld gun stud fixing will be allowed subject to the approval in writing of the Engineer. Drilling of building structural steelwork shall not be allowed except in special circumstances and then only with prior permission in writing by the Engineer.

2.03 CABLE LADDERS

A. Cable ladders shall be H-type made from 2mm mild steel with 3mm coupling plates. Side channels shall be strengthened by reinforcing inserts or other means to increase torsional rigidity. Rungs shall be slotted type. Cable ladders shall be hot-dip galvanized and shall be complete with coupling pieces, bends, tees, reducers, risers, drop-outs, intersections and all other accessories as required and these shall be of the same material, thickness and finish as the ladders.
2.04 CABLE TRUNKING

A. Cable trunking shall comply with British Standard 4678 and consists of butting sections generally not less than 2000mm long manufactured from sheet steel with stove enamel finish. The lids shall be made from the same material and shall be removable over the whole length of the trunking and secured at centers not greater than 500mm with cadmium plated cup-headed brass screws. These screws shall locate into tapped holes in the trunking. The trunking shall be provided with lips on its opening side to form a tray and clips shall be inserted at centers not greater than 500mm to retain the cables in position when the lid is on the side of the trunking.

The minimum thickness of metal employed in the construction of this trunking shall be 1.2mm and of the following thickness for various sizes:

- 1.2mm thick - up to and including 100mm x 100mm
- 1.6mm thick - up to and including 150mm x 150mm
- 2.0mm thick - up to and including 230mm x 230mm

Adjoining sections of trunking shall butt tightly and shall be joined by means of an internal fishplate connector attached by not less than eight cadmium plated steel cup-headed bolts and hexagon nuts, passing through clearance holes. Two pairs of bolts on either side of the joint shall be connected by tinned copper braids with split soldering washers under the nuts to provide electrical continuity across the joints. The trunking shall be mechanically and electrically continuous throughout. Where trunking is used to carry various services, it shall be subdivided into three separate compartments for power, telephones and auxiliary services.

2.05 OUTDOOR CABLE TRAYS

A. Responsibility of supply and installation shall be as indicated on Drawings.

B. Assemble cable trays sun shaded cable trays for outdoor complete with couplers, bends, tees, risers, reducers and all other accessories and of the same material, thickness and finish as the trays. Use manufacturer's standard accessories. Site fabrication will be allowed only where special sections are required and subject to the approval of the Engineer.

C. Use mushroom head steel roofing bolts and nuts to B.S. 1494 part 1 to fix adjacent sections and cable trays and/or accessories. Holes cut in trays for passage of cables shall be provided with grommets to B.S. 1767, otherwise they shall be bushed or lined. Cut cable trays only along a line of plain metal and not through perforations. Prepare all cut edges of trays and remove all burrs and sharp edges prior to installation and treat with zinc rich epoxy paint.

D. Fix cable trays by pedestals or support channels and hanger rods or by cantilever brackets fixed to walls or columns. Fixings shall be disposed at regular intervals not exceeding 1.2m and at 225mm from bends and intersections. Avoid mid-span joints. All screw bolts and nuts used for fixing shall be zinc plated to B.S. 1706 Class B coatings.

E. All supporting materials, angles etc. shall be hot dip galvanized.

F. All cable trays exposed to sun shall be provided with sun-shade. Sun shade shall be supported at least 10cm above cable tray, and should have 2 side slope along the cable tray.
2.06 HANGER RODS

Galvanized steel rods of minimum 10mm dia. in one piece continuously threaded shall be adopted as hanger rods for cable trays, turnings, ladders etc.

PART 3 - EXECUTION

3.01 GENERAL

All installation work shall be as per local authorities’ rules and regulations. Where no local authorities’ regulation is available, IEE wiring regulations shall be followed.

3.02 CABLE TRUNKING

- All trucking shall be properly aligned and shall run parallel or right angles to walls and the ceiling beam.
- The trucking shall be supported at not more than 100 cm. All supports shall be galvanized.
- The trucking ends shall be properly closed.
- Earth continuity shall be provided at points through braided copper tape.

3.03 CABLE TRAYS

- Cable trays shall not sag more than 3 degrees between supports
- Cable trays shall be supported at not more than 100 cm by galvanized wall brackets/supports or by stainless steel hanger rods.
- Cable trays shall not be cut through perforations

3.04 SEALING (FIRE BARRIRES)

Fire resisting caulking compound for sealing trays, trucking, conduits, cables, Ducts, pipes and sleeves shall be of a putty like consistency workable with hands. All materials for caulking and sealing shall be approved by Civil Defense wherever applicable.

3.05 RETAINERS

Cable retaining straps or cable ties shall be used as applicable to the raceways and shall generally be spaced 100cms.

*** END OF SECTION ***
PART 1 – GENERAL

1.01 GENERAL

A. PVC conduits shall generally be allowed in CAST-IN-SITU. Surface installed Conduits (below or above false ceiling) shall be rigid steel (GI). Where heavy protection against mechanical damage is required only rigid steel (GI) conduit shall be used.

B. All conduits and conduit fittings shall comply with concerned local authorities Specifications.

C. In precast concrete slabs etc. GI conduit shall be used.

D. All conduits are fire retardant colored for all systems even if used in concrete slabs.

1.02 CONDUIT SYSTEM

Conduit system shall be provided including all necessary fittings, supports, Accessories, all other hardware complete as required.

For underground installation UPVC conduit shall be used.

All materials for caulking and sealing conduits, pipes, sleeves etc. through fire rated Walls or floors, shall be approved by the concerned local authorities as similarly applicable to cable trays and Trucking.

1.03 RELATED WORKS SPECIFIED ELSEWHERE

C. Section 16200 D. Cables & Wires
   Section 16300 Supporting Devices

1.04 QUALITY ASSURANCE

A. Relevant British Standards

B. Concerned local authorities’ rules and regulations

C. Alternative codes and standards which will satisfy the engineer that the material offered is of equal standard to that specified.

1.05 SUBMISSION

A. Cut away samples with manufacturer’s details.

B. Shop drawings of proposed conduit layouts
PART 2 - PRODUCTS

2.01 STEEL CONDUITS (G.I Conduit)

Steel conduits shall be heavy gauge steel conduit hot dip galvanized inside and out-side. The steel conduits, all junction boxes and other accessories shall be accordance with British Standard 4568 Parts 1 and 2 and shall be Class 4. The internal diameter of conduits shall be not less than 20mm.

All conduit boxes shall be constructed in malleable iron and in accordance with British Standard 31 Class B in the case of standard junctions or Class B5 where conduit is looped from point to point. All conduit work shall be so arranged to permit wiring to be drawn in after completion of conduit work. Where conduit work is concealed above suspended ceilings or in other building finishes the wiring shall be possible without disturbance to the building finishes. The conduit work at lighting points shall always be terminated in a standard or loop-in junction box and such boxes shall be firmly secured to enable the luminaire to be fixed to the lugs of the conduit box and be suspended therefrom without other support. Where conduits are terminated in a box without a screwed spout the junction shall be made by means of a coupling and an external thread brass bush with hexagon head.

In general, conduits shall be concealed within the building structure, behind suspended ceilings, within partitions, in floor screeds or plaster finishes. No conduit work shall be exposed on the surface unless this is specified or in services plant rooms. All external work shall be carried out using galvanized steel conduit and accessories. The installation shall be electrically and mechanically continuous throughout and where polyvinyl chloride conduit is utilized this shall be achieved using a separate polyvinyl chloride insulated earth wire installed throughout the conduit run with terminations being made in conduit boxes or metal enclosures of apparatus. All conduit ends shall be reamed to remove sharp edges and threads shall be of sufficient length to enable conduits to butt within couplings or to the stop end in box spouts. Draw-in boxes on straight runs shall be provided at no more than 9000mm centers. Where right angle bends are formed in the circuit, draw-in boxes shall be provided at no more than 7500mm centers and not more than two right angled bends shall be employed in any one run. Where conduit work is run external to the buildings a drain hole of 3mm diameter shall be drilled in the bottom of switch boxes and other low points to drain condensation. Conduits shall be fixed by means of spacing saddles on rough concrete or brickwork. On fair faced brickwork or plaster spacer-bar saddles may be used. Saddles shall be spaced at internals of not more than 1300mm on straight runs and not more than 200mm on either side of a bend or junction box. Fixings shall be made by means of galvanized steel wood screws of not less than 3mm diameter and 40mm in length, screwed into plastic or fiber insert plugs. All lighting point boxes, switch boxes or socket outlet boxes shall be fixed by means of two 8-gauge x 40mm steel screws.
2.02 PVC CONDUITS

A. All rigid PVC conduit and conduit fittings shall conform to British Standard 4607 are to be certified as suitable for use at ambient temperatures up to 55 Deg.C. Additionally, the material shall not soften or suffer any structural degradation at a temperature of 85 Deg.C and shall be non-hygroscopic and self-extinguishing type.

All boxes and extension rings shall be fitted with brass inserts for the securing screws and with an earth terminal. Conduit fittings and accessories shall be of the same manufacture and shall be of the unthreaded type.

The internal and external surfaces of conduits shall be smooth and free from burrs and similar defects. The interior and ends of conduit fittings shall be free of sharp edges and corners and shall be smooth and well-rounded to permit easy drawing in of cable and to prevent any damage to cable insulation.

Boxes in ceiling for lighting/fans etc. shall be of GI type.

All joints between conduits and fittings shall be watertight using vinyl cement recommended by the manufacturer of the conduit. A vinyl solvent shall be used for permanent joints and a cement of the type that shall remain in a sticky condition shall be used for expansion couplers.

A separate insulated earth wire shall be drawn into all PVC conduits.

The PVC conduits shall be installed generally in accordance with the requirements set out for metal conduits. Additionally, the method of supporting PVC conduits shall allow for the longitudinal expansion and contraction of the conduit.

2.03 CONDUIT (FLEXIBLE CONNECTIONS)

A. Where conduit work must be terminated with a flexible connection, as in the case of motors, the rigid conduit shall be terminated in a box adjacent to the motor and the connection between this box and the motor junction box made in flexible conduit. This shall be a corrosion resistant flexible metal tubing with a polyvinyl chloride sheath terminated at each end by a compression gland screwed into the connection boxes. An insulated stranded copper connection of section not less than that quoted in Table 54F of the I.E.E. Regulations shall be provided in each instance to ensure earth continuity.
2.04 CONDUIT (CAPACITY)

A. The number of polyvinyl chloride single core cables run in any one conduit shall be restricted in accordance with concerned local authorities Regulations (latest Edition).

Where three-phase circuits are run in conduit all three phases and the neutral of the circuit shall run in the same conduit.

2.05 METALLIC CONDUIT BOXES FOR EXTERIOR LOCATIONS

All boxes installed in exterior locations, plant rooms, ducts etc., shall be fitted with approved type gaskets to provide a waterproof seal between box and Cover or other item fitted to the box.

PART 3 – EXECUTION

3.01 PVC conduits and fittings shall be joined by using sealing cement (vinyl solvent paint) to ensure a watertight joint. The cement shall be of a type that remains in a sticky condition. When PVC conduits are embedded in concrete slabs, they shall be securely held in place by fixing to shuttering and reinforcing bars. In walls, they shall be run in cut chases and fixed by saddles or crumpets.

3.02 Chases shall be deep enough to allow full thickness of plaster cover to be applied. Bends in PVC conduits shall be neatly made with a proper size bending spring.

3.03 Except when embedded in concrete slab, all conduits shall be installed parallel to the lines of the building and at a minimum of 100mm away from pipes or other non-electrical services. Boxes shall be fixed independently to the building so as not to be supported by the conduits. Empty conduits when left with ends exposed for some time shall be closed with suitable plugs to prevent entry of dirt and foreign matter.

3.04 Conduits shall be installed in such a manner to prevent trapped condensation. Pull boxes shall be provided as required for easy drawing of wires and shall be in readily accessible locations with covers fixed by brass screws.

3.05 No wire is to be drawn inside conduits until they are completely erected and approved by the Engineer. The conduits shall be swabbed through to remove any dirt or loose matter before drawing of wires.

3.06 The sizes of conduits shall be in accordance with the number and sizes of wires to be drawn inside them as indicated in IEE or latest concerned local authorities Regulations.
but no conduit smaller than 20mm. shall be used. A pull wire or tape shall be provided in all empty conduits with no less than 200mm. of slack left at each end.

3.07 Flexible conduits shall be used for connection of motors, HVAC equipment, recessed light fittings ...etc. Fixed conduits shall be terminated in a conduit box and flexible conduit shall then connect to the equipment.

3.08 For flexible conduit on earth wire shall be wound around the flexible conduit and connected at each end to earth terminal.

3.09 The conduit system shall, in general, be surface mounted in all plant rooms, electrical rooms and in Service Tunnel.

3.10 The following general rules shall be adopted.

   B. Conduit saddles shall be used at every 50 cms where the run is straight.
   C. Saddles shall be used on both sides of a bend or coupling.

*** END OF SECTION ***
PART 1 - GENERAL

1.01 All cables shall be designed for operation in systems where continuity of supply is the first consideration. They shall also be satisfactory in operation under the variations of current, voltage and frequency as may be met under fault and surge conditions on the system.

All materials shall be of the best quality and of the class most suitable for working under the condition of the systems. They must be capable of withstanding the normal variations of temperature and service conditions without disturbance or deterioration.

In general, cables and wires shall conform to the international standards and to the concerned local authorities Specifications.

1.02 CONDUCTORS

The conductors shall be high conductivity copper, stranded for power cables and solid for control cables according to the type of insulation, the copper conductors will be plain or tinned.

1.03 Cables shall be installed on cable trays or on building structure as indicated on the Drawings. They shall be neatly fixed in straight lines. On cable trays, cables shall be fixed by cable clips or ties while, on building structure cable cleats shall be used. The spacing of cable supports shall be as indicated in I.E.E. Regulations table B.2M. The minimum radius of bends for cables shall be in accordance with table B.1M of the regulations with bends made neatly and uniformly.

1.04 Where single core cables are used for feeders, care shall be taken to ensure equal division of current among cables which shall be arranged in trefoil formation.

