

Family & Juvenile Protection Unit (FJPU)

SPECIFICATIONS

CONTENTS

SECTION

- | | |
|----|--------------------------------|
| 1 | GENERAL |
| 2 | CONCRETE WORKS |
| 3 | BLOCK WORK & BRICK WORK |
| 4 | STONE WORKS |
| 5 | TILING WORKS |
| 6 | GYPSUM BOARDS AND PARTITIONS |
| 7 | CARPENTRY & JOINERY |
| 8 | METAL WORKS |
| 9 | ACOUSTICAL CEILING |
| 10 | GLAZING |
| 11 | INTERNAL AND EXTERNAL FINISHES |
| 12 | PAINTING AND DECORATING |
| 13 | MECHANICAL WORKS |
| 14 | ELECTRICAL WORKS |

Family & Juvenile Protection Unit (FJPU)

SECTION 01

GENERAL

0101. Scope of Work

The work involves the Renovation of the old building,

The project comprising:-

- Ground Floor
- First Floor
- Second Floor
- Third and fourth Floor (limited work)
- Roof and top roof
- External Works

All connected Electro-Mechanical, Lift and external works.

The work includes demolition, addition, alteration and all connected Electro-Mechanical works complete as detailed on drawings, as specified and to the approval of the Engineer.

0102. Drawings

A list of Contract Drawings available with the Tender is attached to this Specification.

0103. Abbreviations of Standards

The following abbreviations have been used for the Standards applicable to the Works under the Contract.

BS	- British Standards
CP	- Code of Practice
ASTM	- American Society for Testing and Materials.
ACI	- American Concrete Institute.
ISO	- International Organization for Standardization.
ANSI	- American National Standards Institute.
AASHTO	- American Association of State Highways & Transportation Officials.
DIN	- Deutsches Institut für Normung.
BSEN	- European Standards - Adopted as British Standards.
EN	- Euronorms Harmonized Standard.
UL	- Underwriters Laboratories Inc.
IEC	- International Electrotechnical Commission.
CENELEC	- Committee European de Normalisation Electrotechnique.

Referenced Standards are part of the Contract Documents and have the same force and effect as if bound with this specification.

0104. Standards

The works have been designed to incorporate and utilize economically, goods, materials and workmanship to various specifications which are detailed herein. Reference is commonly made to British Standards (BS) and British Standard Codes of Practice (CP) and to the American Society for Testing and Materials Standards (ASTM). Different National or International Standards ISO, DIN, etc., that correspond to the specified BS or ASTM Standard may be used provided that their requirements are not less stringent, and provided that the Contractor presents copies of such Standards translated into English. If any redesign of the Works is necessitated by the adoption of such alternatives the costs incurred shall be borne by the Contractor.

Except where specifically indicated otherwise all references shall be deemed to refer to the current standards (the latest edition or issue) as of the date of the signing of the Contract.

0105. Units of Measurement and Abbreviations

All units of weight and measurement shall be based on the Metric system of Weights and Measurements except standard products which may be expressed in nominal units of the Imperial System.

The metric terms and symbols occurring in the Contract Documents are based on the "System International d'Unites (S1 System)".

<u>Abbreviation</u>	<u>Description</u>	<u>Abbreviation</u>	<u>Description</u>
m	Linear Meter	mm	Millimeter
m ²	Square Meter	cm	Centimeter
m ³	Cubic Meter	No	Number
Kg	Kilogram	C	Celsius
Tone	1000 Kilogram	LS	Lump Sum

0106. Definitions

Wherever in the Contract Documents, or on the Drawings, the words "as directed", "as Described", "as ordered", "as requested", "as required", "as permitted", or words of like import are used, it shall be understood that the direction, description, order, request, requirements or permission of the Engineer is intended. Similarly, the words "approved", "acceptable", "satisfactory" and words of like import shall mean approved by, acceptable to, or satisfactory to the Engineer.

0107. Inconsistency in Contract Documents

The Contractor shall execute the Works according to the provisions of the Contract Documents. Any work indicated in one of the documents but omitted and/or not stated in one or more of the other documents shall be treated as though it were included in all of them.

Any discrepancies between the quantities or their descriptions in the Bills of Quantities, the Specification and/or the Tender Drawings, shall be referred for clarifications prior to the submission of the Tender which shall be clarified as Addendum to the Tender. Any

discrepancies noted after the Tender has been accepted shall be referred to the Engineer for a ruling. The ruling of the Engineer shall be final and binding on the Contractor and the Contractor shall execute the works accordingly without any increase in cost or extension of time to the Project.

If the Contractor should discover that any work has been omitted from and/or not indicated entirely or partially in all the documents, he shall report the facts immediately to the Engineer. If the work is something which in the opinion of the Engineer could not have been foreseen by an experienced Contractor, the Engineer shall issue to the Contractor a variation order stipulating the details of the work to be done.

Save as aforesaid in the above paragraph, no additional payment shall be made in respect of work carried out in connection with discrepancies between the various Contract Documents.

0108. Errors in Computing Contract Documents

The Contractor shall be responsible for any error which he makes in computing any quantities of material and labor required or costs involved or through any lack of knowledge of the site or misunderstanding of any thing shown or implied on the Drawings or in the Specifications and/or the Bills of Quantities.

The Contractor must refer any discrepancy in the Drawings or the Specifications to the Engineer before proceeding with any of the Works. The decision of the Engineer as to the Interpretation of the discrepancy will be final as specified above under "Inconsistency in Contract Documents".

Any item or items of work not specifically shown on the Drawings or referred to in the Specifications but which would be necessary for the proper construction of the works in accordance with the best practice is implied and must be included for as incidental to the Contract Sum.

Any item for which the Contractor has not inserted a price in the Bills of Quantities shall be deemed to be covered by other prices or rates therein.

0109. Site Offices, Latrines, etc.

The Contractor shall provide and maintain on the site for the duration of the Contract the following:-

- A temporary office for the accommodation of his Agent/Engineer and his Staff, including all necessary sanitary facilities. Such office shall be open at all reasonable hours to receive instructions, notices or other communications.
- A suitable and adequate temporary office shall be provided by the Contractor for the sole use of the Engineer and his staff.

This office shall comprise:

- 1 room of 20 square meters,
- 2 rooms of 12 square meters,
- 1 conference room of 30 square meters,
- 1 sample room 20 m2 with adequate number of steel racks,
- Separate sanitary facilities,
- Electric outlets and lamps,

3 new air conditioning units silent type and minisplit unit for the conference room.
Hot and cold water,
Elevated water tank 1 (one) m3 capacity,

- Site office shall have the following furniture & equipment:

1 Managerial readymade desk and swivel chair,
4 visitors chairs,

One IBM Compatible Micro Computer having the following:-

- . Intel Core I5 or higher.
- . CD-ROM drive.
- . Printer 3 in one (Printer, Scanner, Fax).

Software of MS Windows 7 and MS office professional 2010 with Arabic support, MS project 2010, AutoCAD 2007 shall be provided.

- Office and computer stationery shall be supplied as required,
- An approved sign board written in Arabic and English. The size of the Sign board and lettering including the wordings shall be as directed by the Engineer.

All offices, latrines, sign-boards and other temporary works shall be dismantled and removed from the Site on completion of the whole Contract and the Site shall be made good and left clean and tidy to the satisfaction of the Engineer.

0110. Toilet Facilities

The Contractor shall provide and maintain clean portable toilet facilities if temporary facilities on site as specified elsewhere are not permitted by the local authorities or the Client, or if during the progress of the work the temporary facilities are to be removed or relocated. The Contractor shall include in his contract sum for the above provision as applicable.

The Contractor shall not use the permanent facilities within the building unless permitted by the Engineer in writing. If use of permanent facilities within the building is permitted these shall be maintained in a clean and sanitary condition to the satisfaction of the Engineer.

After completion of Works the permanent facilities shall be restored to perfect condition and handed over along with the works by the Contractor at no extra cost to the Client.

0111. Sign Boards

2 Nos. Illuminated Primary sign boards shall be provided in Arabic and English giving the names of the 'EMPLOYER', 'PROJECT', 'ENGINEER', and 'MAIN CONTRACTOR' only, and strictly in accordance with the format attached herein. However a perspective view of the project mounted in a suitable glass frame and illuminated adequately shall also be fixed on the board. The size of this perspective view will be as agreed with the Engineer.

The sign board shall consist of a supporting structure securely anchored to the ground and with sign plates fitted on it. All working details including sitting and positioning shall be submitted for approval and shall be approved before fabrication or erection commences. The sign boards shall be properly illuminated to the required illumination levels and good Engineering Standards and to the approval of the Engineer.

Secondary sign boards shall be provided where necessary to cater for Specialist Consultants and Sub-Contractors. These shall to the standard and type of construction as that of the primary signboard and shall be approved before fabrication or erection commences. Each sign plate shall be of the same size as those used for Engineer and Contractor on the primary signboard.

The Contractor shall comply with current regulations of the Municipality and obtain approval of the Municipality. The Contractor shall keep clean and maintain the sign boards and remove them and make good all works disturbed upon completion of the Contract. The Contractor shall provide space for signboards and pay all costs in connection with them including Municipality fees.

0112. Temporary Works and Reinstatement

The Contractor shall provide and maintain all temporary roads and tracks necessary for movement of plant and materials, and clear them away on completion and make good all works damaged or disturbed.

The Contractor shall submit drawings and full particulars showing the site layout of all Temporary Works to the Engineer for his approval before commencing any works. The Engineer may require modifications to be made if he considers them to be insufficient and the Contractor shall give effect to such modifications but shall not be relieved of his responsibilities for the sufficiency thereof.

The Contractor shall provide and maintain weatherproof sheds for storage of materials pertinent to the Works both for his own use and for the use of the Employer and clear them away on completion of the Works.

All injury to the surface of the land, to the beds of water courses, projecting banks, etc., where disturbed by the Works (other than where specifically ordered by the Engineer) shall be repaired by the Contractor or the Authorities concerned, at the Contractor's expense. All such making good shall be to the approval of the Engineer.

The requirements detailed above shall be provided and maintained at the expense of the Contractor.

The Employer shall not be liable for loss or injury to any Temporary Works.

0113. Locating, Protecting, Maintaining and Diverting Services and Public Utilities

The Contractor shall ascertain the whereabouts of all existing services and public utilities such as electrical cables, telephone lines, sewers, water supply lines, gas lines, pipes, wires, fences, etc., on the site, both above and below ground. Service and other utilities may exist in certain locations not indicated on drawings. Completeness or accuracy of information given on the drawings are not guaranteed. It is the responsibility of the Contractor to ascertain their whereabouts from the concerned authorities before commencing any works on site. The Contractor shall also obtain any re-routing requirements from the concerned authorities and shall be responsible to carry out such works accordingly to the satisfaction of the authorities and the Engineer.

Where diversions of services are not required in connection with the permanent works, the Contractor shall project, uphold, maintain and keep the same in working order in their existing locations and shall restore them to their original condition on completion to the satisfaction of the Engineer.

The Contractor shall make good, at his own expense, all damage caused to any of the services and public utilities by him or his sub-contractors, except where the Public Authority or Private Party Owning the same, elects to make good the damage under their own arrangements. The cost incurred in making good the damages by the Public Authority or Private Party shall be paid to them by the Contractor on demand.

All costs in connection with the above works shall be borne by the Contractor without any extra cost to the Client.

The Client shall not be liable for any loss or injury in connection with any of the above works.

0114. Watching

The Contractor shall allow for all necessary watching for the security of the Works and the protection of the public, including shelter and other facilities for any watchmen so required.

0115. Water for the Works

The Contractor shall provide all necessary water for the Works, with all temporary plumbing and storage, pay all charges, and alter, adapt and maintain temporary work as necessary and remove and make good on completion.

0116. Temporary Lighting for the Works

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

0117. Safeguard of Life and Health

The Contractor shall take and apply all necessary measures for the safeguard of the life and health of his workmen, including the provision and maintenance of adequate First Aid Facilities throughout the Contract Period.

0118. Safety

The Contractor shall nominate a suitably qualified person to undertake the duties of Safety Officers and Safety Supervision on site.

He shall make himself fully conversant with the safety regulations and requirements of good engineering practice and of the local authorities and implement them effectively to the approval of the Engineer.

0119. Fire Protection

Adequate precaution shall be taken against fire throughout all the Contractor's and Sub-contractor's operations. Flammable material shall be kept to an absolute minimum, and, if any, shall be properly handled and stored. Gasoline and other flammable liquids as well as pressurized gas tanks shall be stored in and dispensed from safe containers. However,

storage of such containers shall not be within the building. Except as otherwise provided herein, the Contractor shall not permit fires to be built or open type heating devices to be used in any part of the Work.

Construction practices, including cutting and welding, and protection of adjacent materials during construction shall be in accordance with good standard practices for such work. The Contractor shall provide a sufficient number of approved portable fire extinguishers, distributed within the building and construction site.

The Contractor shall comply with all safety regulations requirements of the Public Authorities and relevant good engineering practices.

The Contractor shall make arrangements for periodical inspection by local fire authorities and shall co-operate with the said Authorities to promptly carry out their recommendations.

0120. Scaffolding

The Contractor shall provide, erect, maintain, dismantle and clear away at completion proper and adequate scaffolding including that required for Sub-Contractors and Specialists. Putlog holes should be made good to match the adjacent surface as the scaffolding is dismantled. The Contractor shall be entirely responsible for all safety precautions in connection with the stability of the scaffolding and for its entire sufficiency for the Work.