1.05 Proper cable glands of nonferrous material shall be used for cable entries into distribution boards and equipment.

1.06 Each end of each cable shall be provided with identification label lettered with feeder or circuit designation to the Engineer's instructions. The labels shall be permanently fixed in distribution boards, terminal boxes, isolators, etc. and shall be made of durable material ensuring permanent legibility.
1.07 STANDARDS

Unless otherwise specified, cables wires and terminations shall comply with the following standards as appropriate:

**Cable and Wires**

- **BS 1442**: Galvanized Mild Steel wire for armoring cables.
- **BS 2897**: Aluminum strip armor for cables.
- **BS 6234**: Polymethines insulation and sheath for cables
- **BS 6360+IEC 228**: Copper conduct for cables
- **BS 6746+IEC 540**: PVC Insulation & Sheath for cables.
- **BS 6346+IEC 502**: PVC Insulated Cables
- **BS 5467+IEC 227**: Armored Cables
- **BS 6004+IEC 227**: PVC Insulated Cables for Power and Lighting
- **BS 6207+IEC 245**: Insulated Flexible Cords
- **BS 4579**: Performance of Mechanical and Compression Joints for Cables
- **BS 6081**: Termination of MICC Cables
- **BS 6121**: Mechanical Cable Glands.

All cable terminations shall comply with the concerned local authorities' requirements.

1.08 TESTS

- The cables shall be factory tested in accordance with the applicable standards, codes or recommendations.
- For each cable type, the following test certificates, providing tests have been carried out shall be submitted to the Engineer for approval.
- Mechanical properties of insulation and sheathing components.
- Resistance to cracking.
- Pressure test at high temperature.
- Resistance to flame propagation.
Final tests shall be made at site and the following routine tests will be carried out:

- Conductor resistance test.
- Insulation resistance.

1.09 RELATED SECTIONS

A. Section 16120 Conduits
B. Section 16110 Raceways
C. Section 16300 Supporting Devices

1.10 SUBMITTALS

A. Provide product data for each type of cable.
B. Shop floor drawings showing cable routes and method of laying, spacing and space factor applied.
C. Submit cable assembly from each reel /drum.
D. Provide samples of cable markers, cable ties etc.

PART 2 - PRODUCT

2.01 PVC INSULATED/PVC SHEATHED CABLES

These shall be 600/1000V, single or multi-core conforming to BS 6346 with high conductivity plain annealed stranded copper conductors to BS 6360, PVC insulated with an extruded layer of PVC bedding and a final outer extruded PVC sheath. The insulation and sheath shall be to BS 6746 with insulation colored to identify phases and neutral in accordance with BS 6746 C. Armored sheathed cables shall have a single layer of galvanized steel wires for multi-core cables and aluminum wire or tape for single core cables.
2.02 CROSSED LINKED POLYETHYLENE CABLES

These shall be single core or multi-core cables, 600/1000V conforming to BS 5467 with high conductivity plain annealed stranded copper conductors to BS 6360, insulated with cross linked polyethylene (XLPE) to BS 6899 applied by a combined extrusion and vulcanization process to form a compact homogeneous layer, cables bedded and overall sheathed by a black PVC layer to BS 6746. Armored cables shall have a single layer of galvanized steel wires for multi-core cables and aluminum wire or tape for single core cables.

2.03 WIRES

A. Single core cables shall be plain annealed copper conductor to BS 6360, insulated with PVC to BS 6746, 600/1000 V grade conforming to BS 6004, single core for drawing inside conduits and trucking.

B. Single core cables shall be continuous from outlet to outlet and no splice shall be made except within outlet and junction boxes. A separate neutral wire shall be provided for each circuit. Wires shall be left sufficiently long to permit making final connections. The color of insulation shall be as specified in IEE regulations for different phases, neutral and earth wires.

2.04 FLEXIBLE CORDS

Flexible cords shall be circular silicon rubber insulated glass fiber braided, three core 300/500 volts and shall comply with BS 6500. The conductors shall be tinned, annealed copper and the core shall be colored Brown, Blue, Green/Yellow for identification.

2.05 MICC CABLELING/WIRING

In all hazardous areas, the cabling/wiring shall be done with MICC cables/wires. The decision of the engineer in respect of choosing such areas will be final and binding. Generally, such areas are gas stores, areas handling medical gases, cold stores etc. MICC cables shall be to the following standards:

- Flame Proof Barrier: BS 5345 Part 1
- Manufactured & Tested to: BS 6207
- Quality Assurance: BS 5750
- Cable Terminations: BS 6081
- IEC Standards: IEC 702.1/IEC 702.2
PART 3 - EXECUTION

3.1 GENERAL

Cables/wires shall be installed as per the concerned local authorities’ regulations. Where no concerned local authorities’ regulations exist IEE regulations shall be followed.

3.2 EXAMINATION

A. Verify that interior of the building has been protected from weather
B. Ensure that all raceways are thoroughly cleaned.
C. Verify that all construction works likely to damage wires /cables have been completed.

3.3 INSTALLATION

A. Use suitable wire /cable pulling lubricants.
B. Support cables above accessible ceiling. Do not rest cables on ceiling panels.
C. Use suitable rollers and pulling devices.
D. Perform field inspection and testing in the presence of the Engineer.
E. Verify all earth continuities.
F. 
G. Identify all circuits (Cables) with appropriate marking devices.

*** END OF SECTION ***
SECTION 16300
SUPPORTING DEVICES

PART 1 - GENERAL

1.01 VOLTAGE

All single-phase devices shall be rated for 240/V 50 Hz and all three phase devices shall be rated for 415/V 50Hz.

1.02 DESCRIPTION

Provide wiring devices including switches receptacles, switch fuse units, junction boxes, control devices etc. as specified, indicated on drawings and as required for proper functioning.

1.03 RELATED WORKS SPECIFIED ELSEWHERE

A. Section 16120 Conduits
B. Section 16110 Raceways
C. Section 16200 Cables & Wire

1.04 REFERENCE STANDARDS

<table>
<thead>
<tr>
<th>Device</th>
<th>Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lighting Switches</td>
<td>BS 3676 part 1/1989 &amp; CENELECPREN60669-1</td>
</tr>
<tr>
<td>Fuse Connecting unit</td>
<td>BS 1362</td>
</tr>
<tr>
<td>20A DP Switch</td>
<td>BS 3676 part 1</td>
</tr>
<tr>
<td>Switch Socket Outlet</td>
<td>BS 1363/1984</td>
</tr>
<tr>
<td>Flux Outlets</td>
<td>BS 5733/1995</td>
</tr>
<tr>
<td>Dimmer light Switches</td>
<td>IEC 669-2-1, BSEN 50082-1</td>
</tr>
<tr>
<td>Cooker Control Unit</td>
<td>BS 4177/1992</td>
</tr>
<tr>
<td>Metal Clad Boxes</td>
<td>BS 5733</td>
</tr>
<tr>
<td>Weather Proof Socket outlets</td>
<td>BS 1363/1984</td>
</tr>
<tr>
<td>Sentry Socket outlet</td>
<td>BS 7288/199</td>
</tr>
</tbody>
</table>

Where No Reference Standard is mentioned the applicable BS standard shall apply.
PART 2 - PRODUCTS

2.01 SOCKETS

A. Sockets shall be 250V, three pin, 16A switched type to BS 1363. Safety shutters shall cover pin holes to prevent accidental contact. Contact arrangement shall be such that contact is made on two sides of the rectangular pins of plugs.

B. UPS Socket outlets should be differentiated from the normal supply socket outlets by color (Blue).

C. Sockets shall be fixed inside galvanized stamped steel boxes which shall be flush mounted in walls.

D. Pedestal mounted floor outlets shall be provided in locations where no wall or column is available.

E. Sockets shall have White molded cover plates as approved by the engineer. The mounting heights for wall sockets shall be 300mm above finished floor level unless otherwise indicated on the Drawings.

F. Three phase sockets shall be of 5 pin design (3 phase + neutral + earth) as per the concerned local authorities Specifications. The current rating shall be as shown on drawings. All housing parts shall be pressure die cast in zinc base alloy and finished in hammered gray stove enamel; cable grips on the plugs shall have a rubber compression ring. The weather tightness shall be ensured by the rubber gaskets between plug and socket. Socket shall be provided with a screw-on cap. Plug top shall be provided with each socket.

G. Sockets working on normal plus emergency supply shall be provided with neon indicator which will remain illuminated even in off position.

I. Weatherproof sockets outlets shall have the weather tightness as mentioned in paragraph ‘E’ above and shall comply with the concerned local authorities Specifications.
J. Terminal shall be grouped in-line with terminal screws backed out and terminals shall be marked.

2.02 JUNCTION BOXES

The junction boxes shall be DP 250V or TP 415 with current rating as shown on drawings or indicated in schedules. DP or TP switch controlling Junction Box shall be provided with neon lamp. Floor mounted J.B. shall be of water tight design as required by the particular equipment being fed through the J.B.

Indoor Wall mounted Junction box and its associated switch shall White molded & provided with flex outlet.

2.03 SWITCHES

A. Switches shall be of minimum 10A ratings unless higher ratings are shown on drawings.

B. Switches shall generally be flush mounted and of grid type at a height of 1200mm above finished floor level, unless otherwise indicated on the Drawings. Switches shall be White molded cover plates as required by the engineer. Wiring terminals shall be of the screw type or solder-less pressure type having suitable conductor release arrangement. Where two or more switches are in the same position, they shall be installed in one box and covered by a multi-gang cover plate.

C. Weatherproof switches shall have weather tightness as per Clause 2.01 (F) above.

D. Where Modular switches are employed the cover, plate shall be manufactured in die cast metal with corners of square edged profile, and finished with a durable heat cured lacquer. The Modular switches shall be 1 – 8 gang as indicated in drawings.

2.04 DIMMER SWITCH FOR FLUORESCENT TUBULAR LAMP

Remote control potentiometer unit shall be used for electronic dimmable ballast shall be used. It shall have a rotary switch for ‘ON/OFF’ function and a control voltage range with “MAX” and “MIN” trimmings.

2.05 FUSED SWITCHED OUTLETS (If needed for any particular equipment)

These outlets shall be to BS 4662 and provided with fuse links to BS 646 or BS 1361 or BS 1362 complete as required.

2.06 MOUNTING BOXES

Mounting boxes shall be 1 gang or 2 gang as specified and shall be manufactured from hot dip galvanized steel. Each box shall have brass earth terminal fitted in base and shall include ample knockouts and adjustable lugs.
2.07 DOUBLE POLE SWITCHES (If Needed)

The double pole switches shall be with indication neon lamps and shall be rated 20 amps unless otherwise mentioned. The face plate shall as per the concerned local authorities Specification G.3.2 and G.3.3.
2.08 SPARKLESS SOCKET OUTLETS

All outlets shall conform to degree of protection as applicable to non-sparking equipment.

2.09 SPARKLESS SWITCHES

All such switches shall conform to degree of protection as applicable to non-sparking equipment.

2.10 JUNCTION & SERVICE BOXES

The Junction & Floor Service boxes shall be supplied by the system supplier namely the Under Floor trucking or the Cast-in situ system as the case may be.

2.11 UPVC TRUNKING

Where Skirting & dado application are involved UPVC trucking of elegant profile shall be used. The system shall can accept wide range of components offering wide range of configurations. It shall be possible to use flat tees or angles & various type of adapters to navigate.

The trucking system shall be manufactured with requirements of BS 4678: Part 4 & BS 4662. Copies of test certificates shall be provided by the suppliers.

2.12 ISOLATORS AND SWITCH FUSES

A. Isolators and switch fuses, where mounted individually shall be of sheet steel/Polycarbonate construction with /without doors and front operated handles. They shall be of the quick make, quick break type with removable shields over the fixed contacts, door interlocks and 'ON/OFF' indicators.

B. Isolators and switch fuses shall be single or triple pole with neutral, of ratings as indicated on the Drawings and provided with earth terminals. They shall be in accordance with IEC 408. The switch fuses shall be suitable for H.R.C. type fuses of Class Q1 to B.S. 88.

C. All outdoor isolators and switch fuses shall be in weather proof enclosures.

PART 3 - EXECUTION

3.1 MOUNTING HEIGHT

A. All devices shall be installed at levels as per the concerned local authorities’ regulations.

B. Where Outlets feed piece of equipment then these shall be installed as per equipment manufacturer/supplier’s requirements.

C. Where no data is available regarding the outlet for the equipment, it shall be installed at the level given by the engineer. As a guide line, generally switches shall be mounted at 1350mm above finished floor level and sockets shall be fixed at 300mm above finished floor level unless otherwise required for specified uses e.g. Above bench or near the equipment etc.
3.2 FIXING

A. Fix outlet boxes securely
B. Fix exposed outlet boxes to permanent inserts or lead anchors with machine screws.

3.3 LIGHTING SWITCHES

Locate at the strike side of the door.

3.4 PULL BOXES /JUNCTION BOXES

A. Fix pull boxes at minimum 10 Meter spacing and to limit the number of bends in conduit to not more than two 90 deg. Bends
B. Locate junction boxes as inconspicuously as possible but accessible after work is completed.

3.5 SPARES

Contractor / supplier shall provide 2 % of all supporting devices to the client for future use before certificate of completion of the project.

*** END OF SECTION ***
PART 1 – GENERAL

All Electrical Distribution equipment should be type tested assembled by approved factory.

1.01 DESCRIPTION

A. The main distribution equipment shall comprise main low tension switch boards, switching metering panels, main and sub-main switch boards, distribution boards, isolators, switch fuses ...etc.

B. The supply and distribution arrangement shall be as indicated on schematic diagrams in the Drawings.

C. The equipment shall be assembled and tested in the factory of the approved local panel builder/manufacturer. Where any equipment need to be assembled at site, a prior approval of the engineer would be necessary.

D. Before placing any order for the supply of equipment, it shall be ensured that the physical sizes of equipment when installed shall not infringe any clearance required by the concerned local authorities’ regulations. Where no such regulation is available IEEE regulations shall be applied.

E. The contractual responsibility for the supply and installation shall be as indicated on drawings.

1.02 REFERENCE STANDARDS

Switchboards and Motor Control Centers shall comply with the following as appropriate. Where no regulation / standards are mentioned latest IEC, standards shall be applicable.

BS 88 Cartridge Fuses
BS142 (Latest) Electrical Protective Relays
BS 159 Bus bar & Connections
BS 162 Electrical Power Switchgear
BS 3938 IEC 185 Current Transformers
BS 4794 IEC 337-2 Control Devices
BS 5685 Electricity Meters General
BS 89 IEC 51 Direct Acting Indicating Electrical Measuring Inst.
BS 5685 IEC 521 Electric Meters
BS 5420 IEC 144 Degree of Protection of enclosures
BS 4752 IEC 947-2 Switchgear & Control Gear
IEC 947-4 Contactors
IEC 947 (Part 1-7) Low Voltage Switchgear & Control Gear
IEC 439 (Part 1-4) Low voltage Switchgear & control gear assemblies
1.03 RELATED WORKS

Section 16110  Raceways
Section 16120  Conduits
Section 16200  Cables and Wires
Section 16300  Supporting devices
Section 16620  Diesel Generator
Section 16635  Earthling
1.04 SUBMISSION

A. Shop Drawings
Submit dimensional shop drawings including sections and elevations and showing positions of major components position and method of fixing and terminating cables.

B. Project Data
Submit full specifications of the enclosure and the components of the switchgear and switchboards and panels.

PART 2 - PRODUCT

2.01 MAIN LOW TENSION PANEL BOARDS

A. The main low tension switch boards shall be of indoor construction, dead front, metal enclosed free standing, dust and vermin protected, front operated and of clean and modern appearance.

B. The switchboards shall be assembled and coordinated by one manufacturer and shall be constructed in accordance with B.S. 5486: part 1.1977/IEC 439.

C. The panel shall be of the cellular cubical type class 2CC FBA and shall be of the folded sheet steel construction fabricated out of electro galvanized cold rolled sheets of minimum 2mm thickness for body and frame work and not less than 1.5mm for doors and cover plates.

D. The panels, after fabrication, shall be thoroughly cleaned in a vapor degreasing tank to remove all traces of oil and wax and provided with a coat of electro- static, polyester powder coating, light grey color, shade No. 10A03 to BS 4800.

E. All doors and removable cover plates shall be provided with neoprene gasket so as to obtain degree of protection IP53 to IEC 144.

F. Each outgoing breaker shall be enclosed in its own compartment (cell) fitted with a hinged door interlocked with the operating handle in such a way that:
   1. It shall be possible to open the door only when the handle is in ‘OFF’ position.
   2. It shall not be possible to switch the unit ‘ON’ when the door is open. Moreover, no live parts shall be exposed when the compartment door is open.

G. Protection against shock shall be provided in accordance with the requirement of BS 5486 Part 1.

H. The switchboard shall be of the rear access pattern and vertical cable way shall be provided in each section of the switchboard. The cable way shall be provided with bolt-on covers. All terminals in the cable way shall be fully shrouded to prevent accidental contact when the covers are removed.

J. All external bolts or screw heads shall be chrome or cadmium plated.

K. The equipment in the switchboard shall be accessible with indicating instruments mounted not higher than 1.8m. And the centerlines of operating devices not higher than 1.8m. Above switchboard base. The switchboard shall be properly fixed to the floor with foundation bolts grouted in the floor or bolted to channels laid across the cable trench.
L. The switchboards shall have top or bottom cable entry as required. Basically, main incoming cables shall be bottom entry and outgoing cables top entry.

M. The switchboards shall contain the air circuit breakers, bus bars, bus couplers, MCCBs, instruments, earth bus, ...etc. as specified here under and as per drawings with ratings and arrangement as shown on the Drawings and shall be complete with all internal wiring and connections.

N. The switchboards shall be tested at the manufacturer’s premises as well as commissioned after installation in accordance with tests stipulated in IEC 439.

O. Additionally, Main Low Tension Switch Board shall comply with the concerned local authority’s requirements.

2.02 BUSBARS

A. The switchboard shall be provided with fully rated Bus bars for the entire width of the board. In addition, each section or panel of the switchboard shall be provided with vertical bus bars of adequate rating to provide branch connections to the outgoing breakers.

B. The horizontal and vertical bus bars and connection shall be fully segregated such that these shall not be accessible when the compartment doors and cable way covers are opened. They shall be provided with barriers which are removable by tool or special key.

C. The bus bars shall be made of electrolytic, hard drawn high conductivity flat pure tinned copper bars complying with IEC Standard. The whole bus bar system shall comply fully with the requirement of latest IEC standards.

D. The bus bars shall be air insulated and shall be rigidly supported on purpose made insulators of non-hygrosopic glass fiber moldings having a tracking index of not less than 600.

E. The Main Low Tension Panels (MLTPs) bus bar together with its connections to the incoming and outgoing unit shall be suitable to withstand a short circuit of 50,000 sym. amperes and in all other cases; it shall be suitable for the fault level at that point. The bus bars shall be provided with colored PVC levings at regular intervals for phase identification. Painted bus bars may be acceptable in special cases when panels are manufactured/assembled in Jordan.
A. The air circuit breakers shall be of the air break trip free draw out type with the main contacts encased in a reinforced polyester casing and offer double insulation from the operators on the breaker front face. The air circuit breaker shall be fully tropicalized (T2) as defined in IEC 68.2.30 and shall have salt spray resistance as per IEC 68.2.11. The ACB shall comply with IEC 947.2 utilization category B with \( I_{\text{sc}}=I_{\text{cu}}=I_{\text{cw}} \) and shall accept reverse feeding without reduction of performance. The ACB shall comply with the isolating function requirements of IEC 947.2 section 7.1.2 and shall have minimum 500 V 50Hz operational voltage, 1000 V 50Hz rated insulation voltage and 8kV withstand surge voltage \( (V_{\text{imp}}) \). The 3-pole and 4-pole versions shall have ratings as shown in the drawings. In the 4-pole version the neutral pole shall have the same current rating as the other poles from 800 to 4000A. The breaking capacities shall not be less than 50 kA symmetrical for 1 sec. at 415 volts. Evidence of the service breaking capacity \( (I_{\text{sc}}) \) shall be produced by test certificates from one of the internationally recognized testing Laboratories. (ASTA, CESI, ESEF/ASEFA, KEMA, PEHLA or SATS).

B. Unless otherwise mentioned the ACB shall be of the O-C-O stored energy spring type with a closing time less than or equal to 80 milliseconds. Electrically operated circuit breakers shall have the spring charging motor connected so that the springs remain charged always with the motor disconnected after charging. The spring charging time shall not exceed 4 seconds. A standby manual operating handle for spring charging shall be provided for operating the circuit breaker in case of power or motor failure. Antidumping shall be provided by integral devices to prevent reclosing after a close-open operation if the closing impulse is maintained after the breaker has opened. External relays are not acceptable.

C. The circuit breaker shall have three positions of the draw out mechanism, namely service position where all main and auxiliary contacts are made, test position where main contacts are open but auxiliary contacts are closed and isolated position where all contacts are open. Mechanical indication on the front of the ACB shall be provided to indicate:
   A) Main Contacts Closed ‘On’,
   B) Main Contacts Open ‘Off’,
   C) Springs Charged,
   D) Springs Discharged
   E) Service Position,
   F) Test Position, And
   G) Isolated Position for Draw out Mechanism.

D. Any attempt to withdraw or insert the breaker when it is ‘ON’ shall trip the breaker automatically. An interlocking shall be provided to prevent insertion of a circuit breaker having a rating higher than the current rating of the ACB cradle.

E. Insulated safety shutters shall screen all live parts in the ACB cradle when the breaker is in the isolated or racked out position.

F. The moving contacts comprising the main and arcing contacts shall have visual wear indicator and be of the spring-loaded type. The main contacts and clusters shall be site replaceable. The electrical endurance shall not be less than 4000 operations for rating up to 3200A and not less than 2000 operations for ratings above.

G. The circuit breakers shall have sufficient number of auxiliary contacts for interlocking system as indicated and described on the drawings and for interfacing with building automation system (BAS), with two spare sets of normally open and normally closed contacts. It shall be possible to connect all auxiliary wiring from the front face of the air circuit breakers and this wiring shall be taken through a set of disconnecting contacts, so that all auxiliary wirings are automatically disconnected in the isolated and draw out positions.
H. The circuit breakers shall be equipped with MCR, overcurrent and earth leakage protections by means of integral self-powered microprocessor based solid state RMS sensing current relays. The long-time overcurrent protection shall have a setting range between 40 and 100 per cent of sensor rating in steps of 2 per cent. The corresponding time delay shall be adjustable from 15 to 480 seconds the short time overcurrent protection shall have a setting range from 40 per cent to 15 times the sensor rating. The corresponding time delay shall
be adjustable from 15 seconds. The sort times the sensor rating. The corresponding time delay be adjustable from instantaneous to 400 milliseconds with the possibility select time inverse characteristic for improved discrimination. Instantaneous overcurrent protection shall be adjustable from 2 times the current up to the circuit breaker electrodynamic withstand. The earth protection shall have current settings from 10 per cent of the rated current 1200 A in steps of 10 per cent. The time delay setting shall be variable 100 milliseconds to 400 milliseconds in steps of 100 milliseconds.

J. The RMS value of the phase currents and interrupted current values shall be displayed on the built-in digital ammeter and the LED’s shall indicate the type of fault on the front face of the trip unit. An indicator shall give indication of the main contact wear per the number of operations and the values of the switched currents. A bar graph shall display the load indication of each phase and the highest value of phase currents shall be stored and displayed on demand. Trip unit malfunction or internal overheating shall be indicated by a self-monitoring alarm. (Some features may differ from one manufacturer to another)

K. The air circuit breaker used on bus-section shall be identical to Air Circuit Breaker specified but with only the Making Current Release (MCR) protections and instruments specified but with the following indications:
   1. Circuit breaker closed.
   2. Circuit breaker open.
   3. Circuit breaker tripped.

L. The main low tension panels shall be provided with cable boxes to suit the incoming cables from the transformer which are supplied and installed by the concerned local authorities.

2.04 CURRENT TRANSFORMERS

Current transformers shall be of Class C accuracy for indication and Class CM accuracy for metering purpose. The secondary windings shall be rated at 5A and the rated output shall be suitable for the burden.

2.05 INSTRUMENTS

A. The measuring instruments shall include ammeter voltmeters, maximum demand indicators and selector switches as indicated on the Drawings.
C. Ammeters shall be moving iron type, to B.S. 89 scaled 0-2000 A for main incoming supply.
D. Voltmeter shall be moving iron type to B.S. 89 scaled 0-500V and provided with 6-position selector switches allowing reading of line to line and line to neutral voltages.
E. Maximum demand indicators shall be of the thermal type with a 15-minute time delay.
F. The instruments shall have anti-glare glass fronts, anti-parallax scales and white faces with black numerals and markings. The instrument cases shall be semi-flush mounted and shall be approximately 100 x 100mm square. Accuracy shall be one percent of full scale values. Moving elements shall be provided with zero adjustments external to the cases.
2.06 kWh METERS

A. The kWh Meters for the concerned local authorities shall be suitable for operation on 415/240 volts, 3 phase, 4 wire, 50 Hz supply.
B. The meter shall be absolutely dust and vermin proof, protected from corrosion due to high humidity and compensated against the effect of temperature up to 55 Deg.C.
C. The Meters shall maintain their accuracy over many years’ service under Jordan climatic conditions. The counters shall be of the cycle-meter type with six digits and shall give a direct reading of power consumption to six figures, the lowest figure being units and not tenth of units. Pointer type counters are not acceptable.
D. Multiplying factors shall not be used except for the larger size of current-transformer operated meter, where 10 and 100 may be used. The calibrating adjustments shall be operated by screw-driver only.
E. The Meter cover and cases shall be of metal and not plastic.
F. The ratings for direct connected whole current meters shall be 50, 75 and 125 amperes maximum per phase and the terminal holes shall not be less than 6,9 or 12mm. diameter respectively.
K. Higher ratings meters shall have not less than 5mm. diameter terminal holes and shall be operate through current transformers with 5 amperes rating to the secondary side and the counter or the meter shall be calibrated to read the primary Kwh passing through the current transformers.
L. The current transformers shall be of the ring or slide on bus bar type.
M. Three current transformers of 2000/5A shall be provided for each meter.
N. All meters shall be handed over to the concerned local authorities for Calibration before final erection and connection.

2.07 FUSE SWITCHES

A. Fuse switches shall fully comply with BS 5419: 1977, IEC 408: 1972 meeting all of the concerned local authorities’ requirements.

2.08 MOULDED CASE CIRCUIT BREAKERS

A. The molded case circuit breakers shall comply with IEC 947-1 and IEC 947-2 standards and shall be of the quick make and quick break type having free toggle mechanism ensuring full contact pressure until time of opening, whether actuated automatically or manually. They shall be of utilization category ‘A’ having rated service breaking capacity (Ics) as indicated in the drawings. The circuit breakers shall be suitable for isolation as per IEC 947-2 and shall have rated operation voltage of 500V 50 Hz, insulation voltage of 750 V, 50 Hz. The breaker shall be available in 3 or 4 pole versions as per the drawing. All poles shall operate simultaneously for circuit breaker opening, closing and tripping. The mechanism shall be completely enclosed in the compact molded Bakelite case. The molded case circuit breaker shall provide class II insulation (according to IEC 664) between the front and internal power circuits. The breaker shall be designed for both vertical and horizontal mounting and it shall be possible to supply power either from the upstream or downstream side without any adverse effects on the electrical performance. Evidence of the service breaking capacity (Ics) shall be produced by test certificates from one of the internationally recognized High Voltage Laboratories (ASTA, CESI, ESEF/ASEFA, KEMA, PEHLA or SATS).

B. Breakers contacts shall be made of non-welding and non-corrodible composition. Circuit breakers shall be actuated by a toggle or handle that clearly indicates the three positions ‘ON’, ‘OFF’ and ‘TRIP’ thus indicating clearly abnormal conditions of the circuit. In order to ensure suitability for isolation complying with IEC-947-2, the operating mechanism shall be designed such that the toggle or handle can only be in OFF position if the power contacts are all
actually separated. The molded case circuit breakers shall be able to receive a locking device in the “isolated” position and there shall be a “push to trip” button in front to test operation and the opening of the poles. The circuit breaker rating, the ‘push to trip’ button, outgoing circuit identification and the contact position indication must be clearly visible and accessible from the front, through the front panel or the door of the switchboard. Single pole breaker with handle tie or bar equivalent construction are not acceptable for a multi-pole breaker.
Molded case circuit breakers shall be the fixed type. Plug in type breaker connections are not acceptable.

C. Breakers shall have the rating and rated service breaking capacity (Ics) as per IEC 947-2 as indicated in the drawings. The breakers shall be of current limiting type. For short circuits, the maximum thermal stress I²t shall be limited to $10^6$ A²s for ratings up to 250A and $5 \times 10^6$ A²s for ratings above up to 630A.

D. Circuit breakers shall have inverse time tripping characteristic with automatic release secured through action of a combination of thermal-magnetic or electronic trip units which shall trip free of the handle and operate in response to an overload or a short circuit.

D. It shall be possible to equip the molded case circuit breaker with a motor mechanism if needed and closing of mechanism shall take place in less than 80 ms. The operating mechanism shall be of the stored energy type only. The addition of motor mechanism or a rotary handle shall in no way affect circuit breaker characteristics and shall not block device settings.

E. The MCCB’s shall be designed for adding auxiliary contacts such as shunt or under voltage releases after installation at site. The auxiliaries shall be separated from power circuits. It shall be possible to install auxiliary switches for fault/status indication in already energized MCCB without the need to trip the MCCB.