Scaffolding shall be a complete system from a manufacturer approved by the Engineer. The Contractor shall provide shop drawings and design calculations to prove the sufficiency of the proposed system for the intended applications for the approval of the Engineer as and when called for to do so. However approval accorded by the Engineer shall not absolve the Contractor of any of his responsibilities or obligations.

0121. Sheds

The Contractor shall provide and maintain weatherproof sheds, air conditioned where necessary, for storage of materials pertinent to the Works and clear them away at the completion of the Works.

Cement and other perishable material shall have floors raised 150 mm off the ground. The Contractor shall clear away at completion and make good all work disturbed.

0122. Keeping Site Free From Rubbish

The premises and the Project site shall be maintained in a reasonably neat and orderly condition by the Contractor and his sub-contractors and kept free from accumulations of waste materials and rubbish during the entire construction period. The Contractor shall remove all crates, cartons and other flammable waste materials or trash from the work areas at the end of each working day.

Floors shall be "broom-cleaned", or its equivalent, during the course of the work. Additional cleaning of all other items which are provided as a part of the Contract, including removal of dust, dirt, stains and finger marks from all finished wood, metal, marble or glass surfaces, shall be performed by the Contractor as required to the approval of the Engineer, before handover of the works.

The Contractor shall be responsible for the general cleaning and maintenance of the premises and the Project site and for the co-ordination of the clean-up work of all trades.

The Contractor shall ensure that each trade shall clean and maintain its portion of the work as required and as directed by the Engineer. If the premises and job site are not maintained properly, the Engineer may have any accumulations of waste materials or trash removed and deducts such costs from payments due to the Contractor.

Elevator shafts, electrical pipe and duct shafts, chases, enclosed spaces and similar spaces which are generally unfinished, shall be cleaned by the Contractor and left free from rubbish, loose plaster, mortar drippings, extraneous construction materials, dirt and dust, before requesting the Engineer to make final inspection of the work.

All areas of the building in which painting and finished work is to be performed shall be cleaned by the Contractor or his sub-contractor(s) thoroughly just prior to the start of the work, and these areas shall be maintained in satisfactory condition for painting and finishing. This cleaning shall include the removal of trash and rubbish from these areas; broom cleaning of floors; the removal of any plaster, mortar, dust and other extraneous materials from all finished surfaces, including but not limited to, all exposed structural steel, miscellaneous metal, woodwork, plaster, duct work, conduit and also all surfaces visible after all permanent fixtures, grilles, registers and other such fixtures or devices are in place.

The Contractor shall institute an effective program of rodent and pest control for the entire site within the construction limits. During the construction period, services of an experienced exterminator shall be utilized if desired and as directed by the Engineer. The Contractor shall provide suitable covered containers for all edible rubbish and shall enforce their use by all employees. Containers shall be emptied and the contents removed from the site as often as required to maintain an adequate rodent/pest control program.

0123. Photographs and Advertising

The Contractor shall supply once a month at his own expense and as directed by the Engineer three colored copies of progress photographs of a size not less than 15 centimeters by 10 centimeters of such portions of the Works completed and in progress as may be directed by the Engineer. The negatives of the photographs with the dates inserted on shall be the property of the Engineer and no prints from these negatives may be supplied to any person unless authorized by the Engineer.

The Contractor shall treat details related to the Contract as confidential. No photographs or other documents may be used for advertising or other purposes without the written authority of the Employer, which authority shall not be unreasonably withheld.

0124. Setting Out

The Contractor shall employ an experienced Land Surveyor to carry out all setting out and surveying work.

Before the commencement of the Works the Contractor will be supplied with the information necessary to establish the lines and levels of the Works. The Engineer has shown on the Drawings all the Survey markers established but can give no warranty for their existence at the start of the Contract nor will he accept responsibility for replacing any survey markers found to be missing. Where survey markers have been established by the Engineer the Contractor shall check the accuracy of their position and level and shall immediately notify the Engineer of any discrepancies.

The Contractor shall, as soon as practicable, supply the Engineer with records in approval form relating to all reference pegs and bench marks and shall keep such records up to date by formal notice to the Engineer.

All survey reference pegs shall be carefully preserved except where construction requires their removal, and before such removal the approval of the Engineer shall be obtained.

In order to establish the existing ground levels over the areas of the works, the Contractor shall establish a grid over the Site and agree the levels with the Engineer. The Contractor shall prepare drawings representing the configuration of the areas which shall be signed by the Engineer and the Contractor as record.

The Contractor shall establish bench marks and grid lines at each floor showing exact floor elevations and other lines and dimensional reference points as required.

0125. Shop Drawings

Provide accurately prepared, large scale and detailed shop drawings on reproducible sheets, prepared specifically for the Project for all disciplines and as instructed by the Engineer. The shop drawings shall show adjacent conditions and related work. Accurate field dimensions and conditions shall be shown. Any special coordination with other trades required shall be clearly noted.

Notwithstanding any specific requirements, if at any time before the commencement or during the progress of the work it appears to the Contractor that for the proper execution of a specific part of the Works, shop drawings are necessary, these drawings shall be prepared by the Contractor and submitted to the Engineer for approval. The Engineer shall have authority to order at any time and the Contractor shall provide any number of shop drawings which, in the opinion of the Engineer are necessary for the proper execution of a specified work. The Contractor shall not proceed with the above mentioned work unless these shop drawings are approved by the Engineer.

All shop drawings shall be properly checked and coordinated with all connected trades/disciplines by the Contractor and shall be signed by a designated qualified coordination Engineer as proof of verification and correction and submitted to the Engineer.

0126. Record Drawings

The Contractor shall maintain one complete set of drawings of all disciplines (Architectural, Structural, Electrical, Mechanical, civil, landscaping, External works etc.), at site exclusively to note all deviations/changes and submission at the time of completion of the works. All changes/deviations and details such as levels of foundations, routing of services, invert levels of pipes, cables, manholes, etc., the position of tees, bends, cleanouts and other appurtenances, details of underground services encountered and any other relevant data, locating dimensions where appropriate shall be accurately and neatly recorded on these drawings as work proceeds. All changes noted/recorded on the drawings shall be submitted to the Engineer for approval as and when the changes occur and are recorded.

0127. As Built Drawings

The Contractor shall within 15 days of issuance of Provisional completion certificate, prepare a completely new set of drawings for all disciplines of the Project as executed incorporating all changes/deviations and all the recorded data on the set of record drawings maintained at site and submit the same in duplicate to the Engineer for approval. The

Contractor shall verify and reflect any modifications and/or changes noted by the Engineer on the submittals and shall be resubmitted to the Engineer for approval. This process shall be repeated until final approval of the Engineer is accorded. When approved by the Engineer, the Contractor shall submit three copies of all drawings duly marked "As-Built" along with one set of reproducibles which shall become the property of the Employer.

The **"FINAL PAYMENT CERTIFICATE"** shall not be made until the **"AS BUILT DRAWINGS"** are submitted. The final payment certificate shall not be made except for the actual works that have been completed in accordance with the Specifications and been duly presented on the "As-Built Drawings".

The Contractor shall not be entitled to any extra payment or extension of time for the correction, preparation and supplying of the drawings.

0128. Customs and Local Dues

All state dues, tolls rates, duties, fees and charges in connection with the Works shall be deemed to be included by the Contractor in his contract unit rates.

0129. Expatriate Labor

The Contractor shall make his own arrangements for the engagement of expatriate labor and staff if required and for the housing, health, welfare and repatriation of same and shall conform in all respects with the conditions and requirements of any law and of any Regulations or Orders of the Government of the country wherein the Site is situated or any Authority which may be applicable including any such Law, Regulation or Order passed or made or coming into force after the date of Tender and/or during the execution of the Works.

0130. Alternative Materials

Should the Contractor wish to offer alternative items or materials to those specified he shall supply details of such alternatives together with details of any reduction in the Contract Price should the alternative be allowed to be substituted for the specified items or materials. All offered alternatives shall comply fully in all respects with the Specifications of the particular items or materials. Acceptance or refusal of any alternatives will be entirely at the discretion of the Engineer.

If during the course of the Contract certain materials or items required for use in the Works should be unobtainable, despite the best effort of the Contractor, the Contractor may offer for the approval of the Engineer alternative materials or items, provided that they possess the minimum requirements of the originally specified material.

In the event of acceptance of any alternative materials or items a suitable price reduction shall be made in respect of any decrease in value but no price addition shall be made in respect of increase in value.

In the event of refusal of any alternative materials or items the Contractor shall not be relieved of any of his obligations under the Contract and shall be solely liable for any delay or loss occasioned by his failure to provide the materials or items as specified.

0131. Materials, Goods and Workmanship Generally

The whole of the goods materials and workmanship incorporated in the works shall be new and of the best quality available and shall be to the approval of the Engineer.

Should the Engineer discover on the Works any materials other than those specified or approved, he may order their removal from the site and for their replacements as specified. All costs incurred for such removal and replacement, and of associated works shall be borne by the Contractor.

0132. Schedule of Procurement of Material

The Contractor shall produce a "Schedule of Procurement of Materials" and submit the same within 3 weeks of commencement of works for the approval of the Engineer. This schedule shall give the following information:

- (a) Item to be procured
- (b) Quantity
- (c) Date of submission for approval
- (d) Date of approval
- (e) Date of order
- (f) Expected date of arrival at site
- (g) Date required on site

The Contractor is required to produce documentary evidence that all materials or items have been ordered in sufficient time to ensure their arrival on site sufficiently in advance of their incorporation in the Works.

No claim will be considered for extension of the Contract Period due to non-availability of materials as a result of the Contractors failure to comply with this requirement.

0133. Samples and Testing of Materials

A. Samples

Prior to ordering or delivering any materials or manufactured items to the Site, the name and address of the supplier(s) and, where required by the Engineer, adequate samples, schedules and manufacturer's certificates of all the materials and goods to be used in the Works shall be submitted to the Engineer for approval at no extra cost to the Project.

In case of rejections further samples, until final approval is accorded, shall be submitted. The Contractor shall have no claims to extra cost or time lost due to improper submissions, the resultant rejections and the approval process.

If considered necessary and ordered by the Engineer, the samples shall be tested for compliance at the Contractor's expense in a laboratory approved by the Engineer.

B. Testing

The Contractor shall be responsible for the sampling, storage, transportation and laboratory testing of products and materials as required in the Specification.

The Contractor shall make available on site necessary equipment for the use of the Engineer for tests to be conducted at site.

- Eg. - Slump cone with base plate and tamping rod.
- Thermometer suitable for measuring concrete temperature.
 - Magnetic flux principle instrument for non-destructive method of testing paint film thickness.
 - etc.

In addition, suitable experienced labor to carry out the operations in connection with the above shall be provided by the Contractor as required by the Engineer.

The Contractor shall allow for the costs of the above in his unit rates.

0134. Co-ordination of Builder's Work

The Contractor shall co-ordinate the requirements for holes, fixings and other similar builder's work.

The Contractor shall ensure that such builder's work as shown on the drawings is in accordance with his own and his sub- contractor's requirements. Details of holes, fixings, etc.. which are not shown on the drawings but are required by the Contractor or his sub-contractor shall be submitted to the Engineer for his written approval. No holes or fixings shall be formed without prior approval by the Engineer. No claim will be entertained for this work and for any abortive work executed due to lack of co-ordination.

0135. Periodic Reports

The Contractor must present to the Engineer detailed weekly reports and monthly summary report showing the following:

- (a) Labor force working during the period.
- (b) Quantity and Type of materials and equipment used during the period.
- (c) Quantity of works executed.
- (d) Climatic conditions with special reference to any direct effect they may have on the works.
- (e) Unforeseen circumstances which may hamper the progress of the Works.
- (f) Graph showing the relation between the executed portions of the works and the corresponding portions in the Work Program.

The Contractor shall prove to the Engineer upon his request the correctness of the above mentioned reports without having the right to use such documents to support a claim for any extra payment or compensation whatsoever in regard or in relation to such reports. However this shall not vitiate the rights of the Engineer to use the report as evidence to decide on any aspects connected with delays and claims.

0136. Site Progress Meetings

During the course of the Work, Site progress meetings shall be held at regular intervals, at least once every two weeks, or at other intervals as directed by the Engineer, for the purpose of coordinating the Contractor's Works and to ensure that full compliance with the various sequences of the Contract are maintained. Minutes of such Site meetings will be recorded by the Engineer and copies will be distributed to all persons concerned and full effect shall be given to all instructions contained therein.

Prior to such meetings the Contractor shall give to the Engineer's Representative details in writing of that portion of the Works he proposes to construct during the coming two weeks

with details of the plant and methods he proposes to employ. These proposals shall be discussed at the meeting and no work based on such proposals shall proceed without the approval of the Engineer's Representative.

The Contractor shall have no claim against the Employer for costs incurred by him in changing the method of working or in the provision and use of other additional plant.

0137. Safety of Adjoining Existing Buildings, Roads, Services, etc.

The Contractor shall take all necessary precautions during the excavation for the Works particularly those excavations which are adjoining existing buildings, roads, services, etc., and shall protect such buildings, roads, services, etc., from damage or collapse by means of temporary or permanent shoring, strutting, sheet piling or secant pile walls or underpinning or excavations in short lengths and/or other methods to suit the dictates of the situation and as approved by the Engineer. He shall properly support all foundations, trenches, walls, floors, etc.. affecting the safety of the adjoining existing buildings, roads, services, etc.