G. It shall be possible to assemble earth fault protection of MCCB’s by adding a residual current device directly to the circuit breaker case and it shall operate without an auxiliary power supply. The added RCD’s shall comply with appendix B of IEC 947-2 standard. They shall be immunized against nuisance tripping as per IEC 255 and IEC 801-2 to 801-5 standards.

H. MCCB with ratings up to 250A shall be equipped with thermal magnetic or electronic trip units which are fully interchangeable types. The breakers with ratings over 250A shall be equipped with electronic trip units which shall remain operational for ambient temperatures up to 60°C. Electronic trip units shall comply with appendix F of IEC 947-2 standard. It shall be possible to fit lead seals to prevent unauthorized access to the settings of the electronic and thermal magnetic trip units. MCCB’s equipped with thermal magnetic trip units shall have adjustable thermal protection and fixed magnetic protection for current ratings up to 160A. For current ratings, greater than 160A the thermal magnetic trip units shall be adjustable from 5 to 10 times the current rating. In four pole breakers, the neutral pole shall have the tripping threshold equal to that of the phases unless otherwise stated in the drawings.
K. MCCB’s up to 250A frame size equipped with electronic trip units shall sense the actual RMS values for:
   a) Long time protection from 40% to 100% of the trip unit rating,
   b) The short time protection shall be adjustable from 2 to 10 times the thermal setting,
   c) The instantaneous protection shall have the threshold fixed between 12 and 19 times nominal current, depending on the rating.

L. MCCB’s over 250A up to 630A frame size shall be equipped with electronic trip units shall sense the actual RMS values for:
   a) Long time protection from 40% to 100% of the trip unit rating,
   b) The short time protection shall be adjustable from 2 to 10 times the thermal setting,
   c) The instantaneous protection threshold shall be adjustable from 1.5 to 11 times nominal current and d) A thermal memory (in the event of repeated overloads, the electronic trip units shall optimize protection of cables and downstream devices by memorizing temperature variations). A load monitoring function shall be an integral part of the electronic trip units indicating four load levels (60%, 75%, 90% and 105%) by LED’s (with flashing LED for 105%). It shall be possible to install with the electronic trip unit a high threshold earth fault protection, load monitoring and LED’s in front to indicate the cause of tripping. It shall be possible for the MCCB to communicate with Building Management System (BMS).

M. The following frame sizes shall be adopted for different breakers:
   - up to 80A 100/125A frame size
   - 100A to 160A 250A frame size.
   - 250A to 350A 400A frame size.
   - 350A and above 630A frame size

N. Each MCCB’s shall have minimum 2 pairs of NO /NC auxiliary contacts

2.09 EARTH LEAKAGE RELAYS

A. Earth Fault Relay
   a. The relays shall comply with IEC 755
   b. The relays shall be protected against nuisance tripping caused by switching surges or by lighting surges.
   c. The relays shall be of solid state type (mechanical type shall not be accepted), self-protected from high magnitude earth faults and protected against dirt, vibration and moisture.
   d. The relays shall be able to operate in the presence of fault currents with DC components.
   e. Each relay shall accept a wide range of auxiliary supply voltages from 48V to 240V AC and 48V to 300V DC as per the requirement in the drawings.
f. The sensitivity of relays shall be adjustable as per the requirement in the drawings from 0.03A to onward. The relays shall have time delay option if required from instantaneous to 1 sec. using an 8-position switch.
g. The size of the relays shall be compact. They shall be suitable for mounting on symmetrical rail horizontally or vertically.
h. The relays shall be equipped with one changeover output contact. The continuity of the measurement circuit shall be monitored to ensure that the toroid circuit is not open.

B. Current Sensors (Toroid)
   a. Rectangular type for busduct feeders
   b. Circular type for cable feeders
   c. The range of associated toroidal transformer shall be of the closed type with an inside diameter of 30 to 200 mm.
   d. To have cable guides to ensure that feeder cable is centered within the sensor.
   e. The maximum link resistance from toroid to relay link must not exceed 3 ohms.

Current operated earth leakage relays shall be used either in conjunction with circuit breakers for tripping the breakers or for giving alarm signal only by an indicator lamp and alarm bell in cases of earth leakage.

2.10 EARTH BUS

The copper earth bus shall be minimum 50% of the phase conductor size extending throughout the length of the switch board and fixed to the steel members of the switch board. The earth bus shall be extended at the ends for connection to the earth electrodes and shall have provision for terminating earth continuity conductors.

2.11 MAIN AND SUB-MAIN DISTRIBUTION BOARDS

A. The main and sub-main distribution boards shall be totally enclosed, dust protected and factory fabricated suitable for operation on 415/240 V, 3 phase, 4 wire, 50 Hz supply.

B. Main and sub-main distribution boards shall comprise main incoming isolator, bus bars, molded case circuit breakers, earth leakage relays, earth bus etc. with ratings and arrangement as shown on the Drawings and all housed in a sheet steel panel fully rust-proofed and electro static powder coated paint; equipped with a hinder door with approved locking device.

C. The main isolator shall be a triple pole and neutral molded case circuit breaker without tripping element.
D. The bus bars shall be high conductivity copper bars to B.S. 159 with ratings as indicated on the Drawings for the three phases and neutral. The bursars shall be arranged and marked to the approval of the Engineer.

E. The molded case circuit breakers and earth leakage relays shall be as specified in paragraph 2.08 and 2.09 above.

F. The rated service breaking capacity (ICS) of MCCBs shall be 50 KA for MLTP, 28KA for MDBE, 22 KA for MSBs and MCCs, 14 KA for SMSB and MCC fed from MSB unless indicated otherwise on the Drawings.

G. The earth bus shall have adequate rating and length for connecting the incoming and outgoing earth wires or tapes.

H. The distribution boards shall be complete with all necessary internal wiring and connections.

J. High conductivity copper bars or rods covered by colored PVC sleeving for phase identification shall be employed for connections of 200A and higher. For smaller connections PVC insulated cables to B.S. 6231 shall be used with colored insulation for phase identification.

K. The arrangement of the boards shall be such that the main isolator and MCCBs can be operated when opening the door but to gain access to the MCCBs, cabling and terminations a second cover should be removed. There shall be ample clearance and ample space available inside the boards for cabling and terminations. Adequate clearance shall be maintained between phases and non-current carrying metal and terminals shall be so located that in the final connected positions there shall be no crowding of wires in close proximity of metal.

L. The boards shall be complete with cable glands for convenient terminations of incoming and outgoing cables. The cable glands shall be so fixed inside the board that ample clearance exists between various feeders.

2.12 M.C.B. DISTRIBUTION BOARDS

A. MCB distribution boards shall comprise of a totally enclosed dust and vermin protected, factory fabricated heavy gauge sheet steel enclosure of 2mm thickness and door of 1.5mm thickness and of ample size with a hinged door and approved fastening device. The enclosure shall contain an isolating switch, adequately rated bus bars for phases, neutral connector blocks, earth terminal block and single or triple pole miniature circuit breakers with ratings and arrangement as shown on schedules. DB enclosures shall be suitable for 18 or 24 or 36 SPN ways, has the case may be. HRC fuses shall be provided in MCB Distribution Boards where fault level exceeds 6KA.
B. In corridors DBs enclosure shall be housed in electrical closets. All electrical closets shall be of the same size with architectural finishes as required.

C. All risers falling in areas like corridors or important rooms shall be provided with a hinged access door with finishes as required by architect.

D. The main isolating switch shall be of SPN or TPN air break design. Where indicated on the Drawings, the MCBs for the lighting circuits and socket outlet circuits shall be electrically separated by the provision of separate busbars and each section shall be protected by a separate current operated earth leakage circuit breaker. The RCCB shall afford earth leakage protection for the lighting and power sections. Fuses shall be provided for DBs wherever necessary and/or shown on drawings.

E. The neutral and earth terminal blocks should be provided with arrangement for connecting on each block one cable for each outgoing circuit and one incoming cable of size indicated on the Drawings. The wiring between the RCCB and busbars shall be carried out with coloured PVC insulated cables with copper conductors for phase identification. The arrangement of the enclosure shall be such that the MCBs and COELCB cannot be operated without opening the hinged door but to obtain access to MCBs and COELCB, it should be necessary to remove a second cover. Adequate clearance shall be maintained between phase and non-current carrying metals. Terminals shall be so located that in the final connected positions, there shall be no crowding of wires in close proximity of live metals.

F. MCBs shall be so arranged in the board that it shall be possible to replace a triple pole MCB with three adjacent single pole MCBs or vice versa. The board shall be flush mounted type unless indicated otherwise on the Drawings. Cable glands shall be provided where required.

G. MCB

MCB shall comply with EN60439-3 and shall be symmetrical rail mounted type available in one, two, three or four poles version. They shall be trip free type with quick make, quick break mechanism. The rated ultimate breaking capacity (Icu) of the MCB’s shall be at least equal to the prospective fault level at the point of the distribution system where they are installed, unless cascaded with an upstream breaker. The minimum rated ultimate breaking capacity (Icu) of the MCB shall be 10 kA if not mentioned on the drawings. MCB can be reverse fed without reduction in performance. Trip setting as indicated on the schedules of points. The MCB shall have thermal overload trip to accept 5% overload and to trip at 30% of rated current as per IEC 947-2. The instantaneous magnetic trip shall operate at 5 to 10 times the rated current for 1P, 2P, 3P or 4P breakers. It shall be possible to replace 3 single phase units with one 3 phase unit. The breakers shall be of current limiting type (DIN type). The quick lag
type breakers (QL/plug in type) are not acceptable. Evidence of the ultimate breaking capacity (Icu) shall be produced by test certificates from one of the internationally recognized High Voltage Laboratories (ASTA, CESI, ESEF/ASEFA, KEMA, PEHLA or SATS).

The operating mechanism shall be mechanically trip free from the operating handle so as to prevent the contacts from being held closed against short circuit and overload conditions. It shall be “automatic resetting type”. The individual operating mechanism of each pole of a multi pole MCB shall be directly linked within the MCB casing and not by operating handles. The operating handle shall be of the toggle type with possibility of padlocking facility and rotary handle. Each pole shall be provided with bi-metallic thermal element for over-load protection and magnetic element for short circuit protection. Current discriminations tables shall be provided for each rating of the breaker. The terminals shall be of the tunnel type (IP 20) in order to minimize the risk of direct contact. It shall be possible to fit on site auxiliaries like shunt trip coil, under voltage release, ON-OFF switch, alarm switch or residual current device 30 or 300 mA with remote tripping possibility.

The term ‘rcb’ /’rcbo’ shall denote an mcb with built-in earth leakage protection.

**H. RESIDUAL CURRENT CIRCUIT BREAKER (RCCB)**

RCCB shall comply with CEE 227 or IEC 1008 standards. The RCCB shall provide the functions of isolation, switching and earth leakage protection of electrical circuits. They shall have a residual current operated electromechanical release which operates without auxiliary source of supply to an earth leakage fault between active conductors and earth. RCCBs shall incorporate a filtering device preventing the risk of unwanted tripping due transient voltage. They shall provide a high degree of protection against earth faults, fire hazards and electric shock.

RCCBs shall be available in 2 and 4 pole versions with current ratings from 16A to 100A and an earth leakage trip rating as specified in the schedule of points. They shall be suitable for operation on 415V, 3 phase, 4 wire, and 50 Hz supply. They shall have an operating temperature from -5 to + 60° C. RCCB shall have a trip indication on the front face by a red mark. It shall be possible to achieve vertical discriminations with RCCBs.

RCCB alone shall have a short circuit withstand capacity of 3 KA. RCCB must be protected with short circuit protective devices installed upstream inside the DB enclosure having appropriate fault level protection.

RCCB shall consist of the following mounted in a robust body of all insulated material:
- A current transformer
- A tripping coil with contact assembly
- Main supply contact
- On/Off switch
- A test button
- A trip free mechanism

Where a RCCB is used as a separate item and not housed within a distribution or switchboard, it shall be housed in a dust protected enclosure to prevent accidental contact with live terminals.

**I.** Where contactors are shown in DBs, the distribution board shall have deemed to be understood as a multiple section board.

**J.** All outdoor MCB distribution boards shall be in weatherproof enclosures.

**K.** The term RCB shall mean an MCB with built-in earth leakage protection similar to ‘Quickguard’ of Square-D
L  CONTACTORS

The contactors shall conform to BS 775, IEC 947-4 suitable for Class II duty and having a making and breaking capacity in accordance with utilization category AC3. Unless specially required otherwise the operating coil shall be rated for 240V 50Hz. Contactors shall be rated for continuous duty. Contactors not forming a part of Distribution Board shall be housed in a purpose made enclosure having appropriate IP rating suitable to the mounting location.

M  PULSE RELAYS

Pulse relays shall be suitable AC or DC operation as per system manufacturer Normal practice. The operation voltage may be 240V 50Hz or 24V DC. The pulse relay shall be suitable for actuation manual through built-in Push button.

2.13 MOTOR PROTECTION

Motor Protection against the short-circuit shall be achieved by motor circuit breakers of moulded case type and the combination with control-command devices (Breaker + Contactor + Overload relay) shall be of type 2 co-ordination as defined by the IEC standards 947-4.1. The type 2 co-ordination should be tested in laboratory and the manufacturer should guarantee the same by submitting the type-2 co-ordination tables. The co-ordination table shall indicate for each motor rating, the circuit breaker type and set up characteristics, the contactor type and the thermal relay type with its setting range.
The specifications mentioned in the MCCB’s section is applicable for the breakers used in the motor protection. The moulded case circuit breakers used for motor protection shall be equipped with adjustable magnetic trip unit for short-circuit protection with settings from 6 to 14 times the nominal rating of the device.

The contactors used for Motor protection shall have contactor utilization category AC3 at 415V 50Hz as per IEC 947-4. Tripping class for overload relays used for motor protection shall be of one of the tripping class (class 10A, 10, 20, 30) as per IEC 947-4 depending on the motor starting characteristics.

2.14 ELECTRONIC SOFT STARTERS

Where these starters do not fall under the electrical sub-contractor’s scope of work, the specifications may be used for all co-ordination works.

The concerned factory manufacturing the equipment must be ISO 9001 certified for quality assurance and the product supplied shall bear the CE mark.

Contractor to provide complete coordination / selection table prepared by the soft starter manufacturer and indicating clearly the recommendation components such as fuses, breakers, contractors and overload relays so as to achieve Type – 2 coordination as per IEC guidelines. These components shall be from the same manufacturer for easy substitution and consistent operational reliability of the equipment. Mixing of brands is wholly unacceptable. The soft starters in general shall comply with the following.

Enclosure
- Equipment shall be manufactured in accordance with IEC regulations.
- The enclosure used shall be adequate per EMC and Low Voltage directives. The equipment shall be CE marked.
- Units above 20A shall be fitted with adequate forced air-cooling (fan-type).

Control Circuit

The soft starter shall comprise a uPtype control arrangement (PCB based) for triggering control and offer as a minimum, the following functions, selectable using DIP- switch or settable using potentiometers:
- Start Ramp (settable) for up to 60 sec.
- Stop Ramp (settable) for up to 240 sec.
- Startup Voltage (settable) 10 to 60%
- Stop Voltage (settable) 10 to 60% (for Pump Stops)
- Current limit during start (settable)
- Energy saving feature (selectable) for optimal power factor, current and efficiency levels on a real time basis, provided with activation delay (selectable).
- Kick start function for transient high-torque condition to overcome high initial inertia/friction loads (selectable)
- High Current Trip (selectable)

Status indications shall comprise as a minimum, LED display of the following:
- Fault (internal)
- Phase Loss
- Overload
- Ready
- Running
- Ramp-up complete
- Energy Saving function active (if selected)

Further as a minimum, the following volts-free signals shall be made available:
- Fault
- Overload
- Ramp-up complete

**Power circuit**

The following features shall be provided as standard:
- Start and stop ramp to be achieved using reduced voltage triggering of thermistors connected in antiparallel, with each phase individually double-protected by adequate snubbed circuits and visitors to withstand 4kV at 2.5Hz for 60 seconds or more.
- Diodethyristor paralleling in unacceptable.
- Starter shall be suitable for continuous duty. Further, the circuit must be suitable for constant mains voltage, even when starter is not in use.
- Electronic overload relay to be provided as option in all ratings above 30A and as standard feature for heavy-duty applications to protect the unit from thermal overloads, phase-loss and locked rotor conditions. In addition, an option of over-current trip (selectable) shall be provided to prevent damage due to short-circuits. External electronic or thermal overload relays may be proposed as an option.
- Adequate heat sinking shall be provided. Further, a thyristor overheat trip shall be provided for added protection.
- Adequately sized terminals shall be provided for linking to cables. Where busbars are used, terminal expansion attachments shall be provided accordingly.

**Technical Support**

The equipment shall be supplied complete with comprehensive documentation comprising the installation and operation instructions. In addition, the following documentation shall be provided on request and where applicable:

- Selection details including starting curves based on manufacturer’s recommendations.
- Coordination tables (where used) for Type-2 coordination as per IEC.
- Connection drawings for the scheme used.
- Basic trouble-shooting guide (if not already included in the ops manual)
General

The equipment shall be compliant with the following wrt operation:

- Rated installation voltage of 690Vac.
- Starter shall be typically for minimum 6 starts per hour (subject to application type and kW rating)
- For units used in continuous running with fewer starts, a bypass contactor recommended by the soft starter manufacturer shall be used to minimize heat loss.
- Actuation of bypass contactor shall be achieved by using relay output on completion of ramp up.
- Operating temperature shall be 0°C to 50°C with adequate de-rating where required (application dependent). Also, the equipment shall be suitable for normal operation without derating, within an altitude range of 0-1000 meters.

2.15 ELECTROMECHANIC MOTOR STARTERS

Where these starters do not fall under the electrical sub-contractor’s scope of work, the specifications may be used for all co-ordination works.

A. Provide motor starters of electromagnetic, air break type suitable for 3 phase, 50 Hz. 415V, AC System and in accordance with IEC 947-4

B. Starters shall be of the plug-in type mounted on withdrawable trays including power and control plug pins and earthing contact with facilities for padlocking.

C. Starters controlling motor less than 11 KW may be of the direct on line type. For motors of 11 KW and higher ratings employ automatic star delta starters. Starters shall be provided with three phase overload relays having thermal characteristics suitable for the associated motor and its starting characteristics and suitably compensated for ambient air temperature variation. In addition, provide single phasing protection. Means should also be inherent in the starter for automatically disconnecting the motor from the electricity supply in the event of interrupted supply or under voltage. Provide earth leakage protection for all motors.
D. Starters shall have in addition to the auxiliary contacts required for interlocks, alarms, BAS, and controls two additional sets of normally open and normally closed contacts.

E. Motor Protection against the short-circuit shall be achieved by motor circuit breakers of moulded case type and the combination with control-command devices (Breaker + Contactor + Overload relay) shall be of type 2 co-ordination as defined by the IEC standards 947-4.1. The type 2 co-ordination should be tested in laboratory and the manufacturer should guarantee the same by submitting the type-2 co-ordination tables. The co-ordination table shall indicate for each motor rating, the circuit breaker type and set up characteristics, the contactor type and the thermal relay type with its setting range.

The specifications mentioned in the MCCB’s section is applicable for the breakers used in the motor protection. The moulded case circuit breakers used for motor protection shall be equipped with adjustable magnetic trip unit for short-circuit protection with settings from 6 to 14 times the nominal rating of the device.

The contactors used for Motor protection shall have contactor utilization category AC3 at 415V 50Hz as per IEC 947-4. Tripping class for overload relays used for motor protection shall be of one of the tripping class (class 10A, 10, 20, 30) as per IEC 947-4 depending on the motor starting characteristics.

F. For each starter, provide the following:
   1. 1 set of ‘ON’ and ‘OFF’ push buttons for starting and stopping of motor.
   2. Red and Green indicating lamps to show status of motor.
   3. Suitably scaled ammeter with selector switch for each motor above 7.5 KW.
   4. All auxiliary contacts for BAS.
   5. Instruments for KW indication by BAS.

G. For each motor circuit, its associated circuit breaker and its starter shall be housed in one cell or unit and interlocked so that cell door cannot be opened and started unit cannot be withdrawn unless the breaker is in the ‘OFF’ position.

2.16 AUTOMATIC VOLTAGE STABILISER

Wherever specified/indicated, the stabilizer shall be constructed on booster transformer principle. The rating of the stabilizer shall be as indicated on drawings or as specified in the B.O.Q

Technical Requirements

<table>
<thead>
<tr>
<th>Ambient Temp.</th>
<th>up to 50 °C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cooling type</td>
<td>Natural air cooled</td>
</tr>
<tr>
<td>Input</td>
<td>415V AC 15% at 50Hz</td>
</tr>
</tbody>
</table>
The stabilizer shall be equipped with filters for transients, compensator for unbalanced load in 3 phases, protection against faults and malfunctions. The stabilizer shall be fixed with 3 Ammeters, voltmeters

**PART 3 – EXECUTION**

**3.01 CIRCUITS AND CONNECTIONS**

A. Provide all outgoing circuits with separate compartment and/or screen so that equipment for any one circuit can be maintained without risk of contact with line connections on any other circuit.

B. Connect feeders, for circuits rated up to 63A, to terminal blocks located in separated compartments at top or bottom, conveniently arranged to facilitate termination of cables and suitably identified.

C. For feeders, rated more than 63A, suitably extend copper links rigidly supported and covered with coloured PVC sleeves.

D. Provide all feeders with cable lugs and brass cable glands.

E. Provide removable gland plates suitable for the glands required for the specified cables. Where cables are single core, the gland plates shall be of a non-ferrous metal.

F. Provide all small wiring of stranded copper, not less than 2.5mm² with PVC insulation to B.S. 6231. Small wiring shall be neatly bunched and cleated in harness form, or shall be enclosed in purpose made plastic trunking or troughing. Wiring cleated to metal surfaces shall be insulated from the metal. Where wiring runs through sheet steel panels, holes shall be grommeted with suitable grommets.

G. Connect small wiring associated with external circuits to terminal strips conveniently arranged.

H. Provide each connection with separate incoming and outgoing terminals with no more than two wires to be connected to any terminal.

J. Wire all spare contacts to terminal strips suitably positioned.

K. Identify all wiring using plastic ferrules at both ends

**3.02 FLEXIBLE CONDUITS**

A. The final conduit/connections to motors or apparatus shall be in flexible conduits

* END OF SECTION *
PART 1 GENERAL

1.1 GENERAL REQUIREMENTS

A. The work of this Division shall be governed by the following documents:
   2. Instructions to Tenderers.
   3. Form of Agreement.
   4. General and Special Conditions of Contract.
   5. Form of Tender.
   6. Appendices.
   7. Applicable Divisions.

B. Comply with requirements of Section 16010 electrical General Provisions.

C. It is the Contractor’s responsibility to be fully aware of and comply with all of the requirements of the above listed documents.

1.2 SCOPE OF WORK

A. Supply all labour, tools, services and equipment and provide all the materials required to complete this section of the work.

B. The lighting installation for this project shall consist of the following systems but shall not be limited to.
   1. General lighting.
   2. Emergency and exit lighting system as shown on drawings and luminaire schedule.

   3. Exterior and site lighting.

C. Generally, the lighting installation shall be carried out by installing conduits within the building structure and walls forming a flush installation in mechanical rooms, electrical switch rooms and other service areas the installation shall be on the surface.

D. Generally some of the lighting installation may be switched utilizing programmable low voltage switching.

E. Emergency lighting and exit signs shall be connected as shown on drawings.

F. External lighting shall be contactor controlled incorporating scheduled BMS or KNX lighting control system.
1.3 QUALITY ASSURANCE

A. Acceptable Manufacturers.
   1. Subject to compliance with the requirements of the Contract documents, acceptable
      manufacturers are to be firm regularly engaged in the manufacturer of lighting
      fixtures of similar quality whose products have been in satisfactory use under similar
      service conditions for not less than ten years.

1.4 SUBMITTALS

A. Reference Applicable Divisions – Submittals

B. Reference Applicable Divisions - shop drawings, products and data and samples.

C. Submit shop drawing of:
   Each type of lighting fixture detailing.
   i. Catalogue illustrations of luminaire proposed for each specified application.
   ii. Design and installation requirements.
   iii. Photometric curves and isolux diagrams for each luminaire with indication of minimum light output ratio.
   iv. Date indicating each luminaire type’s maximum and minimum ambient operating temperatures, and special features, where applicable to withstand onerous conditions, ie. High ambient temperature, intense direct sunlight blowing sand and grit, salt laden air etc.

Computer print out of exterior flood lighting of the building.

D. Samples and shop testing.
   Fixture (Recessed type)

   i. For the lighting fixture (recessed in F.C) the contractor shall obtain from the ceiling manufacturer a 3m x 3m sample of the ceiling assembly for the Jebsum F.C. The fixture manufacturer shall finalize the details and dimensions the fixture recessed to be co-ordinated with and accommodate the ceiling assembly.
   ii. Inform the engineer fourteen (14) days in advance of the assembly being completed and obtain the consultant approval for the assembly.
E. Spares

Provide spare luminaires, control gear, lamps and louvres as listed hereinafter.
Luminaries: recessed type: 50 No.

Lamps
i. Provide 20% spare & tubes of each lamp & tube type and rating with a minimum of 10 lamps or tubes of each type and rating.

Control Gear
i. Provide 20% control gear of each control gear type and rating with a minimum of 10 control gear per type and rating.

Louvres & Lenses
i. Provide 5% spare lenses & louvres of each type.

Emergency conversion modules.
i. Provide 10% of each type with a minimum of 5 modules per type and rating.

1.5 DESIGN CRITERIA

Generally, all luminaires have been selected to achieve the underlisted illumination levels for the reflectance’s of surfaces applicable, and a maintenance factor of 80% - 90%:

<table>
<thead>
<tr>
<th>Location/Function</th>
<th>Min. Service</th>
<th>Illuminance (LUX)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conference Room</td>
<td></td>
<td>500</td>
</tr>
<tr>
<td>Corridors</td>
<td></td>
<td>100</td>
</tr>
<tr>
<td>Entrance Hall</td>
<td></td>
<td>400</td>
</tr>
<tr>
<td>Mechanical Plantroom</td>
<td></td>
<td>300</td>
</tr>
<tr>
<td>Meeting room</td>
<td></td>
<td>400</td>
</tr>
<tr>
<td>Offices</td>
<td></td>
<td>500</td>
</tr>
<tr>
<td>Public Areas</td>
<td></td>
<td>200</td>
</tr>
<tr>
<td>Pump Room</td>
<td></td>
<td>200</td>
</tr>
</tbody>
</table>
Stairs 200  
Store 300  
L.V. Room 300  
Pantry 150  
Toilets and lockers 200  
Waiting Area 300  
Lounge 250  
Guest Room 250  

Note: Max. Service illuminance shall not exceed 20% of the above levels.

PART 2-PRODUCTS

2.1 LUMINARIES - GENERAL

A. Standards
1. IEC Standard 61 - Lamp Caps and Holders.  
2. IEC Standard 64 - Tungsten Filament Lamps.  
3. IEC Standard 81 - Tubular Fluorescent Lamps.  
4. IEC Standard 82 - Ballasts for Tubular Fluorescent lamps.  
5. IEC Standard 155 - Starters for Fluorescent Lamps.  
6. IEC Standard 188 - High Pressure Mercury Vapor Lamps.  
8. IEC Standard 598 - luminaires, incorporating:  
   Part 1: 598-1, General requirements and tests - 1979 including all subsequent amendments.  

B. Equipment
1. Luminaires shall be completely self-continued, unless otherwise specified, and include all control gear, lamp holders, reflectors and diffusers, as required.  
2. Luminaires shall be recessed, surface-mounted or suspended as indicated on the Drawings, by code reference and identified in luminaire Schedule and Data sheets.  
3. All diffusers shall be of the light stabilized and non-discoloring type.  
4. The design, construction and finish of all luminaires shall be entirely adequate for operation in the ambient conditions and at the supply characteristics stated in section 16010 of this specification. All luminaires shall be designed and installed to permit easy relamping.  
5. Where possible a terminal block shall be provided inside each luminaire and the wiring between this terminal block and lamp holders, choke, capacitors, etc., shall be completed in heat resistant (135°C) cable of adequate size. Terminal blocks fixed to outside of luminaire housings shall be shrouded type with cable cord grip.  
6. Where space is not available for the installation of a terminal block at the luminaire, a separate terminal block shall be provided in an adjacent junction box connected back to the luminaire in heat resistant (135°C) cable of adequate size.  
7. All luminaires shall be suitable for connection to rigid conduit, and/or flexible circular sheathed cable.  
8. all weather-proof luminaires shall be fully suitable for outdoor use and shall not deteriorate after extended use in the ambient site conditions state.  
9. All mounted luminaires shall be connected to the control box in heat resistant (135°C) cable.
2.2 EXIT SIGNS

A. Shall be bilingual, details as shown in the following documents and to the approval of Civil Defense authorities:
   - Signage and Graphics
   - Luminaire Schedule
   - Electrical Drawings
   - Data Sheets included herein.