The Contractor shall alter, adapt and maintain all such Works described above for the whole period of the Contract and shall finally clear away and make good all damage done.

The Contractor shall be held solely responsible for the safety of the adjoining existing buildings, roads, services, etc., and the sufficiency of all temporary or permanent shoring, underpinning, strutting, piling, etc.

The construction and efficiency of the shoring, underpinning, strutting, secant pile wall, sheet piling, etc., shall be the responsibility of the Contractor. Should any subsidence or any other damage occur due to the inefficiency of the shoring, underpinning, strutting, etc. or any other support provided, the damage shall be made good by the Contractor at his own expense and responsibility.

The shoring, strutting, piling, etc., shall be executed in such a manner as to cause as little inconvenience as possible to adjoining owners or the public and the Contractor shall be responsible for negotiating with the adjoining owners, and/or Municipality the means to safeguard their property and for the use of any portion of their land for the purpose of executing the excavations and no claims submitted on this ground will be entertained.

The Contractor shall submit a detailed method statement for his proposed shoring and dewatering system supported by design calculations for the approval of the Engineer. The Contractor shall also be responsible to follow the local rules and regulations in this connection and obtain the approval of the concerned Municipal and other authorities, before commencing any dewatering, shoring and excavation works. If the system is not approved by the Engineer the Contractor shall submit revised method statement proposing an alternative system. The Contractor shall also incorporate any comments and modifications required by the Engineer and resubmit the same for approval. This process shall be repeated till final approval is accorded by the Engineer. The Contractor shall not be entitled for any additional cost or time on account of the above revisions or the approval process.

Any approval accorded by the Engineer shall not relieve the Contractor of any of his responsibilities or contractual obligation under this contract.

0138. Safe Access and Maintenance of Traffic Flows

The Contractor shall provide and maintain all temporary roads and tracks necessary for movement of plant and materials, and clear them away at completion and make good all works damaged or disturbed.

The necessity for, provision of, details of, and maintenance of temporary road diversions and existing road closures shall be subject to the approval of the Engineer, the Traffic Police and the Municipality.

No public or private facility shall be removed or interrupted without the written permission of the Engineer. Such permission will not be given until suitable permanent or temporary alternatives approved by the Engineer have been provided by the Contractor or in the case of accommodation works, by the owner of the facility or his agents.

The Contractor shall be responsible for making arrangements with the Statutory Undertakings, Public Authorities and the Engineer, as appropriate, concerning the phasing into his program, of all works which need to be done by the Contractor or his sub-contractors.

The Contractor shall take any and all measures reasonably required by any Public, Statutory Authority or the Client for providing safe passages to the adjoining building, for the support and full protection of all mains, pipes, cables and other apparatus during the progress of the Works, and shall construct and provide to the satisfaction of the Authority concerned, all works necessary for the prevention of damage or interruption of services. If in the execution of Works, any subsidence is caused by any act of neglect or default of, or any damage to any apparatus, or any interruption of or delay to the provision of any service, by the Contractor, he (the Contractor) shall bear and pay the cost reasonably incurred by the Authority concerned in making good such damage and shall make full compensation to the Authority for any loss sustained by reason of such act of neglect, default, damage, interruption or delay.

The Contractor shall, at all times during the progress of the Works, afford facilities to properly accredited agents of any Public, Statutory Authority and the Engineer for access to all or to any of their apparatus situated in or under the Site, as may be necessary for inspecting, reporting, maintaining, removing, renewing or altering such apparatus in connection with the construction of the Works or for any other purpose whatsoever.

The position of Services mains, drains, sewers and telephone lines shown on the Drawings have been based on information extracted from the records of the various bodies and must be regarded as approximate only. The Engineer does not guarantee either the accuracy of the information or that the location of such apparatus is as shown on the Drawings, and no warranty must be implied as to the position, depth, size or gradient thereof. The Contractor must make his own enquires of the Statutory Undertakers, Public Authorities and the Engineer and satisfy himself as to the exact position of such apparatus and the depth, size and gradient thereof.

0139. Protection of Finished Works

The Contractor shall carefully protect his own finished work, the works of his subcontractors and the works of Local Authorities if any, up to the time of completion and final handover of the project. The Contractor shall be liable for the reinstatement of any work damaged during the progress of the Works, caused by any reason whatsoever.

0140. Soil Investigation

The soil investigation report enclosed herein is for reference and guidance only. The Contractor shall ascertain the soil conditions on his own by carrying out necessary soil investigations as required. It shall be the responsibility of the Contractor to ensure that the minimum design soil strength is met with. Any modification required to the foundations or the

soil strata under the foundations to satisfy the design requirements shall be carried out at no extra cost and/or time to the Contract. The Contractor shall however submit all the necessary details of his findings and his proposed modifications for the approval of the Engineer before commencing work. However, any such approval accorded shall not relieve the Contractor of any of his contractual obligations and responsibilities.

End of Section 01

SECTION 02

CONCRETE WORK

GENERAL

0101. Standards

The requirements of the British Standards, BS 8110 "The structural use of Concrete", BS 8007:1987 "Code of Practice for the Design of Concrete Structure for retaining Aqueous Liquids", shall be followed where applicable.

The following British, ACI and ASTM Standards shall be complied with where applicable:

<u>BS No.</u>	<u>Title</u>
BS 12: 1991	Ordinary Portland cement.
BS 812	Testing of aggregate.
BS 882: 1992	Aggregates from natural sources for concrete.
BS 1199 & 1200: 1976	Building sands from natural sources.
BS 1881	Testing Concrete (including non-destructive tests methods).
BS 3148: 1980	Tests for water for making concrete.
BS 4254: 1991	Two part polysulphide based sealant.
BS 4466: 1989	Scheduling, dimensioning, bending & cutting steel reinforcement.
BS 4482: 1985	Cold reduced steel wire for reinforcement.
BS 4483: 1985	Steel fabric for the reinforcement.
BS 4550	Methods of testing cement.
BS 5075	Concrete Admixtures.
BS 5328: Part 1: 1991	Specifying concrete.
: Part 2: 1991	Concrete mixes.
: Part 3: 1990	Procedures for producing and transporting concrete.
: Part 4: 1990	Sampling, testing and assessing compliance of concrete.
BS 5642: Part 1: 1978	Sills.
: Part 2: 1983	Copings.
BS 6954	Tolerances for building.
BS 7263: Part 1: 1990	Pre-cast concrete flags, kerbs, edging and quadrants.
: Part 2: 1990	Code of practice for Laying Pre-cast concrete units.
BS 8007: 1987	Concrete structures for retaining aqueous liquids.
BS 8110	Structural use of Concrete.
BS EN 196-6 : 1992	Methods of testing cement - Determination of fineness.
BS EN 196-7 : 1992	Method of taking and preparing samples of cement.
BS EN 196-21: 1992	Determination of chloride, CO ₂ & alkali content of cement.

ACI

ACI 305	Hot Weather Concreting.
ACI 308	Standard Practice for Curing of Concrete.
ACI 318:89	Building Code Requirement for Reinforced Concrete.

ASTM

ASTM A615/A615M-93	Deformed and Plain Billet Steel Bars
ASTM C33 -93	Concrete Aggregates.
ASTM C94-94	Ready mixed concrete
ASTM C150-94	Ordinary Portland cement Type 1.
ASTM C186-94	Heat of Hydration of Cement.

0102. Qualifications

The Contractor shall follow the guide lines contained in the latest editions of the codes, specifications and standards listed above, except where more stringent requirements are shown or specified.

Plant and field inspection and testing of concrete and all ingredients there in, and reinforcement shall be performed by an independent laboratory approved by the Engineer at the Contractors expense. Materials and installed work may require testing and re-testing as directed by the Engineer, at any time during the progress of the work which shall be carried out by the Contractor at his own expense.

The Contractor shall provide free access to visit and inspect the materials, stockpiles and facilities, proposed works, plants and sources of materials by the Engineer.

All tests including re-testing of rejected materials and installed work shall be done at the Contractors expense.

0103. Method Statement

During the mobilization period the Contractor shall submit a method statement detailing his proposal for the organization of all concreting activities at the site as well as off site for the approval of the Engineer.

The Contractor shall submit method statements for any particular activity when called for by the Engineer and demonstrate its feasibility through mockups/placement samples of appropriate sizes as approved and directed by the Engineer.

MATERIALS AND WORKMANSHIP

0104. Cement

Ordinary Portland cement complying with BS 12 or ASTM C 150 for Type I shall be used for all Concrete

Cement shall be of recent manufacture and shall be used within a period of 3 months from production.

0105. Cement Test & Analysis

Prior to any shipment to site the Contractor shall supply the Engineer with the manufacturer's statement of specification and test certificate together with the date of manufacture certified by an independent agency in the country of origin. The date, quantity of cement and the number of the relevant delivery note shall also be stated. Before or after delivery the Engineer shall have the right to reject any cement if the result of additional tests he may request do not meet the required standard. The Engineer shall have access to the cement store and have the right to take samples for these additional tests. The Engineer reserves the right to take samples and order any additional/re-tests in accordance with ASTM C186-

94, BS EN 196-6:1992 and BS EN 196-7:1992 at no extra cost to the Client. The Contractor shall remove all rejected cement from the site without delay.

0106. Cement Storage

Cement storage shall be subject to approval and shall afford easy access for inspection and identification of each shipment in accordance with test reports. It shall be used in the order in which it was delivered.

Bagged cement shall be delivered to site in the manufacturer's original sealed bags or containers and shall be stored in a dry, weather tight, properly ventilated structure, with adequate provisions for preventing the absorption of moisture and raised at least 150 mm off the ground to prevent deterioration. The storage shall be large enough to allow sufficient cement to be kept to allow continuity of work. Not more than 10 bags shall be piled one on top of the other while shoring in bags. Suitable shading shall be provided to limit the temperature to 40 deg. C.

If cement in bulk is used it will be stored in approved purpose made silos large enough to allow continuity of work. No cement shall be stored on site for more than 2 months from the date of production.

Aggregates

0107. General

All aggregates fine and course shall comply in every respect with BS 882: 1992 and ASTM C33. They shall be well graded, clean, hard, free from undesirable material, and obtained from an approved source in Ras Al Khimah.

It is preferred that the fine and course aggregates are obtained from the same source (approved at the commencement of the works), throughout the Contract. If it is necessary to change to a further approved source, all the tests on aggregates mentioned herein and elsewhere shall be repeated.

During excavation at a particular source of aggregate, care shall be taken to ensure that the excavation does not get too close to the high water mark where there may be a high concentration of salts due to the evaporation of water. The Engineer may inspect the source of aggregate during the progress of the Contract, and may order further tests if he considers them necessary.

0108. Grading of Aggregate

Course aggregate shall be prepared as single sized and blended to produce a normal size grading. The combined grading shall be within the appropriate grading limits laid down in BS 882 and as described below.

The gradation of fine aggregate shall be in accordance with BS 882. All-in aggregate shall be permitted for low-grade concrete only.

For normal use, aggregates shall consist of fine aggregates (those passing a 5 mm (3/16") sieve, and coarse aggregates (those retained on a 5 mm (3/16") sieve batched separately which, when combined together, give a grading curve which lies within the following limits:

<u>Sieve Size</u>	<u>% Passing by wt.</u>	<u>Sieve Size</u>	<u>% Passing by wt.</u>
20.0 mm (3/4")	100	1.18 mm (No. 14)	16 - 34
10.0 mm (3/8")	45 - 75	600 µm (No. 25)	9 - 2
5.0 mm (3/16")	30 - 48	300 µm (No. 52)	2 - 1
2.36 mm (No. 7)	23 - 42	150 µm (No. 100)	0 - 15

The amount of material passing BS 75 micron sieve in the combined aggregates when tested in accordance with BS 812 (wet sieving method) shall not exceed the following limits:-

Fine aggregate - 3% by weight
Coarse aggregate - 1% by weight

0109. Sampling of Aggregates

Sampling and testing of aggregates when required by the Engineer shall be carried out in accordance with BS 812. If adequate laboratory facilities do not exist on site, samples must be taken and sent to a testing laboratory approved by the Engineer. Samples of about 0.015m³ (1/2 cu.ft.) and 0.03 m³ (1 cu.ft.) of fine and coarse aggregate shall be sent in suitable airtight containers.

0110. Testing of Aggregates

All fine and coarse aggregates shall be imported from sources approved by the Engineer and shall be within the limits laid down in the table below in respect of contamination and reactivity:-

CONTAMINATION AND REACTIVITY OF AGGREGATES

Property	Method of test & Standards	Maximum Limit (% by weight)
Clay, Silt and Dust	Wet Sieving through 0.075 mm sieve, BS 812: Part 103.	<i>Coarse Aggregates</i> Natural or Crushed Gravel 1 % Crushed Rock 1 % Crushed Rock 1 % <i>Fine Aggregates</i> Natural or Crushed Gravel 3 % Crushed Rock 5 %
Clay Lumps	ASTM C 142	Coarse Aggregate 1 % Fine Aggregate 1 %
Organic Impurities	ASTM C 40	Colour standard not darker than Plate No. 3
Chlorides AS C1	Acid soluble * BS 812: Part 117	Coarse Aggregate 0.02 % Fine Aggregate 0.05 %
Sulphates as SO ₃	Acid Soluble * BS 812: Part 118	Coarse Aggregate 0.3 % Fine Aggregate 0.3 %
Potential alkali reactivity	ASTM C 289 **	If the total amount of potentially reactive material exceeds 0.5 % by weight of the total aggregate the alkali in the cement shall be restricted to 3 Kg/m ³ of concrete Innocuous
Chemical method of Cement Aggregate Combination	ASTM C 289 ASTM C 227`	Innocuous 6 month expansion 0.1 % max.

* Strict control shall be exercised to ensure that the maximum chloride content indicated is not exceed at any time. Any violations shall be cause enough for rejection at any stage of the construction.

** Aggregate may initially be assessed for its reactivity in accordance with ASTM C 289 and if potential reactivity is indicated than mortar bar tests in accordance with ASTM C 227 shall be carried out.

The tests and the maximum acceptable limits sampled and tested in accordance with the specified BS, shall be as indicated in the table below:-

RELEVANT TESTS AND STANDARDS FOR AGGREGATES

Property	Method of test & Standards	Maximum Limit (% by weight)
Contamination and Reactivity	As detailed in the table above	
Grading	BS 812: Part 103 (Dry)	As detailed under Aggregates
Surface texture	Descriptive, BS 812	Limit not applicable
Water absorption	Weighing dry & saturated ASTM C 128 / C127	Coarse Aggregate 2 % Fine Aggregate 2.3 %
Soundness 5 Cycles	ASTM C 88	MgSO ₄ 12 % Na ₂ SO ₄ 12 %
Drying shrinkage	BS 812: Part 120	Shrinkage 0.05%
Shell content Coarser than 10 mm Size 2.36 & 5 mm Finer than 2.36 mm	BS 812 Part 106	maximum 5 % maximum 10 %
Particle shape Flakiness index Elongation index	BS 812 Part 105.1 Part 102.2	maximum 25 % maximum 25 %
Specific Gravity	ASTM C 128/C 127	Course & Fine aggregate 2.6
Mechanical Properties	10% fines, BS 812: Part 111 Impact Value Part 112 Los Angeles abrasion test (ASTM C-131 or C-535)	Minimum 100 kN 30 % 30 %

0311. Frequency of Routine Tests on Aggregate

The Contractor shall carry out the various tests at the frequencies indicated below:

However the Engineer shall reserve the right to call for additional tests wherever it is warranted.

FREQUENCY OF ROUTINE TESTS ON AGGREGATES

Property	Method of Test	Maximum Limit (% by weight)
Grading	BS 812 Part 103	Each 2 weeks or per 100 m3 whichever is more frequent.
Material finer than 0.075 mm	BS 812 Part 103	Each 2 weeks or per 100 m3 whichever is more frequent
Clay lumps & friable Particles	ASTM C 142	Each 2 weeks or per 100 m3 whichever is more frequent.
Organic impurities	ASTM C 40	Each month or per 200 m3 whichever is more frequent.
Water absorption	ASTM C128/C127	Each month or per 200 m3 whichever is more frequent.
Specific Gravity	ASTM C128/C127	Each month or per 200 m3 whichever is more frequent
Shell content	BS 812 Part 106	Each 2 months or per 400 m3 whichever is more frequent.
Particle shape	BS 812 Part 105.1 & 105.2	Each 2 months or per 400 m3 whichever and 105.2 is more frequent
Acid soluble chlorides, CL Qualitative, Quantitative	BS 812 Part 117 A & B - Ditto - Appx C	At source and) On each delivery to site 1 representative test per week of) aggregate to be used
Acid soluble Sulphates S03	BS 812 Part 118 Appendices A/B	On each delivery to site 1 representative test per week of aggregate to be used
Soundness, Mg S04	ASTM C88 (5 cycles)	Each 48 concrete days
Mechanical strength 10% fines or impact Los Angeles abrasion	BS 812 parts 111,112 ASTM C 131/C 535	Each 72 concrete days Each 72 concrete days
Moisture variation	by Moisture Meters	Twice daily for sands
Drying shrinkage	BS 812 Part 120	At start of project and whenever there is a change in the source of supply.
Potential Reactivity -of Carbonate -of cement aggregate combination	(ASTM C295, C289) (ASTM C586) (ASTM P214 & C227)	At start of project and whenever there is a change in the source of supply

0112. Storage of Aggregates

The ready mix concrete supplier shall at all times maintain sufficient quantities of each type of aggregate considered by the Engineer to be sufficient to ensure continuity of work.

Each type and grade of aggregate shall be stored separately in bins, in such a manner that segregation of the various size particles shall not occur. The floors of the bins shall be of concrete or other approved material having sufficient slope to ensure adequate drainage of aggregates before being used for concreting.

Suitable precautions shall be taken to avoid contamination of aggregates by wind blown dust, etc.

Suitable approved shading shall be provided to control the temperature and any contaminations especially chlorides.

Storage bins shall be emptied and cleaned at regular intervals as approved by the Engineer.

0113. Water

Water for mixing and curing shall be obtained from an approved source and shall be clean and free of acids, oils, vegetable, and deleterious matter which may have an effect on the strength and appearance of the hardened concrete by discolouration or efflorescence.

The Contractor, when required by the Engineer, shall arrange for analysis of samples of the water to be made by an approved testing laboratory and the water shall comply in all respects with the requirements of BS 3148:1980.

The PH value of water shall be within the range of 7-9 and the concentration of inorganic contamination shall not exceed the values indicated below:

- | | |
|---|------------------|
| - Dissolved solids excluding those listed below | - 2200 ppm 0.20% |
| - Sulphates, alkali carbonates or bicarbonates | - 1000 ppm 0.10% |
| - Chlorides | - 500 ppm 0.05% |
| - Suspended solids | - 2000 ppm 0.20% |

Sea water and brackish water shall not be used for the mixing of concrete.

0114. Admixtures and Additives

Admixtures and additives (water reducing additives, retarders, etc.) shall be used only with the prior approval of the Engineer. Additives shall be subjected to tests before approval and during progress of work on site at the discretion of the Engineer. All costs incurred towards all tests shall be borne by the Contractor.

Admixtures shall conform to one of the following standards:

- ASTM C494 Chemical admixtures for concrete.
- ASTM C1017 Chemical admixtures for use in flooring Concrete.

Admixtures/Additive shall:

- have no adverse effect on the shrinkage and water tightness properties of finished concrete.
- not have any added chloride (0%, Calculated as calcium chloride by weight of cement in the concrete).

0115. Water Proofing Admixture to Water Tank

Concrete mix where specifically indicated shall be mixed with a hydrophobic waterproofing, hydrophobic pore-blocking(HPB) admixture composed of ammonium stearate to increase the

water tightness and durability and reduce the absorbency of the concrete. The HPB admixture shall be of an approved type which shall provide a waterproof and corrosion resistant construction.

Concrete mix design, batching, placing, finishing, curing, handling, etc., shall be strictly in accordance with the instructions and detailed specification of the HPB admixture manufacturer and subject to the supervision of that company or their nominated representative.

A super plasticiser of proven compatibility with the HPB admixture, recommended by the HPB admixture manufacturer shall be added to reduce the water content and maintain sufficient workability. In all cases, the free water/cement ratio shall not exceed the limits indicated on the structural drawings and other clauses elsewhere in this Section. No other admixtures shall be included or added without the written approval of the Engineer. The Contractor shall satisfy the Engineer that the HPB admixture and any other additives/admixtures used either by themselves or in combination, do not have any detrimental effect on the strength or other properties of the concrete.

The Contractor shall conduct and test a trial mix of the concrete with the HPB admixture to satisfy the Engineer that the concrete conforms to strength, water/cement ratio, slump, water absorption value indicated below and other performance requirements as specified for Concrete.

Water absorption values must not exceed 1%, when tested in accordance with BS 1881: Part 122: 1983 on cubes that are 7 days old. Samples from the production concrete shall be taken at regular intervals and tested to monitor compliance with the water absorption specification as directed by the Engineer.

The Contractor shall ensure that the HPB manufacturer/ representative is provided free-on-site service and access during mixing, batching and placing of concrete containing the HPB admixture (both at the batching plant and at the site of placement).

The HPB representative shall inform the Engineer of any contraventions or irregularities noticed by him regarding the batching, mixing and placing of the concrete with HPB admixture, despite his best efforts to rectify the same.

The Contractor shall submit a written guarantee signed and countersigned by the HPB admixture manufacturer/representative, the concrete supplier and the Contractor himself, providing a 10 year guarantee against any leakage, deterioration and corrosion caused by the failure of the concrete with the HPB admixture, from the date of issuance of the Provisional acceptance certificate.

The Contractor shall also pass on to the Client any and all guarantees provided by the manufacturer of the HPB admixture and the supplier of the concrete.

The Contractor shall be required to repair/replace all defective work or damages resulting from defective materials or workmanship including all replacement of material during the guarantee period at no extra cost to the Client.

0116. Cement Content

A cement quantity shall be chosen appropriate to strength and workability requirements. However the minimum cement content shall be as detailed on drawing S 00.

0117. Workability of Mixes

The concrete shall contain the minimum water cement ratio possible compatible with such a consistency that it can be readily worked into corners and angles of the formwork, and around the reinforcement without segregation of the materials or bleeding of the free water at the surface. On striking the formwork, the concrete shall present a face which is uniform, free from honeycombing, surface crazing or excessive dusting. Where it is required to restrict the water cement ratio to below a certain maximum limit for durability reasons, this limit shall be as stated in this specification. For prescribed mixes, the water cement ratio shall be as indicated on drawings with slumps indicated below:-

Max.Aggregate Size	40 mm		20 mm		10 mm	
Workability	Medium	High	Medium	High	Medium	High
Slump Limits	50-100	100-150	25-75	75-125	10-25	25-50

0118. Frequency of Sampling for Testing

Tests on cubes are to ensure that strength requirements are being met. Unless otherwise stated the Contractor shall allow for making and testing a minimum of one set of 6, 150 mm cubes for every 100 m³ or part thereof of concrete. Cubes are to be taken from each part of the structure cast during any one day, 'a part of the structure' being a set of columns, beams, foundations or an area of slab. The Contractor will be required to carry out slump tests in accordance with BS 1881: Part 102:1983 to satisfy the Engineer that the slump requirements as specified under Workability of Mixes are met.

0119. Testing of Concrete

All sampling and testing of samples of concrete shall be carried out in an approved laboratory as per BS 1881. Reports of all cube tests shall be supplied to the Engineer within 24 hours of being carried out. All cost incurred with the testing and test records shall be borne by the Contractor.

Concrete cylinders 150 mm diameter, 300 mm high may be taken and tested in accordance with ASTM C39. The minimum compressive strengths shall be as indicated on drawings or 80% of the strengths specified for 150 mm cubes as applicable.

0120. Records

Records on testing of materials shall be kept by the Contractor and a copy of each of the test results shall be supplied to the Engineer.

The 'record form' shall include, but not be limited to, the following information as appropriate.

Source of material, aggregate physical and chemical analysis tests, compatibility tests, date and time of mix, batch number, ambient temperature, mix temperature, concrete grade, structural member where the concrete is placed, compressive strength results, allowable concrete strength, method of curing used, etc.

0121. Prescribed Mixes

Concrete shall be as shown in the Table 1 below. The number of mixture may require to be increased. The criteria given in Table 1 are designed to produce concrete of the required strength and durability.

If the maximum aggregate size is 10 mm then the cement content stipulated for the class of concrete given in the Table 1 shall be increased by 40 Kg. per m³.

Table 1 - Table of Mixes

Concrete Class	Max. Size Aggregate mm	Min. Qty of Cemet Kg/m ³	Max. Water Cement Ratio	Characteristic Cube Strength (CCS) N/mm ²		Trial Mix Strength N/mm ²
				7-day	28-day	
35/20	20	370	0.45	26	35	40
15/20	20	275	0.65	11	15	20

The CCS are for concrete which has been cured at a temperature of 20 degree C $\pm$ 1° C., and are the values below which no more than 5% of the test results fall. The 7-day strengths shall be used only as a guide.

Concrete shall comply with BS 8110 except where BS 8007 or this specification differs. Sampling for test purposes shall comply with BS 1881 Part 101 (on site) and Part 125 (in laboratory) or ACI 318-89 as directed by the Engineer.

If air-entertainment is specified the average air content at the time of placing measured in accordance with BS 1881 shall be:

- Concrete containing 20 mm
- Maximum size aggregate 5% + 1%

Concrete for water-retaining structures shall be watertight and shall comply with the recommendations of BS 8007.

Concrete for paving or precast units shall be tested to BS 1881 part 118 and shall have a minimum flexural beam strength of 3.5 N/mm² at 28 days. If the concrete has a specified CCS of 40N/mm² or greater, then the minimum flexural strength shall be 4N/mm².

If concrete specimens are cured at higher temperatures or for longer periods than BS 1881 Part 111 requires, the adjusted CCS shall be calculated as follows:

$$- \quad 100f'/f = A + B \log \{24D (T+12)/1000\}$$

f' = Adjusted CCS
 f = Specified CCS
 T = Curing temperature
 D = Age at testing in days
 A & B = are coefficients given in the following table

- The above equation applies only to OPC, MSRPC and SRPC

Recorded Cube Strength N/mm ²	A	B
Less than 15	10.0	67.5
15 to 35	22.0	60.0
Greater than 35	30.0	52.5

The calculation may be applied for curing at temperatures upto 27 degree C.