PART 3 EXECUTION

3.1 INSTALLATION GENERAL

A. Refer to Section 16010.

3.2 INSTALLATION OF LIGHTING FIXTURES AND LAMPS.

A. Provide all lighting fixtures and lamps shown on the drawings luminaires schedule and data sheets attached herein.

B. Include for assembly, and mounting of all fixtures, complete with all wiring, connections, fittings, hangers, aligners, box covers and accessories which may be required for any fixture to provide a complete, safe, fully operational assembly.

C. Generally, install fixtures in accordance with applicable reflected ceiling plans and/or as directed by the Architect. In equipment rooms, shafts and similar secondary areas, install fixtures after the mechanical and other major work is roughed-in and adjust fixture locations as required.

D. Thoroughly review all ceiling types, construction details and mounting arrangements before placing fixture orders and ensure that all mounting assemblies, frames, rings and similar features are included for and match the requires installation.

E. All fixtures and fixture assemblies shall be properly secured and supported. Support fixtures independent of the ceiling construction complete with all fasteners, framing and hangers. Do not secure fixtures to mechanical ductwork or other vibration producing apparatus unless specifically detailed on the drawings.

F. Where fixtures are suspended from the structure they shall utilize self aligning box covers with an additional ground wire from the outlet through the hanger for continuity of ground.

G. Carefully co-ordinate the fixture installation with the work of other trades ensuring that the necessary depths and mounting spaces are provided. Do not alter fixture locations unless approved by the Architect.

H. All lamps shall be new and intact when the project is complete, and ready for acceptance.

I. Provide safety chains on all surface mounted or suspended fixtures.
F. The final connection to all luminaries integrated into suspended ceilings shall be by means of flexible heat resisting cable terminated at a plug and sockets ceiling rose mounted in the ceiling void directly adjacent to the luminaire. All such ceiling roses shall be appropriately rated to suit the rating of the associated sub-circuit protective device. The plug and socket ceiling rose shall be located directly above or adjacent (within a horizontal distance of 1.5m from the centre of the fixture) at the side of luminaire such that it is readily accessible for disconnection and maintenance.

G. Earthing
1. All luminaries of metallic construction shall be suitably earthed, the earth wiring being connected by a terminal provided within each fitting specifically for this purpose.

2. Where luminaires are suspended, a cable protective conductor shall be connected between the fitting and the final sub-circuit wiring installation.

H. Luminaires Commissioning and Testing
1. At the discretion of the Engineer, make-up site test and demonstrate the operation of special application of fixtures such as building floodlights, landscape fixtures and other decorative fixtures, and adjust their locations within a reasonable distance to obtain the effects desired to the approval of the Architect. Assist in the aligning and positioning of all adjustable fixtures, and ensure that fixtures with adjustable lamp holders are properly positioned to correspond with the lamps specified.

3.3 EXIT SIGNS

A. Provide all Exit Signs as scheduled and shown on the drawings, signage and graphics document and luminaire schedule.

B. Directional arrows on Exit lights shall be as shown on drawings and in accordance with local Civil Defense Department requirements.

*** END OF SECTION ***
SECTION 16640
EARTHING

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Grounding System including, but not limited to the following:
   1. Grounding rods.
   2. Grounding conductors.
   4. Grounding of various systems.

1.02 RELATED SECTIONS

A. Electrical Works, General.
B. Electrical Identification.
C. LV Cables and Wires.
D. Underground Electrical Services.

1.03 REFERENCES

A. British Standard Code of Practice CP1013 - Grounding.

1.04 SUBMITTALS

A. Submit manufacturer’s data, illustrated leaflets, dimensions, fixing details and description of the proposed products.

1.05 QUALITY ASSURANCE

A. Manufacturer’s: Firms regularly engaged in the manufacture of Grounding equipment, whose products have been in satisfactory use in similar service for not less than 10 years. Preference shall be given to local manufacturers and suppliers/agents.

B. All equipment furnished under these Specifications shall conform to the requirements of BS, IEC and Local Standards Organization.

1.06 DELIVERY, STORAGE AND HANDLING

All products shall be carefully packed to avoid damage during transportation.
PART 2 PRODUCTS

2.01 GENERAL

A. All the materials required for Grounding system shall be furnished new and undamaged in accordance with the requirement stated in this section.

B. Conduct soil electrical resistively tests at four locations (minimum) advised by the Engineer. The Grounding calculations based on the test results shall be submitted for Engineers approval, to demonstrate that the proposed design of Grounding system complies with the specifications and standards.

C. For High voltage equipment in Transformer room, a connection shall be provided from the main Grounding loop. Also Grounding pits shall be installed as per Local Electric Supplier requirements, which will be isolated from the main Grounding loop.

D. For communication room, separate Grounding pits shall be installed as per Local Telephone Supplier requirements, which will be isolated from the main Grounding loop.

2.02 Grounding connection bar

A. For connection of MV and LV equipment, sub-station shall have high conductivity copper, Grounding connection bar with minimum dimensions of 50 x 6 mm and mounted on porcelain insulators. The bar shall be of suitable length with pre-drilled holes at a minimum distance of 50 mm between hole centers.

B. Grounding connection bars for transformer neutral and LV switchboard frame shall be separate from Grounding bar for HV and transformer frame.

C. Each Grounding connection bar shall have a permanent label to identify the connections together with the wording "Main Grounding Bar".
PART 3 EXECUTION

3.01 INSPECTION

A. Examine the area and conditions under which the Grounding systems are to be installed and correct any unsatisfactory conditions detrimental to the timely and proper completion of the work. Do not proceed with the work until the conditions are satisfactory in a manner acceptable to the Engineer.

3.02 GROUNDING CONDUCTORS INSTALLATION

A. Standard sizes of stranded copper conductor used for Grounding continuity shall be according to the requirements of IEE Wiring Regulations, 16th Edition.

B. Suitable Grounding facilities, acceptable to the Engineer, shall be furnished on electrical equipment to consist of compression type terminal connectors bolted to the equipment frame or enclosure and providing a minimum of joint resistance.

C. The conduit system shall not be considered as continuous for Grounding purposes. A separate Grounding conductor shall be installed in the same conduit with the phase and neutral conductors. The separate Grounding conductors shall be sized according to IEE Wiring Regulations, 16th Edition. requirements. No Grounding conductors shall be smaller than 2.5 mm² unless this is part of a multicore cable. Where flexible connections are made to equipment, grounding jumpers shall be provided. All connections of heavy gauge steel conduit system shall be checked for good electrical continuity.

D. Exposed conductors shall be installed inconspicuously in vertical or horizontal positions on supporting structures. When located on irregular supporting surfaces or equipment, the conductors shall run parallel to or normal to the dominant surface.

E. Conductors routed over concrete, steel or equipment surfaces shall be kept in close contact with those surfaces by using fasteners located at intervals not exceeding 1 m.

F. Exposed Grounding conductors shall be securely fastened to the mounting surface using copper or brass straps.

G. Clamps, connectors, bolts, washers, nuts and other hardware for bolted connection to Grounding system shall be of copper.

H. Exothermic welds shall comprise moulds, cartridges, materials, and accessories as recommended by the manufacturer.

I. The Grounding conductors entering the building shall be installed in a 25 mm diameter PVC conduit. Waterproofing shall be provided at all entry of Grounding conductors, details of which shall be approved by the structural engineer.

J. Grounding conductors shall be buried at a minimum depth of 750 mm below finished grade.

K. Underground conductors shall be buried in clean sifted Grounding.
L. Except for substations and electric rooms, the exposed Grounding conductor shall run in protective pipes for runs below 900 mm from floor level. Pipe shall also be provided at locations where conduct is likely to be subject to physical damage.

M. Extensions from Grounding loop as shown on the Drawings shall be provided for connection to electrical equipment. Connect the Grounding conductor to the equipment, Grounding bus, pad or lug. In addition to the Grounding grid extension conductors, an Grounding cable to each end of the Grounding bus in each assembly of power distribution board or panel boards shall be provided.

N. Where an Grounding conductor is included with the phase conductors of power circuits, the Grounding conductor shall be connected to the equipment Grounding facilities and to the source Grounding bus. Where an grounding conductor is not included with the phase conductors, the equipment shall be Grounded by connecting a separate Grounding cable to the equipment Grounding facilities and to the tray Grounding cable or source Grounding bus. Except where otherwise shown on the Drawings, integral parts of a cable assembly shall be sized in accordance with the requirements of IEE Wiring Regulations, 16th Edition.

3.03 BUILDING SYSTEMS GROUNDING

A. The building low current systems including communication, control and alarm functions...etc shall be provided with Grounding as shown on the Drawings and in relevant specifications.

B. The installation of the Grounding for building systems shall be in accordance with the recommendations of standards, and the applicable provisions of this section.
3.04 SUPPLEMENTARY AND EQUI-POTENTIAL BONDING

A. In accordance with Section 547 of the IEE Wiring Regulations 16th edition (BS 7671) bonding conductors shall be installed in appropriate locations to ensure all simultaneously accessible exposed or extraneous conductive parts are at equal potential. Undertake such tests and install such supplementary bonding conductors that are necessary to ensure compliance with these requirements.

B. Supplementary bonding conductors shall conform to the requirements of Section 547-03 of the IEE Wiring Regulations and shall have a minimum cross-sectional area of 2.5 mm² where mechanically protected and 4.0 mm² where not so protected.

C. Main equipotential bonding conductors shall conform to the requirements of Section 547-2 of the IEE Wiring Regulations and shall have a minimum cross-sectional area of 6.0 mm².

3.08 FIELD QUALITY CONTROL

A. Grounding resistance tests shall be carried out after installation of the individual Grounding systems in accordance with the Specifications. The Grounding resistance tests shall be carried out in accordance with Section 713-11 of the IEE Wiring Regulations 16th edition and readings obtained officially recorded by all witnessing parties.

C. Prior to connection of Grounding rods to the Grounding system, the Grounding resistance of individual Grounding rod shall be measured by using an approved type of Grounding resistance tester.

D. After completion of all the connections of Grounding system, the Grounding resistance shall be measured from the Grounding test point in presence of the Engineer.

E. All the Grounding resistance test reports shall be submitted for Engineer’s approval.

The presence of the electrode shall be indicated in English and Arabic.

**** END OF SECTION ****
PART 1 GENERAL

1.01 GENERAL REQUIREMENTS

A. The work of this Division shall be governed by the following documents:
   2. Instructions to Tenderers.
   3. Form of Agreement.
   4. General and Special Conditions of Contract.
   5. Form of Tender.
   6. Appendices.
   7. Applicable Divisions.

B. Comply with requirements of all sections of this Division Particularly Section 16010 Electrical General Provisions.

C. It is the Contractors responsibility to be fully aware of and comply with all of the requirements of the above listed documents.

1.02 SCOPE OF WORK

A. This section includes for the complete supply and installation of the lightning protection system specified hereinafter and as detailed on the drawings.

   1. The system shall consist of metallic air terminals as shown on the drawings. The down conductors shall drop to the base of the Radome support structure. The structure and all metal objects in the Radome to be bonded to the down conductor, with removable link provided.
   2. At the base of the Radome additional air-terminals shall be installed and connected to the down conductors, as shown on the drawings.
   3. The down conductors shall continue to drop as shown on the drawings. Additional air terminals shall be installed at roof level and connected to the down conductor network installed around the roof.
   4. All curtain wall mullions shall be bonded together at roof level and joined to the copper air terminals by means of bimetallic connectors.
1.03 QUALITY ASSURANCE

A. Lightning Protection system work shall be performed by one firm specializing in the installation of such systems.

1.04 SUBMITTALS

A. Reference Applicable Divisions - Submittals.

B. Reference Applicable Divisions - shop Drawings, Product Data and Samples

C. Provide a shop drawings riser diagram of the lightning protection system detailing dimensions of all material and equipment.

PART 2 PRODUCTS

2.01 MATERIALS

A. Air terminals: PVC insulated copper tape not less than 25mm x 3mm and upright copper rods (finials)

B. Down Conductors: Copper tape not less than 25mm x 3mm PVC sheathed, colour as specified by the Architect./50 mm2 CU insulated cable

C. Fastening and attachment straps, brass.

D. Test Clamps: Brass and/or gun metal of solid manufacture to accept copper down conductors separated from copper earth electrode conductors.

E. Electrodes: solid copper rods, extendable type 1.5 meters long x 19mm diameter, phosphor bronze coupling screw, hardened steel tip, hardened steel driving cap.

F. Flexible Ground Connections: Single core stranded copper conductors PVC sheathed colour green, and yellow, size as indicated.

G. Test Pit: Concrete test pit with removable cover for periodic testing of earth electrodes.

H. Connector pit, concrete pit precast with removable granite paver as cover. Provide lamacoid labial inside pits.

I. Aluminum conductor, may be tape or single flexible cable, to suit mullion detail.
PART 3 EXECUTION

3.01 INSTALLATION

A. Install lightning protection as indicated in accordance with the local codes and BS 6651 :1992.

B. the down conductor shall be clamped to the Radome support structure and taken to the roof level. All metal materials in the Radome shall be bonded to the down conductor, through removable links.

C. At the base of the Radome on the concrete structure of the building install additional air terminals as detailed. Down conductors shall be installed and taken to the roof level to be continued down.

D. where an air termination is installed on the roof, support the tape on raised pads to allow the run of rain water. Weld air termination systems to down conductors.

E. install air terminals and tape on the parapet walls of the roof structure. Connect all tapes and install down conductors as detailed.

F. Bond air terminations on roof to steel reinforcement bars by means of bimetallic connectors as shown on drawings.

G. Down conductors shall terminate at ground level in test pits below pavement.

H. Install down conductors vertically with fixing clips every 2 meters and terminate at grade level in test clamp.

I. Install the earth electrodes 4 meters into the ground plus additional sections to obtain the correct readings at each electrode less than 10 Ohms.

J. Connect and bond all equipment mounted on roof in addition to any metallic installations to the air termination network.

K. Bond curtain wall vertical mullion sections together by means of an Aluminum connector at a maximum of 10m mullion to mullion horizontal distance. Connect to the nearest lightning pit at grade by means of a bimetallic connector and copper tape.

L. Test system is accordance with section 16030.

* END OF SECTION *
PART 1 GENERAL

1.01 The contractor shall be responsible for the supply, installation, commissioning and servicing of the Analogue addressable fire alarm system.

1.02 The contractor must review the consultant’s proposal for suitability to his system. All deviations should be brought to the notice of the Engineer.