Before placing concrete the Contractor shall obtain approval of the mixes proposed for each class of concrete and the average target strengths. The mixes shall be designed to achieve the minimum workability for the Contractor to place and compact the concrete with the equipment proposed for use.

0122. Trial Mixes

Preliminary laboratory tests shall be carried out to determine the mixes to satisfy the specification with the approved materials.

Trial mixes shall be tested to determine the following properties of mixes proposed for initial field tests:

- Bleeding in accordance with ASTM C232 (non- vibrating) shall not exceed .5%.
- Drying shrinkage in accordance with BS 1881 Part 5 or BS 6073 Part 1, Appendix D.
- Air content if applicable BS 1881 Part 106.
- Free water/cement ratio.
- Workability BS 1881 Part 102.
- Fresh and hardened concrete densities BS 1881 Parts 107 and 114 respectively.
- Compressive strength, BS 1881 Part 116.
- Water permeability DIN 1048(maximum 10 mm at 28 days and 15 mm at 7 days)

If the values obtained are unacceptable, the mixes shall be re-designed.

At least 35 days before commencement of concreting, trial mixes shall be prepared under full-scale site conditions and tested in accordance with BS 1881.

Samples of concrete incorporating the reinforcing details to be used shall be cast and examined, before hardening using hand tools, and after hardening by coring to assess the mixes. Cores shall be taken in accordance with BS 1881 Part 120.

Trial mixes shall be made on each of three days; the workability shall equate to the designed target value. Six cubes from each mix shall be taken, three for test at 28 days.

Further trial mixes shall be made if the range (the maximum minus the minimum of the three cubes results in any batch) exceeds 15% of the average of that batch, or if the range of the three batch average of the batches.

The mixes shall be tested to determine the following properties:

- Bleeding in accordance with ASTM C232
- Air content if applicable BS 1881 Part 106.
- Free water/cement ratio
- Tensile strength in accordance with BS 1881 Parts 117 and 118.

The average 28-day CCS of the three trial mixes shall not be less than the designed mean strength, and the results of the above tests shall be acceptable before the mix is approved. Otherwise the mix shall be re-designed.

The Engineer will review the Contractor's trial-mixes and crush the test cubes at seven (7) and twenty-eight (28) days. The Engineer will then determine which of the trial mixes shall be used. If none of the trial mixes for a class of concrete meets the specifications, the Engineer will direct the Contractor to prepare or place until its job-mix proportions have been approved by the Engineer.

The approval of the job-mix proportions by the Engineer or his assistance to the Contractor in establishing those proportions, in no way relieves the Contractor of the responsibility of producing concrete which meets the requirements of these specifications.

The Engineer may also require practical tests to be made of the site by filling trial moulds to confirm the suitability of the mix for the works, the type of plant used for mixing, the method of compaction used and the formwork face intended for use in the works.

All costs connected with the preparation of trial-mixes and the design of the job-mixes shall be borne by the Contractor.

0123. Strength Requirements

Where the Engineer requires trial mixes to be made for prescribed mixes they shall be made as described for designed mixes in BS 8110 Part 1, and the average strength of the 9 cube tests shall be at least equal to the trial mix strength and the minimum strength of any one cube shall be at least equal to the characteristic strength shown in Table 1 of Prescribed mixes.

During the course of the construction of the Works, the Contractor shall make test cubes as directed by the Engineer. One set of six (6) cubes shall be taken from each individual concrete member, but additional cubes shall be taken as directed by the Engineer. Three (3) cubes shall be tested at 7 days and three (3) cubes shall be tested at 28 days as the Engineer directs. The average values of the cube test results shall exceed the characteristic strength shown in Table 1 of Prescribed mixes, by 1.64 times the standard deviation of the test results.

0124. Remedy in the event of Works Cube Failure

Should any of the 7 day Cube test results fall below the specified requirements, the Contractor shall suspend all further work pertaining to and connected with the concerned

work, if ordered to do so until the 28 day cube test results are analyzed. If the 28 day results are found satisfactory the Engineer may permit the works to be resumed. The Contractor shall carry out investigation to ascertain the cause for the failure at 7 days and shall submit his report and recommendation if any for the review of the Engineer.

The Engineer shall review the same and may order and the Contractor shall carryout any remedial measures to avoid further occurrences.

Should any cube test results of 28 days fall below the specified requirements, the Engineer will decide whether the concrete in the work represented by those cubes can be accepted or not. Failing acceptance, the Contractor shall carry out one or more of the following actions at his own expense to prove the concrete used in the Works is within acceptable limits.

- (a) The drilling and testing of cored cylinders in accordance with the procedures laid down in BS 1881: Part 120: 1983 and Part 124: 1988.
- (b) The carrying out of load tests, or other non-destructive tests in accordance with the procedures laid down in BS 1881: Parts 202 to 206.

The course of action to be taken, the size and location of cores for testing and interpretation will be decided by the Engineer who will also approve the testing authority and laboratory. If the Engineer after these secondary testing procedures have been completed, still considers that the concrete used is not acceptable, the Contractor shall remove all sections of the works containing the defective concrete and replace it with approved concrete at his own expense.

The Contractor shall be solely responsible for all delays and losses cause as a result of the above and shall not be entitled for any extension of time or claims.

0125. Chloride and Sulphate Content

Chloride Content: The total chloride content of concrete made with Ordinary Portland cement conforming to ASTM C 150 Type I & II shall be max. 0.15% expressed as % of chloride "ion" by mass of cement.

Sulphate Content: The maximum sulphate content shall not exceed 4.0% including sulphate ions in cement, expressed as % of SO₃ by weight of cement.

The method of assessment and test shall be in accordance with BS 5328: Part 4: 1990.

0126. Mixing Concrete

The concrete shall be mixed in an approved central batching plant and the weights of materials used for each batch shall not exceed the manufacturer's rated capacities for the machine.

The batching plant shall be kept clean, free from hard or partially set cement, and well maintained in good working order.

The time allowed for mixing (after all the materials have been placed in the mixer) shall be sufficient for thorough mixing to take place. No hand mixing of concrete shall be allowed.

0127. Ready Mixed Concrete

Concrete from approved suppliers of ready mixed concrete with proven record, shall be used in the Works after satisfying all the requirements of these specifications, BS 5328, "Concrete" and ASTM C-94, "Standard specifications for ready mixed concrete".

Prior to commencement of the works the Contractor shall furnish the following details to the Engineer in addition to the concrete satisfying all the requirements stated in the relevant clauses.

- Name and qualification of supplier(s).
- Location of the supplier(s) plant and travel time to the site.
- Certificate of quality assurance.
- Quality control facilities.
- Certificate and test reports on concrete production and products.
- Source(s) of aggregates, cement, etc..
- Quality of water, aggregates and cement
- Production capacities.
- Supplier's test certificate giving results of tests on aggregates for workability, strength and chloride content shall be submitted by the contractor to the Engineer at weekly intervals.
- Any other relevant data such as workability of concrete, admixtures, etc..
- C.V. of personnel year-marked for the project, (approved personnel shall not be changed without prior approval of Engineer.

Ready mixed concrete, mixed off site shall be transported in approved truck mixers and shall be accompanied by a computer printout indicating the following:

- Admixtures and their quantities added.
- Quantity of Concrete.
- Actual batched weights of cement, aggregates, water.
- With a computer printout indicating the following:
- Date and time of charging the truck from the batching plant.

0128. Truck Mixers

Truck mixers, unless otherwise authorized by the Engineer, shall be of the revolving drum type, watertight, and so constructed that the concrete can be conveyed and discharged into the pumps at site maintaining the uniform distribution of materials throughout the mass.

The maximum size of batch in truck mixers shall not exceed the maximum rated capacity of the mixer as stated by the manufacturer and stamped in metal on the mixer.

Each and every delivery to site shall be accompanied with a computer printout indicating the following:

- Admixtures and their quantities added.
- Quantity of Concrete.
- Actual batched weights of cement, aggregates, water.
- With a computer printout indicating the following:
- Date and time of charging the truck from the batching plant.

Concrete shall be discharged and placed in its final position in the form within thirty (30) minutes after water is first added to the mix.

However, this time of 30 minutes may be increased with the use of approved retarders at the discretion and approval of the Engineer, depending on the necessity and circumstances.

0129. Transporting Concrete

Concrete, after being discharged from the mixer, shall be transported as rapidly as possible to its final position in the works by means that shall be approved by the Engineer, and which shall prevent adulteration, segregation, loss or contamination of the ingredients.

The concrete shall be placed and compacted in its final position within 30 minutes of the water being added to the mix. However, this time of 30 minutes may be increased with the use of approved retarders at the discretion and approval of the Engineer, depending on the necessity and circumstances. On no account shall additional water be added nor further mixing be permitted.

The containers that convey the concrete shall at all times be kept clean and free from hardened or partially hardened concrete.

The use of chutes, spouts or piped pumping shall be permitted only with the written approval of the Engineer.

If the Contractor proposes the use of piped pumping for the transporting and placing of concrete, he shall submit a method statement indicating full details of the equipment and operating system he proposes to use for the approval of the Engineer. On approval the Contractor shall ensure that shocks shall not be transferred from the pipeline to the formwork, previously laid concrete and the structure.

The initial discharge of any pumped concrete shall be discarded and not be incorporated in the permanent works.

When concrete is conveyed by chuting or pipes, the size and design of the plant and pipes shall be so selected to ensure continuous flow in the chute or pipe. The slope of the chute or the pressure of the pump shall allow the concrete to flow without the use of any water additional to that approved by the Engineer to produce the required consistency and without causing segregation of the ingredients. The delivery end of the chute or pipe shall be as close as possible to the point of deposit.

The chute or pipe shall be thoroughly flushed with water before and after each working period and kept clean. The water used for this purpose shall be discharged outside and away from any permanent works.

0130. Plant Mix

Mixing at a central plant shall conform to the applicable requirements of the Standard Specification for Ready-Mixed Concrete of ASTM: C-94 and this Specification.

The Concrete shall be mixed in a fully automatic computerized batching plant. The mixing machines (scales/meters, etc.) shall be tested and calibrated for their accuracy by a specialist at regular intervals of at least three months or such periods as approved by the Engineer. These test certificates shall be submitted to the Engineer for his perusal/approval before the commencement of works and after each test.

The accuracy of the measuring equipment shall be within 3 %. The measuring equipment shall be maintained in a clean, serviceable condition.

Mixers shall be tested in accordance with BS 3963:1974 (1980). The quantities of all the materials for concrete shall be charged to the drum by weight while the drum is revolving and shall be mixed in its dry state for not less than 1 minute before water is added from the metered system.

The weights of fine and coarse aggregates shall be adjusted to allow for any free water contained in them. Accordingly the amount of water to be added shall be reduced by this amount of free water contained in the aggregates. The method of determining the free water content shall be approved by the Engineer immediately before mixing begins each day and further during the day as the Engineer desires.

Mixing shall continue until uniform distribution of materials and uniformity of consistency and colour is obtained. The mixing shall be continued for at least 1 1/2 minutes after adding water.

Admixtures that have been approved as part of the design mix shall be added by approved automatic dosing equipment capable of feeding fixed quantities into the mixing water before the water is charged into the mixer.

The Contractor shall ensure that the materials used for each batch in the mixer do not exceed the manufacturer's rated capacity for the machine. The machine shall be kept clean, free from any residual material after depositing each batch of concrete and the mixer drum shall be washed and cleaned out immediately following the completion of each concreting operation or when changing to a mix using a different type of cement.

Site mixed concrete shall not be used without the specific written permission of the Engineer. No hand mixing of concrete shall be permitted. However the ready mix supplier may erect a batching plant on site to the approval of the Engineer.

0131. Retempering

The Concrete shall be mixed only in such quantities as are required for immediate use and any concrete which has developed initial setting shall not be used. Concrete which has partially hardened shall not be retempered or remixed.

0132. Inspection

Concrete shall only be placed after the Engineer has examined and approved the positioning, fixing and condition of the reinforcement and any other items to be embedded, and the cleanliness, alignment and suitability of the containing surfaces.

0133. Placing of Concrete

The concrete shall be placed in the position and sequences shown on the drawings and then deposited as near as possible to its final position in such a manner as to avoid segregation of the concrete, or displacement of the reinforcement or formwork. It shall be further deposited in regular courses or layers not exceeding 300 mm thickness and mechanically compacted, unless otherwise directed by the Engineer.

The Contractor shall so organize his work that the placing of concrete is efficient and continuous between specified or approved construction joints. When vertical lifts of concrete are interrupted or delayed for more than 20 minutes, the surface of the unfinished concrete shall be thoroughly cleaned and washed with cement grout immediately before fresh concrete is added. The first layer of new concrete placed shall not exceed 150 mm in depth and particular care shall be taken with compaction of this layer to ensure a good bond. With vertical sections the unfinished concrete shall be finished off with a clean surface and left for 24 hours to set before any further concrete is placed. The surface shall then be thoroughly cleaned of all loose and foreign matter and laitance which may necessitate the temporary removal of the formwork before placing the remaining concrete.

Concrete shall not be allowed to drop freely for more than 1.5 m. 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.

Laying of thin sections (such as floor slabs) in two courses shall not be permitted except where specified or ordered by the Engineer.

Reinforced concrete must not be placed directly upon the ground. Where blinding concrete is used as a base it shall be of grade specified on drawing S00 laid over the ground to provide a clean working surface.

Extreme care shall be taken by the Contractor while placing/compacting concrete in the vicinity of waterstops and ensure that:

- No air pocket/honey combing are included/formed.
- The correct alignment of the water stop is maintained without any wrinkles/twisting.
- Specified concrete cover to reinforcement is maintained around the waterstops.

Great care shall be taken to prevent sand or other foreign matter from being introduced into the concrete from the workmen's boots or any other source. Structural concreting against open excavations as a back shutter will not be permitted unless approved by the Engineer.

0134. Construction Joints

All construction joints either shown on the drawings or proposed by the Contractor shall be clearly detailed on shop drawings and submitted to the Engineer for prior approval before commencing work. However approval accorded by the Engineer shall not relieve the Contractor of any of his obligations under the contract.

When construction joints necessitate the provision of water bars the same shall be indicated by the Engineer on the drawings submitted by the Contractor who shall provide and install the same at no extra cost to the project in accordance with the manufacturer's instructions.

Beams, girders, haunches, drop panels and capitals shall be placed monolithically as part of the slab system, unless otherwise shown in design drawings or specification. No construction joints shall be permitted in respect of the above.

Vertical joints shall be formed by means of rigid stopends, and all horizontal joints shall be level.

The surfaces of all joints shall be thoroughly roughened, cleaned of all loose and foreign matter and laitance, and washed with water. Just before concreting is resumed, the joint shall be treated with either a thin layer of neat cement grout or a sand and cement grout mixed in the same proportions as the sand and cement in the concrete. This grout shall be worked well into the surface of the concrete. When indicated on drawings the surfaces of joints shall be treated with an approved epoxy bonding agent to the extents shown therein. The bonding agent shall be applied as recommended by the manufacturer.

0135. Water Stops

Water stops shall be of polyvinyl chloride (PVC) and shall be of sizes shown on the Drawings from a manufacturer approved by the Engineer. Water stops shall be produced from virgin PVC base resin and shall not contain any reclaimed material whatsoever.

Care shall be taken to correctly position and secure water stops in position during installation and concreting. The manufacturer's recommended securing devices shall be used.

The center line of the water stop should coincide with the joint line. Splices in the continuity, and at ends shall be heat sealed as recommended by the manufacturer. The handling, storage and installation of the water stops shall be carried out strictly in accordance with the manufacturer's instructions and to the satisfaction of the Engineer.

Submit detailed shop drawings along with samples of the product, manufacturers product catalogues and certificates for the approval of the Engineer.

Extreme care shall be taken by the contractor while placing/ compacting concrete in the vicinity of waterstops to ensure the following:

- No air pocket/honey combing are included/formed.
- The correct alignment of the water stop is maintained without any wrinkles/twisting.
- No damage is caused to the water stops.
- Specified concrete cover to reinforcement is maintained around the waterstops.

0136. Compaction and Vibration

Full compaction of the concrete shall be achieved throughout the entire depth of the layer and generally vibrators shall be used to achieve this. The concrete shall be thoroughly worked against the formwork and around the reinforcement and successive layers shall be thoroughly worked together. Air bubbles formed during mixing shall be expelled as far as practical and particular care shall be taken where sloping formwork is used.

Unless otherwise directed by the Engineer, approved power driven vibrators shall be inserted at such distances apart or applied in such a manner as will ensure that the concrete is

satisfactorily and uniformly compacted. Immersion vibrators shall penetrate the full depth of the layer and when the underlying layer is of fresh concrete shall enter and re-vibrate the layer to ensure the successive layers are knitted together. Over vibration (causing segregation, surface laitance or leakage through the formwork) shall be avoided. Immersion vibrators shall be withdrawn slowly and vertically to prevent the formation of voids. Vibrators shall not be used to work the concrete along the forms, or in such a way as to damage formwork, other parts of the works, or displace the reinforcement. External vibrators shall not be used except with the approval of the Engineer.

0137. Protection and Curing of Concrete

Concrete shall be protected from wind, rain, running water and drying effects of wind, sun and high temperature. The exposed concrete surface shall be protected as follows:-

Immediately after finishing, polythene sheeting shall be placed on all concrete surfaces. After the initial set has taken place, the polythene sheet shall be replaced immediately by wet hessian covered by polythene sheets and shall be kept moist for a minimum period of 10 days from the date of placing.

Continuous wetting or spraying with a self destructive approved curing membrane shall be used on surfaces where it is not possible to cover with wet hessian and polythene sheets such as soffits of slabs and the like, immediately after striking the formwork. The forms must be continuously wetted during the curing period to reduce evaporation effects through the formwork and keep the temperature of the concrete down by the evaporation process.

0138. Concrete in Hot Weather

Throughout the summer months and during hot weather suitable means shall be provided to ensure that the temperature of the concrete when deposited does not exceed 32 degrees C and the ambient temperature is not greater than 39 degree C. Aggregate stockpiles shall be shielded from direct sunshine and sprayed with fresh water, especially when evaporation rates are high, due allowance being made for the extra water in the concrete mix design. Mixing water shall be refrigerated, or have flake ice added and cement shall be stored in white coloured insulated silos or sheds. The Contractor shall erect all necessary shades over and around the concrete being poured to prevent the sun's rays from coming into direct contact with the surface of the concrete or the formwork for a period of at least seven days from the time of pouring the concrete.

The means of shading shall be by the use of hessian, interwoven palms, grass mats or the like, suspended on a suitable framework approved by the Engineer. A suitable air gap shall be maintained between the undersides of the shades and the surface of the concrete.

Concrete placing shall be completed as quickly and efficiently as possible to reduce transit time. Curing of exposed concrete surfaces shall be immediately carried out as specified herein.

0139. Damaged Work

Should any concrete be damaged through neglect in taking the foregoing precautions, or for any other negligence on the part of the Contractor the Engineer may, at his discretion, require the damaged work to be removed and reinstated by the Contractor at his own expense.

0140. Underwater Concreting

Concreting under water will not be permitted unless called for in a particular specification or agreed by the Engineer.

0141. Reinforcement

Steel for reinforcement shall be as shown on the Drawings and shall comply with ASTM A 615 for round bars and deformed high yield bars, and ASTM A 496 for deformed steel wires. All reinforcing steel shall be grit blasted to near white finish of Sa 2 1/2 standard to be free from loose mill scale or rust, oil, grease and other harmful matter immediately before inclusion in this works and shall remain within the limits of over and under weight allowed in the relevant ASTM standards.

The reinforcement steel shall be maintained in the same conditions till the time of placement of concrete. If the steel does develop any rust or declaration due to delay in placement of concrete it shall be grit blasted again or cleaned as directed by the Engineer.

The Contractor shall produce the relevant test certificates from the Mill producing the reinforcement steel for the approval of the Engineer before placing orders to establish the source.

Tests shall be carried out on reinforcement bars delivered to the job site in an independent laboratory approved by the Engineer for compliance with the requirements of the above mentioned Standards. At least 2 samples of each size and type shall be taken as directed by the Engineer and tested.

The Contractor shall provide, in addition, copies of the manufacturer's certificates of test results relating to the steel reinforcement for each consignment brought to site.

The above procedure shall be followed for each and every batch of reinforcement steel ordered and supplied to site.

0142. Storage of Reinforcement

All reinforcement bars or fabric reinforcement shall be stored under cover on timber over concrete or steel crib supports suitably spaced and of sufficient height to keep the steel at least 1 m above the ground. All steel shall be protected from all aggressive elements to the approval of the Engineer.

The reinforcing steel shall be neatly stored, separated in sizes and clearly marked with its diameter or size.

0143. Bending of Reinforcement

The Contractor shall submit detailed bar bending schedules for the approval of the Engineer.

All reinforcing steel shall be bent accurately to the dimensions and curves shown on the Drawings. All bending shall be to the requirements of BS 4466:1989 be completed before positioning the steel in the Works, and normally no heating or welding shall be allowed.

0144. Placing and Fixing Reinforcement

The reinforcement bars, ties, links, stirrups and all other reinforcing members shall be positioned as shown in the Drawings. Corner bars in columns and beams shall be cranked for the entire length of the lap so that the minimum cover requirements are achieved and the true alignment of the reinforcement is maintained. The concrete cover to the reinforcement shall be as specified on the Drawings.

Binding of reinforcement bars shall be done using soft steel binding wire which shall be, approved soft steel wire of 1.5 mm dia. (16 gauge). Purpose made approved, plastic chairs of suitable sizes to hold the reinforcement in position and plastic spacers appropriate to provide the desired concrete cover shall be used.

0145. Fabric Reinforcement

Fabric reinforcement shall be of an approved type complying with the requirements of ASTM A 184 - "Fabricated deformed steel bar mats" and the weights and dimensions shown on the Drawings and shall be supplied in flat sheets. Rolls of fabric reinforcement will not be accepted.

Fabric reinforcement shall be bent accurately to the required shapes before the fabric is laid in position. All bending and cutting shall be done cold and no heating or welding shall be allowed.

All fabric shall be lapped for a minimum length of 300 mm unless otherwise stated on the drawings and tied together on both the longitudinal and transverse directions, and all lapping shall be sufficient for the steel to develop its full strength.

0146. Welding of Reinforcement

In special circumstances where shown on the Drawings, or instructed by the Engineer, mild steel reinforcement may be welded together, and the welds tested if so desired by the Engineer. High tensile steel shall on no account be joined in this way.

0147. Concrete Cover to Reinforcing Steel

Cover to reinforcement shall generally be in accordance with the relevant British Standards, or as shown on the Drawings.

0148. Formwork Construction

Forms shall be of such quality and strength that throughout the placing, compaction, vibration and setting of the concrete the designed and constructed formwork maintains rigidity, position and level within the allowable tolerances shown below from the levels and dimensions on the Drawings. If timber forms are used they shall be of sound, well seasoned timber and free from all loose knots.

<u>Type of Structure</u>	<u>Tolerance</u>
Buried or unexposed concrete	+ 13 mm (+ 1/2")
Exposed concrete	+ 6 mm (+ 1/4")
Floor slabs and paved areas	+ 3 mm (+ 1/8")

All joints shall be sufficiently tight to prevent leakage of grout. If movement or deflection of formwork or loss of grout occurs, and if the Engineer so directs, the Contractor shall cut out and replace the concrete supported by such formwork at his own expense.

For all faces that will be exposed to view or to liquids, formwork shall be constructed and faced with plywood or other approved material so that the inside surfaces are smooth, true and free from all irregularities.

For all other faces of concrete except against existing structures rough formwork may be used, which may be plain sawn timbers, or blockwork.

The inside surfaces of all formwork shall be cleaned and coated with the appropriate grade of BP Energol mould oil. Care shall be taken to prevent the reinforcement from being contaminated.

Where it is required to use internal ties and spacers, their type, spacing and use shall be to the approval of the Engineer. In no circumstances shall these ties and spacers protrude out of the finished concrete. All ties and spacers must be cut back into the structural concrete and the surfaces made good to satisfy the requirements of the minimum concrete cover to the steel.

Concrete shall not be placed until the relevant formwork has been inspected and approved by the Engineer though this shall not relieve the Contractor from the requirements as to soundness, finish and accuracy specified.

A period of not less than 24 hours notice shall be given to the Engineer to allow for the examination and approval of the formwork and reinforcement prior to placing concrete.

0149. Removal of Formwork

Removal of formwork shall comply with BS 8110, Part 1, 1985 unless otherwise specified.

Forms shall be removed in such a manner as will not damage the concrete. No forms shall be removed until the concrete has gained sufficient strength to support itself. Centers and props may be removed when the member being supported has gained sufficient strength to carry itself, and the load to be supported on it, with a reasonable factor of safety. The

following table is a guide to the minimum periods which must elapse between the completion of the concreting operations and the removal of formwork. Notwithstanding this table, no prop or formwork shall be removed without the approval of the Engineer and such approval shall not relieve the Contractor of his responsibilities for the safety of the structure.

- | | |
|--|----------|
| - Vertical sides of beams, walls, upstands and columns | 18 hrs. |
| - Soffits of slabs and concealed beams with props left undisturbed (removing and refixing of props not permitted). | 5 days. |
| - Soffits of drop beams, inverted beams and props left undisturbed below slabs and soffits of concealed beams. | 14 days. |
| - Props of cantilever beams and slabs. | 28 days. |

Any proposal of the Contractor to strike the formwork earlier than the specified periods if submitted along with a detailed analysis of concrete strength at which the formwork or props may be struck, to prove that the deflection and bending stresses are within the allowable limits, shall be reviewed by the Engineer. The decision of the Engineer after their review shall be final and binding on the Contractor and no claim for any additional cost or time shall be entertained in this regard.

While concreting upper slabs, beams etc. at least the lower two floors immediately below shall be adequately supported by props to the satisfaction of the Engineer.

After removal of formwork no remedial works shall be attempted until the work has been inspected by the Engineer. If, in his opinion, any defect cannot be made good satisfactorily he may direct the Contractor to replace such work at the Contractor's expense.

Curing shall commence immediately on removal of formwork, as specified under "Protection and curing of Concrete" in this specification.

0150. Chamfers

All exposed external angles of concrete shall have 25 x 25 mm chamfers and the formwork construction shall allow for that.

0151. Protection of Concrete Substructure

0151A. General

All reinforced concrete substructures shall be protected from aggressive actions of soil, ground water and all detrimental influences due to soil quality at the site.