1.03 The contractor or his representative must have, at least, 10 years’ experience in installing, commissioning and servicing fire detection and alarm systems, at least 5 of which must be with analogue addressable systems.

1.04 All equipment central to the operation of the analogue addressable systems shall be designed and manufactured by the company installing and commissioning the system. As a minimum requirement, this clause covers the following:

1. Fire Alarm Control Panel
2. Repeat Panels
3. Addressable ancillary equipment,
4. Power supplies, and automatic point detection equipment.

1.05 The manufacturer shall be approved to BS5750 part 1 Quality system standard for the design and manufacture of the equipment referred to in clause 1.5 (ISO).

1.06 The main equipment proposed for use shall be approved by at least one of the following:

1. Loss Prevention Council (LPC)
2. Underwriters Laboratories (UL)
3. Association of German Prosperities insurance company (VDS)

1.07 The manufacturer shall have available a complete set of technical manuals for all equipment installed. This must cover technical specification, system design recommendations and guidelines for installation, commissioning, operating and servicing the proposed equipment.

1.08 The manufacturer, given reasonable notice, shall permit the buyer, or its nominated agent, to conduct a quality audit at the premises where the proposed equipment is manufactured.

1.09 All deviations from this specification that the contractor proposes to make shall be clearly indicated in writing, referring to the relevant paragraph(s) of this specification.
1.10 The system offered shall be approved by the concerned local authorities Fire department and any changes in equipment, materials shall be incorporated at no extra cost.

1.11 Applicable Standards and Specifications
Where applicable, the fire detection and alarm system and installation shall comply fully with the British Standards or NFPA rules and regulations.

1.12 OUTPUT SIGNALS UNDER FIRE CONDITIONS

A. Provision shall be made in the Fire Alarm Control Panel to provide the following:
   1. Potential free NO/NC contacts or interface as required for the fire doors & Elevators.
   2. Potential free NO/NC contacts or interface as required for shutting or starting Mechanical/HVAC equipment such as AHUs, Pumps, Dampers, Fans etc as may be required.

B. The Electrical contractor shall be responsible for providing conducting and wiring from the fire alarm control panel up to the required equipment(s) as mentioned in paragraph ‘A’ above.

1.13 SYSTEM DIFFERENCE
There may be some difference between one manufacturer and another. The purpose of these specifications is to lay down the requirements in general for the fire alarm system. The system supplier shall ensure that all the functional aspects of the fire alarm system shall be achieved though the equipment specifications one manufacturer may differ from the other in some aspects. It is expected that the system supplied shall be a product of the latest technology only from the specified brands/manufacturers.

1.14 APPROVALS FROM THE CONCERNED LOCAL AUTHORITIES (i.e. CIVIL DEFENSE FIRE DEPARTMENT)

A. Before commencing any installation works, the contractor shall obtain Engineer’s approval in respect of the system he is going to use. Based on the Contract Drawings the contractor shall prepare all necessary drawing with the help of his system supplier (manufacturer). After coordinating with other trades, the contractor shall submit his drawings to obtain the concerned local authorities Fire department approval.

B. The contractor shall also be responsible for obtaining all approvals from the concerned local authority’s Fire department during and after the installation as deemed necessary and as required.
1.15 SCOPE OF WORK

A Supply, install, test and commission the fire alarm & detection system as specified, as indicated on drawings and as required as per the concerned local authorities Fire Department Regulations.

B Contractor shall install smoke detectors above false ceiling and also where false ceiling depth is 80 cms and above within contract price.

C The electronically operated analogue addressable system including but not limited to the following items.
1. Fire Alarm Control Panel.
2. Fire Alarm Repeater panels (When indicated in drawings)
3. Power supply and standby batteries with charger.
4. Smoke Sensors
5. Sensor Sounders
6. Heat Sensors
7. Beam Sensors
8. Duct Sensors
9. Manual Call points
10. Audio Visual Alarms
11. Alarm Sounders
12. Interface units
13. System interface with Main fire alarm panel (Where indicated)
14. System interface with firefighting system (Sprinkler, Fire extinguishing System)
15. System interface with Air handling units
16. System interface with Elevators
17. System interface with Smoke and fresh air fans
18. System interface with Building Management system.
19. System interface with ATS
20. System interface with Smoke doors
21. Printers
22. System interface with other specified systems like Access Control etc.
1.16 Any additional ductwork, encasement works required shall be the responsibility of the electrical contractor. He shall not be entitled for any additional claims on these accounts.

1.17 It is assumed that the contractor before signing the contract has surveyed the site and ascertained the routes and hurdles.

1.18 RELATED WORKS

A Section 16120 Conduits
B Section 16110 Raceways
C Section 16200 Cables & Wires
D Section 16300 Supporting Devices

1.19 SUBMITTALS

A Shop drawings showing complete details.
B Manufacturer’s detailed instructions
C Submit all shop floor and other relevant drawings to the concerned local authorities Fire department and obtain necessary approvals.

PART 2 PRODUCTS

2.01 CONTROL AND INDICATING EQUIPMENT

A The Fire Alarm Control Panel (F.A.C.P) shall be the central processing unit of the system, receiving and analyzing signals from fire sensors, providing audible and visual information to the user, initiating automatic alarm response sequences and providing the means by which the user interacts with the system.

B System shall be true Analogue with the ability to print the output from a fire sensor over a period of time

C The (F.A.C.P) shall be modular in construction allowing for future extension of the system.

D The (F.A.C.P) shall be able to be easily configured to meet the exact detection zone and output mapping requirements of the building considered.

E The (F.A.C.P) shall be microprocessor based and operate under a multitasking software program. Operating programs and configuration data must be contained in easily up-datable non-volatile memory (EEPROM).

F All devices i.e., Optical sensors, Heat sensors, Duct and Beam Sensors, Fire Alarm Interface units, Electronic Sounders, Manual Call Points etc, shall appear their addresses on visual display unit of the panel on request.
G All devices shall be assigned a maximum of 32-character alphanumerical label. In case of fire, fault or alarming, the label of devices sensing threshold shall appear on visual display unit of the panel.

H The (F.A.C.P) shall meet the requirements of BS5839 Part 4 or NFPA 72 and shall be approved, together with associated ancillary equipment, by the Loss Prevention Council (LPC), (UL) or (VDS).

I No more than 254 addressable input Devices shall be controlled by a single Loop processor card.

2.02 SYSTEM DESCRIPTION

A The (F.A.C.P) Shall be capable of operating with any of the following types of automatic detection equipment:
   Conventional detectors
   Analogue addressable sensors.

B The (F.A.C.P) shall be capable of operating with conventional detectors and analogue addressable detectors suitable for installation in hazardous areas.

C Analogue Addressable devices shall be connected to loops capable of accepting up to 254 devices per loop.

D The (F.A.C.P) shall have a minimum capacity for operating 1 fully loaded addressable loop. This shall be extendible to 32-loops.

E Provision shall be made for each addressable loop to be sub-divided into a geographical zones. The section of wiring corresponding to each zone circuit shall be protected from faults by means of line isolator modules (built-into the detector or by means of using isolator base).

F It shall be possible to allocate all 254 addressable devices per loop.

G The (F.A.C.P) shall have provision to drive and monitor repeater panels providing a repeat of the indications on the (F.A.C.P) display.

K The system shall have two addressing methods:
   1. Software addressing.
   2. Hardware addressing.
2.03 MONITORING AND CHECKING CIRCUITS AND FAULT CONDITIONS

Facilities shall be provided to constantly monitor and check the following circuits and fault conditions.

A The power supply on the loops

B For open circuit, short-circuit, earth fault and any other fault condition in any segment in the loop wiring.

C For communication failure and errors in all cord and loops.

D For faults in Keyboard and printer circuits.

E Monitoring of all devices status.

F Provision shall be done at the fire alarm control panels to silence the loop powered alarm sounders but the visual indication shall remain until the system is re-set.

G It shall be possible to change the sensitivity of analogue sensors from the Fire Alarm Control panel only.

2.04 BASIC SYSTEM FUNCTIONS

A The (F.A.C.P) shall monitor the status of all devices on the Addressable loops for fire, short-circuit fault, open-circuit fault, incorrect addressing, unauthorized device removal or exchange, pre-alarm condition and contaminated sensor detector condition.

B In the event of a fire being reported from the smoke/heat detectors, activation of manual call points or sprinkler operation the sequence of alarm operation shall be as follows:

C If fire condition is reported from a sensor area this should cause a fire signal to be reported at the control panel. The system should incorporate approved delay time and if the alarm is not acknowledged in this period, the evacuation message should be broadcast through the speakers automatically to the affected floor plus the floor above and below. The alert signal to other floors shall be as previously described.

D If a Manual Break Glass Unit is activated or a sprinkler flow switch is operated, then the evacuation shall be transmitted immediately to the affected floor plus the zones required by engineer or the owner. The signal to the other zones shall be as previously described.

E In each of the above cases, upon initiation of an evacuation signal all the electronic sounders in areas such as plant rooms and emergency staircase shall operate immediately. The signals shall not discriminate with floors.

F Activation of the fire alarm system shall directly initiate some or all of the following to be agreed as part of the overall engineering policy.

1. Signal to all elevator machine rooms indicating fire status (to control lifts)
2. Release doors normally locked by magnetic devices.
3. Release doors normally held open by magnetic devices.
4. Shutdown mechanical equipment ventilation plant.
5. Shutdown general exhaust fans.
6. Start up smoke extract fans.
7. Start up exhaust makes up fans.
8. Start up stair vestibule pressurization fans.
10. Initiate alert signals in all panels.

G Supervised by the fire alarm system in Main building

2.05 MAIN FIRE ALARM CONTROL PANEL

A The panel shall be computer controlled using analogue technique to detect smoke/heat/fire conditions. The panel shall be complete with, but not limited to, the following elements:

B 5.7” touch screen display unit adapted to customer-specific needs.

C Integral sealed lead acid battery and charger, with 24-hour back up in the event of supply mains failure.

D Essential control-sound alarms, silence alarms and reset fire. These shall be enabled by a key switch.

E Cancel fault buzzer.

F Fire, fault, warning and power on lamps.

H Up to 254-device capacity per loop.
Simple menu driven function keys with password protection shall be configured in
the touch screen shall allow users to an extensive range of software-based
features such as:

1. Last 150 fire and trouble events minimum
2. Current fault and warning logs
3. Analysis of analogue sensor information
4. Interrogation of sensor cleanliness
5. Enable/disable sensors, zones, sounders, interface, unit channels
6. Fire plan configuration menus
7. Outstation label changes
8. Address allocation
9. Status of outstation
10. Status of all cards
11. Printer on off, line feed and test facilities
12. Address allocation

RS 232 /RS 485 computer communication option.

In addition to the above, all other necessary control, elements and accessories
shall be included to provide a complete and efficient panel confirming to the
requirements of BS or NFPA.

2.06 SMOKE SENSORS

These shall of addressable optical type with built-in isolator in a single head. The
optical element shall monitor for visible smoke from slow smoldering fires. Smoke
sensing design shall comply with BS 5445: part 7 and shall be LPCB approved or
comply with NFPA – 72 and shall be UL approved or VDS approved.

All smoke sensors shall comprise of three components.

1. Termination Plate, Electronic Module and replaceable sensor chamber. The
termination plate shall incorporate the terminals for wiring. The electronic
module shall plug-on onto the termination plate as a second fix item all
electronic components and circuitry suitable for an Analogue addressable sys-
tem.

2. This design shall allow sensing element alone to be replaced, should it be-
become dirty almost dirty, excessively dirty, due to a buildup of dust from the

surrounding atmosphere. When removed, the panel shall display a fault
condition with a message “Sensor chamber Removed” with a relevant
label/address. The sensor chamber shall also have viewing LED indicator.

3. Sensors mounted in the false ceilings may be provided with semi flush
mounting kits if it is required by the engineer.
2.08 HEAT SENSORS

A These shall comply with the requirements of BS 5445: Part 5: 1977 and shall be LPCB approved or comply with NFPA-72 and shall be UL listed or VDS approved. They shall be complete with other elements described for smoke sensors above, for an analogue safe addressable sensing device.

B Sensors mounted in the false ceilings may be provided with a semi flush mounting kits if it is required.

2.09 BEAM SENSORS

A The Beam Sensors shall detect fire by obscuration of an optical beam by smoke. It shall utilize a transmitter and receiver unit. It shall be used in areas as indicated in the drawings.

B The Beam sensors shall be LPCB or UL approved and to BS 5839 Part 5 or NFPA-72 or VDS approved.

2.10 DUCT SENSORS

Duct Sensors shall be safe addressed, loop powered, loop signaled. They shall comprise of a sampling unit with probes extending into a straight section of the mechanical ventilation ductwork. The duct sensor shall comprise of Optical Smoke/Sensing devices.

2.11 CALL POINT

These shall comply with the requirements of BS 5839: part 2: 1983 or NFPA-72, and shall be complete with all-electronic components and circuitry for an addressable device. Polycarbonate cover type option shall also be provided if required. The unit shall incorporate glass to broken. The electronic circuitry shall have built-in line isolator.

2.12 ALARM SOUNDERS

A The addressable Alarm Sounders shall be sited in areas as shown in the schematics and the floor layout drawings. The sounders shall be configured via software to operate individually or in sectored groups; totally independent of the way they have been connected to the loops. The sounders shall have the synchronization feature to ensure that all the sounders give alert and evacuate tones that are totally in phase. Conventional Sounders that “free-run” and therefore be out phase with each other will not be accepted.

B The Sounders shall comply with BS, NFPA or VDS requirements.
2.13 INTERFACE UNITS

These shall be used to interface with the fire/fault signals emanating from the local control conventional (zonal) fire alarm control panels. These units shall also give/accept contact from other services required to be interfaced with fire alarm system with feedback ability e.g. Interfacing with AHU's BMS, Elevators, Pressurization Fans etc. It shall be installed of addressable type with all inputs and outputs are to be fully monitored for cable faults. Power Supply units if required, with the interface shall also be monitored for any faults.

2.14 REPEAT PANEL

A The Repeat Panel shall be sites at the indicated locations. It shall consist of 5.7” touch screen for displaying and control. It shall provide system repeat facilities to repeat all the messages that appear on the main touch screen as well as the common indications. It shall have essential alarm controls and menu facilities.

PART 3 EXECUTION

3.01 INSTALLATION

A Fire alarm components shall be installed directly to conduit outlet boxes at the following mounting height above finished floor level, measured to the center of box unless stated otherwise.

B Fix manual call station semi-recessed at 1.50m heights above finished floor.

C Automatic smoke and heat Sensors: Ceiling Mounted/Surface Mounted/ Above ceiling mounted

D Alarm Sounders: 2.20m above finished floor.