Substructures, ie. foundations and basements, short columns, walls, etc., which are in contact with soil shall be protected by two coats of cement based waterproofing coating similar to Thoroseal of Thoro System Products of Belgium or equal and approved, as detailed on drawings. Likewise blinding surfaces that are in direct contact with the substructure elements indicated above shall also be applied with two coats of the waterproofing coating.

0152. Protection of Ground Slab, Ramps, Steps, etc.

Ground slabs, ramps, steps, and the like which are in contact with soil shall be protected by an approved polythene sheet of 1000 gauge (0.254 mm) thickness laid on blinding concrete as detailed on the drawings or as directed by the Engineer. The continuity of the sheet shall be maintained by minimum laps of 100 mm secured by approved adhesive or tape where necessary and/or as directed by the Engineer. Polythene sheet shall be as specified elsewhere in this section.

0153. Polyethylene Sheet

Polyethylene sheets shall be provided to areas as indicated on the drawings either in transparent or black colour to gauges shown therein. Polyethylene sheets shall be manufactured from 100% prime first grade quality resins to BS 6515:1984. Materials manufactured from recycled, off spec. or waste materials shall not be accepted. The polyethylene sheet shall exhibit all the characteristics of BS 6515:1984 and the Contractor shall produce necessary test certificates to the Engineer to prove the same. Overlaps shall not be less than 100 mm and shall be sealed together using an approved adhesive or tape. The material shall be supplied, stored and installed in accordance with the manufacturers written instructions.

0154. Dry Shake Floor Hardner

Dry shake floor hardner shall be a ready to use blend of non-metallic synthetic mineral aggregate, cement, and special additives produced in a factory under quality controlled environment. The product shall exhibit the following characteristics:

- Hardness : Min 7 on the Mohs scale
- Compressive strength : 70 N/mm² : BS 6319: part 2: 1983
- Abrasion Resistance : 82 % more than controlled concrete grade 30.
- Chemical Resistance : Shall resist oils, mild acids, salt solutions 10%, when cured with a sealing coat.

The rate of application and the method of application shall be strictly in accordance with the manufacturer's instructions. However generally, the following procedure shall be adopted:

Application of the dry shake floor hardner shall begin when the base concrete has hardened enough to a point when light foot traffic leaves an imprint of 3 mm and any bleed water has evaporated.

A raised trestle spanning the slab or appropriate bay widths shall be used. The application shall be carried out in two stages.

Stage 1 - 2/3 of the total required material shall be broadcasted evenly by hand onto the concrete surface.

When the material becomes uniformly dark by the absorption of moisture from the concrete, this first application shall be floated with a wooden float.

Stage 2 - Immediately after floating, the first application, apply the balance of material evenly as in the first application. The surface will be floated again with a wooden float after the surface has obtained a darker hue.

When the surface is sufficiently firm enough to take the weight of foot traffic the surface shall be finished by means of a power float to produce a smooth slip resistance surface. Care should be exercised to ensure that the surface is not over worked.

The surface shall be adequately protected during further construction and shall be coated with a sealer coat as detailed in Section 10, Internal and External Finishes.

0155. Concrete Floating Slab/Sound Isolation Slab

General: Concrete floating slab/Sound isolation slab shall be installed as part of the complete sound and vibration isolation system as detailed and scheduled on the drawings and/or as specified herein.

The floating slab shall be from an approved manufacturer with a proven record of at least 5 years of successful installation of similar development.

The Contractor shall prepare and submit shop drawings along with complete technical literature/ catalogue for the system and design calculations substantiating that the required noise and vibration levels are met with for each of the situations. Samples of the products shall also be submitted for the approval of the Engineer.

Materials: All sound isolation materials specified herein shall be provided by a single manufacturer to assure single responsibility for the proper performance of the isolation system.

The floating floor system shall consist of a proprietary roll-down system of load bearing, high density, molded, pre-compressed, drawn fiber glass isolation pads, individually coated with a flexible elastomeric membrane and bonded into a grid matrix of die cut panels in low density fiber glass foil backed material. Isolation pads shall not be less than 50 mm thick and shall be of flame annealed glass fibers with nominal fiber diameters not exceeding 0.00027 inch and shall have been stabilized by pre-compression and satisfactorily passed dynamic test for isolation performance. The isolation pads shall be spaced to cater for the dead, live and vibration loads that the slab is supporting.

Reinforced concrete slab shall be cast over the roll-down isolation system to thickness indicated on the drawing or as approved by the Engineer, over a 12 mm thick exterior grade plywood shuttering held together by 100 mm x 50 mm x 22 gauge sheet retention plates and wood screws at suitable intervals, to prevent the movement of individual shuttering boards during concreting. 2 layers of 1000 gauge polythene sheets shall be provided with the 100 mm overlaps and sealed with approved adhesive tape. The joints of the sheets of the 2 layers shall be staggered. The Contractor shall ensure that no water/moisture penetrates to the roll-down system.

Proprietary perimeter isolation boards 19 mm thick, shall be provided for the full height of the floating slab thickness. The exposed surfaces of the vertical isolation board shall be filled and sealed with silicone sealant over appropriate baker rods as recommended by the manufacturer of the roll-down system.

Workmanship: The installation of the floating floor system shall be strictly in accordance with the written installation procedures recommended by the isolation material manufacturer and approved by the Engineer.

End of Section 02

SECTION 03

CONCRETE BLOCKWORK

PART 1 - GENERAL

0101 DESCRIPTION

- A. Work included: These specifications cover the supply of materials, manufacture and workmanship of concrete blocks intended to be used for the construction of blockwalling partition facings, claustras, etc..... required for the project in accordance with the Drawings, Bills of Quantities and as directed in writing by the Engineer.
- B. Related work: Documents affecting work of this Section include, but are not necessarily limited to, General Conditions, Supplementary Conditions, and Sections in Division I of these Specifications.

0102 QUALITY ASSURANCE

- A. Codes and standards:
 - 1. B.S. 890 Practice 121, part 1: 1973 latest revision.
 - 2. ASTM C67, Method for sampling and testing bricks.
 - 3. B.S.1257, Methods of testing clay building blocks.
 - 4. B.S.5628
 - 5. B.S.5390
 - 6. B.S. 1243 Latest edition
 - 7. ASTM Designation C150
 - 8. ASTM Designation C91
 - 9. BS 12
 - 10. ASTM C207, "Specification for Portland Cement", Type II
 - 11. ASIM C33, "Specification for Concrete Aggregate".
 - 12. ASIM C207, "Specification for Mydrated Lime for Masonry Purposes.
- B. Use adequate numbers of skilled workmen who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the work of this Section.

0103 PRODUCT HANDLING

All cement, sand, lime shall be stored on the site in such a manner that it will be protected against adverse weather conditions. All mortar ingredients shall be shaded from direct sunlight at least 24 hours prior to use in order that such ingredients are not excessively hot when the mortar is mixed.

PART 2 - PRODUCTS

0104 MATERIALS

- A. Cement: Cement for hollow blocks and mortar shall be fresh Portland cement ASTM Designation C150 and conforming to American Society for Testing Materials Standard Specification ASIMC 150, and white cement ASTM Designation C91 and BS 12.
- B. Aggregates: Aggregates for solid and hollow concrete blocks and mortar shall conform to the requirements for fine aggregates in the CONCRETE Section.
- C. Water: Water to be used in blockwork shall conform to the requirements specified for water in the CONCRETE Section.
- D. Lime:
 - 1. Lime shall be non-hydraulic lime complying in all respects with B.S. 890 and shall be prepared in accordance with the appropriate requirements of British Standard Code of Practice 121 : part 1:1973, latest revision.
 - 2. The Contractor must satisfy himself by analysis or otherwise that the ground lime is not adulterated or air-slaked.
 - 3. Factory-produced, dry, hydrated, non-hydraulic or semihydraulic lime, ready for use, shall be mixed with sand and made into coarse mix or be soaked to putty by mixing with water and allowing to stand not less than sixteen hours before use.
 - 4. The lump or ground non-hydraulic or quick-lime shall be slaked, run to putty and matured for not less than two weeks.

0105 CONCRETE BLOCKS

- A. Aggregate shall be so sized, graded, proportioned and thoroughly mixed in a batch mixer with such proportions of cement and water as to produce homogeneous concrete mixture. However, in no case shall the proportion of cement in the mixture be less than five (5) standard bags (each weighing 50kgs) per cubic meter of concrete.
- B. Blocks shall be manufactured from the highest quality Portland cement and aggregate that is locally available . Sources of cement and aggregate shall be approved by the Engineer prior to manufacturing any block.
- C. Precast concrete blocks shall be manufactured in approved vibrated machines. If for any reason the strength requirement is not achieved, the cement shall be increased at the Contractor's own expense. The water used in the mix shall be clean and of a sufficient quantity to allow complete hydration of the cement without providing an excess when moulding.

- D. Units shall be reasonably uniform in compressive strength and in all dimensions, and shall be straight and free from cracks, spalls and other defects. Any blocks which show visible defects will be rejected by the Engineer and any lots of blocks failing compressive tests will be rejected by the Engineer.
- E. Concrete blocks shall be obtained from an approved local factory. If manufactured on site, the blocks shall be press moulded in approved moulds and vibrating pressure machines with a minimum of 2800 cycles per minute.
- F. Blocks shall be cured in the shade by being kept thoroughly moist with water applied by sprinklers or other approved means for a period of at least seven days. The blocks shall be stocked on a clean and level platform free from earth or other impurities during the curing process, and shall be stocked in honey-comb fashion after curing. The blocks shall not be used prior to one month after the date of manufacture, nor shall any block be used that have not been inspected and approved by the Engineer.
- G. Concrete blocks shall be of the following dimensions :-

Height = 200mm + OR - 1% Tolerance

Length = 400mm + OR - 1% DO

Width = As required + OR - 1% DO

The nominal width of blocks shall be as indicated on the Drawings and as directed in writing by the Engineer.

- H. Hollow concrete blocks shall comply with the following requirements:
1. Density of hollow concrete blocks shall not be less than 1500kg/m³ but shall not exceed 2160kg/m³.
 2. Compressive Strength at Twenty Eight Days.
Over Cross-Sectional Area:
 - a. Load-Bearing Walls:
60kgs/cm² average of 12 blocks.
50kgs/cm² minimum for any block.
 - b. Non-Load- Bearing Walls:
30kgs/cm² average of 12 blocks.
25kgs/cm² minimum for any block.
Water Absorption 20% or less of dry weight.
 - I. Blocks shall be hollow, with two air cells. The cross sectional area of the voids in hollow blocks shall not exceed 40% of the total cross - sectional area. Provide solid blocks where indicated or required.
 - J. The design of the cavities and webs of the hollow concrete blocks shall be submitted to the Engineer prior to manufacture. The thickness of the face shell and of the membrane of solid portions shall be nowhere less than 40mm. The combined thickness of the solid portions shall be not less than one fourth (1/4) of the width and length of the block respectively.

0106 MORTAR

- A. Mortar shall be prepared in the following proportions with the addition of the minimum quantity of clean water for workability:

Cement and sand mortar (1:3) mix, shall be composed of one part cement to three parts of sand by volume.

- B. Mortar shall be consist of 350 kgs of cement per cubic metre of sand with an addition of 10% of hydrated lime (by weight of cement).
- C. Hydrated lime up to one quarter by volume of the dry cement may be added for bedding blocks, upon the approval of the Engineer , to improve workability without appreciably reducing the strength.
- D. Sand shall be clean , sharp sand which is coarse , well graded and free from site, clay, salts and other impurities , sand shall conform to ASIM C33, Specification for Concrete Aggregate.
- E. The ingredients for cement and sand shall be measured in proper clean gauge boxes and the mixing shall be carried out by means of an approved mechanical batch mixer, and mixed for at least 1 1/2 minutes.
- F. Water shall be clean clear fresh water from a source approved by the Engineer.
- G. In the case of cement-lime mortar, the sand and lime shall be mixed first and the cement added . It shall be assumed that the lime has not increased the bulk of the sand.
- H. Cement mortars shall be used within thirty minutes after mixing. Hardened mortars shall not be used in the work and shall, upon the request of the Engineer, be immediately removed from the Site.
- I. If hand mixing of mortar is resorted to, the ingredients shall first be mixed dry in a clean watertight box until uniform colour is obtained after which water shall be added in such a quantity as to form a stiff plastic mass.

0107 FIRECLAY REFRACTORY BRICKS FOR CHIMNEY LINING

- A. Fireclay shall be obtained from an approved local manufacturer and shall be made from fireclays containing a high percentage of silica reasonably free from fluxes. They shall have a high insulation and low thermal-expansion properties, especially manufactured for the purpose.
- B. Mortar is to be made with approved fireclay or special powder as recommended by the firebrick manufacturer , mixed and used in accordance with his insturction.

<u>Designation</u>	<u>Average Compressive Strength Kg/cm2</u>	<u>Average Water Absorption by 5 Hr boiling %</u>	<u>Efflorescenece</u>
Solid clay bricks Gradel	200	17	Nil
Solid clay brick Grade II	100	No limit	Slight

- C. Sampling and testing of bricks for confromity with the physical requirements set out in the above table shall be in accordance with ASTM C67 "Methods for Sampling and Testing Bricks" or BS 1257 " Methods of Testing Clay building Bricks". The Engineer may at any time require additional test to be made.
- D. The manufacturer shall provide evidence that bricks of the quality offered have been in service under conditions of exposure at least for not less than three years in the area and their performance , by inspection has been satisfactory.
- E. The Bricks shall be marked with the following particulars on, or in relation to the Product:
 - 1. The name , trade mark or other indentification of the manufacturers.
 - 2. The strength class of bricks.
 - 3. The work size length, width, height and type.
 - 4. The reference number of B.S. or ASTM.