E Outdoors alarms fix where indicated by the concerned local authorities Fire department and approved by the Engineer.
3.02 TESTING AND COMMISSIONING

A. After the installation is complete, the Contractor shall conduct operating and commissioning tests. The equipment shall be demonstrated to operate in accordance with the requirements of the specification. The system installation, testing and commissioning shall be as per the concerned local authorities Fire department approval and requirements.

B. The Fire Alarm Systems shall be complete programmed in accordance with the concerned local authorities Fire Department Requirements and as specialist from the manufacturer shall attend and demonstrate the complete system.

C. Fire Brigade and testing shall be the Contractor’s responsibility and the Contractors shall do any requirements for approval and handing over the Fire Alarm Installation without the extra payment even in time.

D. Drawing and specification are complementary each to the other.

E. The “CODE FOR THE SYSTEM OPERATION” shall be handed over to the Client at the completion of the maintenance period.

3.03 Shall co-ordinate with other trades for the installation of the system.

3.04 The contractor /sub-contractor will be responsible for providing all access equipment necessary to enable safe installation of the system.

3.05 The Contractor shall provide necessary training to Client’s personnel to give them on job training, instructions etc. for proper operating and maintenance of the system.

3.06 The contractor will repair, correct or replace any defect of any nature that may occur for a period of 2 years from the date of issue of the certification of Completion.

3.07 Contractor shall provide a full set of manuals and operating instructions (service manual). It shall include descriptive brochures, technical manuals for all equipment forming part of the contract.

3.08 SPARES & TOOLS

Contractor shall provide manufacturers recommended spares / tools at the time of completion of the project for the use of the client. These spares / tools are not to be used by the contractor during the period of 2 years of maintenance.

* END OF SECTION *
Telecommunications Standards

The following standards apply to network & Telecommunications works:

1. ANSI/TIA/EIA-568-B-1: Commercial Building Telecommunications Cabling Standard
   Part 1: General Requirements
2. ANSI/TIA/EIA-568-B-2: Commercial Building Telecommunications Cabling Standard
   Part 2: Balanced Twisted-Pair Cabling Components
3. ANSI/TIA/EIA-569: Commercial Building Standard for Telecommunications Pathways and Spaces
4. ANSI/TIA/EIA-758: Customer-owned Outside Plant Telecommunications Infrastructure Standard
5. ANSI/TIA/EIA-J-STD-607-A: Commercial Building Grounding (Earthling) and Bonding Requirements for Telecommunications

PART 1 GENERAL

1.01 GENERAL

A The data System shall comprise of Supply, installation, testing & documentation for a category 6A cabling for the mentioned project provisional.

B Separate raceways shall be used for the data system.

C All runs of raceways shall be accessible for modifications or maintenance.

D Any additional ductwork, encasement works /raceways required shall be the responsibility of the electrical contractor. He shall not be entitled for any additional claims on these accounts.

E It is assumed that the contractor before signing the contract has surveyed the site and ascertained the routes and hurdles.

F The certified installer will be fully responsible on quality of service and warranty certificate to be submitted directly for the contractor under engineer supervision.
1.02 SCOPE OF WORK

The contractor shall supply, install and commission as provisional items first fix of the data System as ONE package, having the following as a minimum:

- Computer cabling cabinets
  - Data Outlet with RJ45 Sockets Category Network
  - Cat6A F/FTP, low smoke zero halogen (LSZH), 4 pair, conductors are 23 AWG with PE insulation, twisted in pairs, warped in shield and protected by a low smoke, flame
  - Raceways, trucking, conduits etc
- All other components, accessories required to complete the first fix Data system.

Not all the mentioned items specified in the specification are required in the contract, some items shall be submitted and installed by others, refer to B.O.Q. for included items.

1.03 CONTRACTOR OBLIGATIONS & QUALIFICATIONS:

The contractor shall carefully examine all of the specifications to ensure that he is fully conversant therewith & has included for everything necessary therein, either expressly provided for or as would normally be expected to be provided for by a reputable specializing in the type & nature of the services Described in The Contract.

The contractor is advised that items or matters not specifically provided for, or partially described or otherwise missing from the specifications, but which are nevertheless necessary for the execution & completion of the services, shall be deemed to have been included by the contractor.

Authorized & certified installers registered with their respective manufacturers with trained & certified engineers shall execute the installation of the cabling system.

The contractor shall carry out all the necessary surveys, design & engineering so as to provide for the services, a whole & complete system to ensure full compatibility of the services with any existing facilities pertinent to the cabling system applications/operations.

The scope of the services includes the provision of all material, labor, supervision, construction, equipment, tools, temporary, spares, consumable & all other things & services required to engineer, design, supply, install, test & commission the cabling system.

1.04 EQUIPMENT & MATERIAL

All equipment, material & the like shall be such so as to withstand the prevailing climatic conditions in Jordan & within the parameters of an ambient tem- premature varying from (-10) to plus fifty-five (55) degrees centigrade & a maximum relative humidity of one hundred percent (100%).
1.05 TESTING & COMMISSIONING

Acceptance testing shall be carried out by the contractor & witnessed by the owner personnel. The contractor shall provide all necessary instruments & accessories required to perform the testing.

1.06 WARRANTY

For passive network components, the system supplier shall warrant to repair or replace & make good at its expense any material found defective during a period of fifteen years from the date of the acceptance certificate.

1.07 RELATED SECTIONS

A. Section 16110 Raceways

B. Section 16120 Conduits

C. Section 16300 Supporting devices

D. Section 16200 Cables & wires

1.08 The specification and BOQ for the data system are for the guidelines of the contractor for the purpose of bidding. The contractor shall include all material and devices though not indicated but required for the proper and efficient installation of the system.

PART 2 PRODUCT

2.01 DATA BACKBONE

Technical specifications:

2.1.1 F/FTP CAT6A (4 PAIRS) CABLES

Network Cat6A Cables, Copper cable, orange, category 6A F/FTP, low smoke zero halogen (LSZH), 4-pair, conductors are 23 AWG with PE insulation, twisted in pairs, wrapped in foil, surrounded by an overall metallic foil shield and protected by a low smoke, flame retardant LSZH jacket, to be use for IP cameras, data outlet and Wifi point

<table>
<thead>
<tr>
<th>Cable construction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sheath</td>
</tr>
<tr>
<td>Material</td>
</tr>
<tr>
<td>LSOH</td>
</tr>
</tbody>
</table>
Cable Properties

Bending
Minimum bending radius, installation 8 x D
Minimum bending radius, installed 4 x D

Tensile Strength
Maximum tensile load, installation (N) 100
Maximum tensile load, installed No stretch

Temperature Range
Operation (°C) –20 to +60
Installation (°C) 0 to +50

Fire Classifications:
PVC : IEC 60332-1
LSOH: IEC 61034, IEC 60754-1, IEC 60332-1

Heat Release
LSOH (MJ/km) 1030

Electrical characteristics 20 C
Characteristic impedance (4<f<100 MHz): 100±15
DC-loop resistance (Ω/km)
Resistance unbalanced, max (%) 2

Optical braid overage (%) 41
Transfer impedance, IEC 96-1
  1 MHz (Ω/m) 5
  10 MHz (Ω/m) 10

Nominal velocity of propagation (NVP) c 0.75
Mutual capacitance, nominal (pF/m) 48
Capacitance unbalanced, max. (pF/m) 1000

2.1.2 FTP RJ45 CONNECTION MODULES (FOR DATA)

The Cat. 6A connection modules are the connection modules that comply with the latest standard proposals of the international standardization bodies. Comply with the cat.6A components requirements of the latest standard proposals of ISO/IEC.

- Conform to Cat.6 requirements according to the EIA/TIA.
- Best transmission properties with Cat.6 patch cords
- Backwards compatible with Cat.5e and Cat.5.
- Fits into all free net patch panels and outlets.
- Error-free connection according to EIA/TIA 568A/B without pair crossover thanks to labeled wiring.
- Simple and time-saving shield contacting with integrated cable strain relief.
- Halogen-free material.
- Certificates available.
**Electric and Transmission Data**

Contact resistance < 50 milliohm (conductor - conductor)
Contact resistance < 20 milliohm (shield - shield)
Insulation resistance > 500 mega ohm (500 VDC)
Dielectric strength 1000 Veff, 50 Hz/1 min (conductor - conductor)
Dielectric strength 1500 Veff, 50 Hz/1 min (conductor - shield)
Coupling resistance IEC 96-1
1 MHz < 15 milliohm
10MHz< 100 milliohm

2.1.3 DUAL FACE PLATES:

The free net dual modular outlets and connection modules combine in various ways. The outlets accommodate a vast range of modules:
For optical wave guides, RJ45. ISDN or analogue telephony. The modules can be linked together in a single outlet and exchanged simply without any need for tools.

To ensure a clearer distinction, individual outlets at the workstation and on the Global Rack can be mechanically and color coded. For greater safety in the event of fire, plastic outlets manufactured to fire category VO. Cat. 5e can be fitted to Cat. 6A Modules on the same outlet, ensuring an easy switch to a higher category - another free net plus!

2.1.4 TRUNKS

Plastic trunks with different sizes should contain all the exposed cabling installation (if any).

**PART 3 EXECUTION**

3.1 All installation work shall be as per Data Transmission rules and regulations. Where no regulation is available, IEE wiring regulation shall be followed.
3.2 The maximum horizontal portion of a cabling system from work area information outlet to a mechanical termination at the patch-panel in the wiring closets must not be more than 85 meters, the cable run must be free of bridges, taps & splices.
3.3 Cables shall be of one continuous length. No joints are to be introduced in any circuit starting from work area outlet to a mechanical termination at the patch panels in the wiring closets.
3.4 Cables shall be laid with bend radii and maximum pull through forces as per manufacturer’s standards.
3.5 Drawing and specification are complementary each to the other.
3.6 The contractor /sub-contractor will be responsible for providing all access equipment necessary to enable safe installation of the system.
3.7 Outlets shall be at least 25cm distance from nearest electrical point.
3.8 Both ends of the cable shall be labeled for identification.
3.9 Detailed cable routing diagram must be produced for installation. This shall be reference for future maintenance, expansion, fault tracing etc.
3.10 Contractor shall provide a full set of manuals and operating instructions. It shall include descriptive brochures, technical manuals for all equipment’s forming part of the contract.
4.4 Network cabling specification

All Cables provided must be of Category 6 Unshielded Twisted Pair (UTP) type and terminated to 568B Wiring Scheme. It is essential that the same wiring scheme is followed for the whole wiring network.

<table>
<thead>
<tr>
<th>Pin Number</th>
<th>Wire Colour</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>White - Orange</td>
</tr>
<tr>
<td>2.</td>
<td>Orange</td>
</tr>
<tr>
<td>3.</td>
<td>White Green</td>
</tr>
<tr>
<td>4.</td>
<td>Blue</td>
</tr>
<tr>
<td>5.</td>
<td>Blue White</td>
</tr>
<tr>
<td>6.</td>
<td>Green</td>
</tr>
<tr>
<td>7.</td>
<td>White Brown</td>
</tr>
<tr>
<td>8.</td>
<td>Brown</td>
</tr>
</tbody>
</table>

**Fig 2. EIA/TIA 568B Network Wiring Scheme**

All cable runs must terminate on patches in a room on each floor. All cable runs must be either in trucking/conduit or secured onto data basket/tray. All cables must be installed to avoid bearing on sharp edges or frictional overheating. Cable sheaths and jackets must not be damaged during installation. Cables must be protected where they pass through holes in walls or ceilings. Cable ties must be used and tightened to comfortably hold but not constrain the outer sheath of the cable to cable basket/tray.

Cables entering the network cabinets should be securely tied to the cable tray within the cabinets, and tied and loomed neatly after termination on the patches. Cable should not be attached directly to the cabinet stanchions.

No cable runs should be longer than 85 meters. It shall be the sole responsibility of the contractor to visit the site, measure all proposed containment runs and detail in writing to the Project manager all runs of cabling that will exceed 85 meters, or give written confirmation that all runs are within 85 meters. No installation cabling is to be undertaken until one of the above has been confirmed.

4.5 Trunking

- All trucking must be 3-part compartmentalized & Category 6A compliant.

- All bends, tees and crossovers should be gusseted to allow for adequate bend radii of the installed cables.

- All trucking needs to be of sufficient capacity to allow for the minimum bend radii of the copper cables.
4.6 Labelling

- All cable drops must be properly labelled at the workstation area and at the patch panel area in the Server room.
- Labels must be on plates, sockets and on cable in two sides.
- The labels must be machine printed. Handwritten labels will not be accepted.
  The labelling schema of the outlet faceplates will be obtained from the ENGINEER office.

Labeling the cables:

- Special Label must be located on 30cm at the end of the cable show where the path of the cable.
- Examples:
  - In the side of the patch panel the label show the floor, department and socket Number that belong to.
  - In the side of the socket the label show the patch panel and port Number.

5.3 Verification and Testing

All cable drops must be tested for proper wire mapping. Category 6A F/FTP cable testing will test each conductor for end-to-end continuity.

Each cable must be tested for correct termination on a pin-by-pin basis. Each station must be tested with a Category 6 Fluke tester to verify compliance with EIA/TIA - 568B colour coding and pin numbering specifications.

Should any cable fail to meet the Category 6A F/FTP standards outlined above, the contractor will be responsible for rectifying the fault, either by re-termination of the cable or by re-running the complete cable if necessary. In either case, the cable must be re-tested to ensure that the rectified cable meets the Category 6A F/FTP standards.

8.2 Contractor Responsibilities:

- Providing all supervision, labour, tools, equipment, materials, transportation, erection, construction, unloading, inspection and inventory housing.
- Obtaining ENGINEER’s permission before proceeding with any work necessitating cutting into or through any part of the building structure such as beams, concrete, tile floors or partition ceilings.
- Promptly repairing all damage to the building due to carelessness of contractor employees and exercising reasonable care to avoid any damage to the building. Reporting to ENGINEER any damage to the building that may exist or may occur during the contractor’s occupancy of the building.
- Taking necessary steps to ensure that required firefighting apparatus is accessible at all times. Flammable materials shall be kept in suitable places outside the building.
- Installing the wire, cable and hardware in accordance with EIA/TIA specifications. Conducting tests and inspections as specified post-installation.
- Promptly correcting all defects for which the contractor is responsible as determined by ENGINEER.
- Removing all tools, equipment, rubbish and debris from the premises and leaving the premises clean and neat upon completion of the work.
- Abiding by the safety and security rules on the work site at all times

Following industry standard installation practices.

*** END OF SECTION ***