PART 3 - EXECUTION

0108 GENERAL REQUIREMENTS

- A. The Contractor shall provide all necessary scaffolding which shall be adequate and safe in all respects. Scaffolding shall be maintained during construction and removed from the project site upon completion of the masonry work.
- B. Prior to begining work, the Contractor shall set up sample wall panels of concrete block masonry for approval by the Engineer, Panels shall demonstrate conditions as they will occur in the executed work, all materials being exactly in accordance with contract requirements. Wall panels shall remain in place until masonry work is substantially completed and approved by the Engineer . Wall panels shall be one meter square.

0109 WORKMANSHIP

- A. All block work shall comply in general with the recommendation of BS 5628 and 5390.
- B. All blockwork shall be laid straight and true in strict accordance with the dimensions, thicknesses and heights shown on the drawings and/or as instructed in writing by the Engineer. 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.
- C. All walls and partitions , where shown on the drawings without indicating the type of the block to be used, shall be built in hollow concrete blocks, unless otherwise directed in writing by the Engineer.
- D. The courses on blockwork shall be properly levelled . All joints shall be filled with mortar, the horizontal joints continuous and the vertical joints broken at each course.
- E. The blocks shall be well soaked before being used and built in position as shown on the drawings and the tops of walls left off shall be wetted before work is recommenced. All blocks shall be well buttered with mortar before being laid and all joints shall be thoroughly flushed up as the work proceeds. All joints shall be in uniform manner and shall not exceed 10mm no one portion being raised more than one meter above another at one time, and wall of partition necessarily left at different levels, must be raked back. All prebends, quoins, internal and external angles, etc.. properly bonded together and leveled round. All blockwork shall be plumbed vertically.
- F. The surface of the walls and partitions prepared for plastering , shall have the joints raked out 20mm from the face of the wall to form key for the plaster.
- G. All blockwalls shall be bonded to reinforced concrete columns by means of wall ties, complying in all respects with B.S. 1243 latest edition. The ties shall be minimum 200mm long of which 100mm shall be embedded in the reinforced concrete column and the remainder set into the blockwall at the rate of two ties per meter. Partitions shall be bonded to main wall by toothing at every fourth coursed into main wall to a depth of not less than 100mm.
- H. All walls and partitions shall be properly cured by sprinkling water for a period not less than three days after completion of laying the course.
- I. Walls and partitions terminating against soffits of beams or slabs shall be lightly wedged with metal wedges after mortar in bed joints has attained its initial set, and the joint packed with mortar.
- J. Cut and fit blockwork next to reinforced door, window, jambs and sills, and form chases for the ends of door and window lintels . No blocks shall abut any built- in fixtures e.g...door and window frames, apertures, louvers, etc....
- K. Pigments shall be added to the mortar used for pointing in the right proportions as recommended by the manufacturer.
- L. Once a mix has been established producing an acceptable colour, nothing should be changed. Altering the proportions of the source of the supply of the sand or cement would almost certainly alter the colour of the mortar. The Contractor shall take into consideration that the colour of the mortar changes while it is drying and setting.

- M. All block walls shall be bonded to adjacent reinforced concrete structures by means of galvanized mild steel cramps at every third course, complying in all respects with BS 1243 latest edition. The cramps shall be minimum 200mm long one end bent up and shot fired into the reinforced concrete and the remainder set into the block wall. Partitions shall be bonded to main walls by toothing at every third course to a depth of not less than 100mm.
- N. All walls and partitions shall be properly cured by sprinkling water for a period not less than three (3) days after completion of laying the course.
- O. Walls and partitions terminating against softies of beams or slabs shall be lightly wedged with metal wedges after mortar in bed joints has attained its initial set, and the joint packed with bitumen impregnated building board strips of appropriate thickness (10,12,18mm).
- P. Special block shall be fitted next to the reinforced concrete structure , door and window, jambs and sills, and to form chases for the ends of door and window lintels. No hollow blocks shall abut any built in fixtures , eg. door and window frames, apertures, louvers, etc.. All hollow blocks at jambs of doors and windows shall be filled in with Class B concrete and where shown reinforced. Where blockwork is described as fairfaced, selected hard, sharp, clean blocks shall be used with well-defined arrises and perfectly rectangular shape. Joints shall be finished off with neat flush pointing , taking care to keep mortar from adhering to any part of the face of the block.
- Q. Cut or leave all chases, apertures, etc... as required for fittings, frames, wiring conduits, cables pipes, etc. Cutting of masonry units shall be executed with equipment or other means approved by the Engineer.
- R. 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. Vertical and horizontal joints shall not exceed 1cm in thickness.
- S. Blockwork over lintels shall be reinforced with two layers of expanded metal mesh reinforcement well bedded in mortar and 150mm longer at each end than the lintel concrete. Concrete lintels in walls of any thickness shall extend 20cm on either side of the door or window jambs, as the work proceeds. The walls which are shown on drawings to be left unplastered as directed shall be faced with selected blocks built fair and pointed with a neat flush joints.
- T. All contact surfaces between block layers, shall be completely covered with mortar. When laying blocks avoid pounding of the corners and jambs after units have been set in position, started to set, the mortar shall be removed and replaced. All blockwork shall be laid with cells vertical, except where otherwise directed by the Engineer. The Contractor shall not allow scaffolding or other objects to dump or rub against block walls or partition. Partitions and walls shall extend from floor slab to underside of floor above unless otherwise shown.
- U. The Contractor shall co-ordinate the work with all other trades for the building in of items such as sleeves, piping, anchors, lintels, flashings, clamps, dowels, bearing plasters, fire cabinets, electrical panels, etc. described under other sections of the Specifications. All work thus builtwork. The Contractor shall also be responsible for the co-ordination of the work with other trades which require openings and cutting into masonry work. The responsibility includes all work connected with the patching and making good of all cut masonry work.

End of Section 03

SECTION 04 STONE WORK

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Work Included:
 - 1. Cut limestone cladding for exterior and interior walls.
 - 2. Metal anchors, mortar, and joint pointing.
 - 3. Joint sealant.
- B. Related work:
 - 1. Drawings and general provisions of Contract, including General and Supplementary Conditions, Bills of Quantities and Specification sections, apply to work of this section.
 - 2. Related Sections:
 - a. Testing laboratory services.
 - b. Concrete supporting wall.
 - c. Bedding and pointing mortar.
 - d. Masonry supporting wall.
 - e. Masonry restoration and cleaning.
 - f. Masonry anchors from structural steel framing members.
 - g. Water repellent coating.
 - h. Sealant for joints.
- C. Products furnished under this section: Placement of wall anchors and devices.
- D. Products under this section: Metal fabricated items for building into cut stone.

1.2 QUALITY ASSURANCE

- A. Codes and standards:
 - 1. ASTM A36 - Structural Steel.
 - 2. ASTM A123- Zinc (Hot Galvanized) Coating on Products Fabricated from Rolled, Pressed, and Forged Steel Shapes, Bars, and Strip.
 - 3. ASTM A167- Stainless and Heat - Resisting Chromium - Nickel Steel Plate, Sheet, and Strip.

4. ASTM C270 - Mortar for Unit Masonry.
 5. ASTM C387 - Packages, Dry, Combined Materials for Mortar and Concrete.
 6. ASTM C568 - Limestone Building Stone.
- B. Quality Assurance: All stones for facing shall be selected well in advance of the time required, samples of stone materials and dressing shall be submitted for the Engineer's approval 30 days before delivery of any such material to site.
- C. Qualifications:
1. Stone Suppliers: Company specializing in quarrying cut stone with minimum ten years documented experience.
 2. Installer: Company specializing in performing the work of this section with minimum ten years documented experience.
 3. Design anchors and supports subject to Engineer's approval.
- D. Mockup:
1. Provide mockup of cut stone wall for Engineer's approval.
 2. Construct stone wall mockup, 1.5 m long by 1.5 m wide, including stone anchor accessories, sill and head details corner condition, and any necessary details
 3. Locate where directed by Engineer on site.

1.3 SUBMITTALS

- A. Shop Drawings: Indicate layout, pertinent dimensions, anchorages, reinforcement, head, jamb, and sill opening details, control jointing methods. Include structural calculations for the above for fixing details subject to the approval of the Engineer.
- B. Product Data: Provide data on stone units, mortar products, and metal products, including test reports and results.
- C. Submit samples, illustrating minimum and maximum stone sizes, color range and texture, markings, dressing, and surface finish.
- D. Submit installation methods and field erection or setting drawings.

1.4 PRODUCT HANDLING

- A. All stonework shall be carefully packed for transportation, exercising reasonable precaution against damage in transit, and shall be delivered promptly as ordered and in sequence in which it is to be erected.
- B. Take all necessary precautions to prevent all stonework from chipping, cracking, or other damage, during the unloading, and storage on the site. Damaged stonework will not be allowed to be installed, and should any damage be found in erected work, such work shall be removed immediately and replaced with new work and the Sub-Contractor shall assume all expenses incurred therefrom.
- C. The stone work shall be stored in the building site on planking set entirely clear of the ground and shall be protected by proper means from damage to arise and from contact with anything which would result in the accumulation of dirt, dust, grease or any other staining, discolouring or disfiguring elements. During extended period of storage, cover the cut stone with tarpaulins, non-staining building paper or boards.
- D. During temporary storage on site, at the end of working day, or during rainy weather, cover stone work exposed to weather with non-staining waterproof coverings, securely anchored.
- E. Cements and Limes: Shall be delivered in original sealed containers plainly marked with name and brand of manufacture, and kept dry until use. Cements and limes which are defective or show partial set or caking shall not be used and shall be immediately removed from the premises.
- F. Sand: Shall be stockpiled on platforms or otherwise protected from direct contact with the ground and shall be so stockpiled and handled as to prevent the inclusion of foreign deleterious substances.

1.5 SEQUENCING

- A. Sequence work to coordinate the installation of stone work with installation of adjacent construction.

1.6 RATES

- A. The rates for stonework shall include the cost of supplying stone dressing, building and all mortar used in the building of the stone and backing, etc. Stonework will be measured by square meter for net area on one face, no extras will be paid for reveals, corners, etc.

PART 2 - PRODUCTS

2.1 STONE

- A. Stone facing to walls shall be durable local stone, First Quality Jamae'en Stone of a source to be approved by the Engineer and of quality and standard that meet the Jordanian specifications and standards set for stone.
- B. Stone shall be even grained, free from cracks, seams, holes, shakes, objectionable irregularities of colour, impurities, structural weaknesses and other defects that would tend to increase unduly the deterioration from natural causes.
- C. Stone Facing:
 - 1. General:
 - a. Where Drawings indicate "stone work", it shall be of the thickness, sizes and profiles as shown. All stonework shall be honed and/or polished finish where exposed, unfilled and filled in areas specified hereinafter as selected by the Engineer. Stonework shall be sound, dense and free from defects which may impair its strength and durability. Care must be exercised in selecting panels for proper colour range when matching, to produce an even overall colour range when panels are matched.
 - b. Thresholds shall be furnished the work herein and turned over to the tile setter for installation. Edges shall be beveled to profiles shown with cut-out ends to engage into door frame jambs. Coordinate trades for proper execution of work.
 - 2. Thickness of Stone: For walls the minimum thickness of each stone shall be 5 cm at ends and the greatest thickness of all stones to be 7cm, unless shown otherwise on drawings.
 - 3. Stone Dressing: Surface texture to be dressed Mufajar for all surfaces and Matabah for window jambs, reveals and setbacks, (unless indicated otherwise in the Bill of Quantities). Samples to be prepared by Contractor.

2.2 MORTAR MATERIALS

- A. Cement :
 - 1. Used for setting beds shall be Portland cement non-staining, conforming to current ASTM C-91, Type I.
 - 2. Cement Colouring: Cement used for exposed joints shall be mixed with approved non-fading pigmented colour non-standing as approved by the Engineer.

- B. Sand: Used in cement beds shall be clean, durable bank sand, free from silt, loam, clay, soluble salts and/or vegetable matter, conforming to ASTM C-144 and graded fine to coarse within the following limits 100% passing no. 8 sieve, 90% to 100% passing no. 16 sieve, 60% to 90% passing no. 30 sieve, 25% to 55% passing no. 50 sieve and 0 to 15% passing no. 100 sieve.
- C. Hydrated Lime : Shall be ASTM C-206, Type S or ASTM C-207, Type S.
- D. Water: Shall be clear, clean, fresh and potable suitable for domestic consumption.
- E. Mortar:
 - 1. Shall consist of slaked lime putty or dry hydrated lime and cement and sand mixed first and cement then added:
 - 1 part cement.
 - 2 parts lime or lime putty.
 - 6 parts of fine crushed stone sand.
- F. Admixtures: Plasticisers, subject to Engineer's approval.
- G. Pointing Mortar Color: According to Local Standards. Color as selected and approved by the Engineer.
- H. Setting Mortar: According to Local Standards.
- I. Add mortar color and admixtures in accordance with manufacturer's instructions. Ensure uniformity of mix and coloration.
- J. Do not use anti-freeze compounds to lower the freezing point of mortar.
- K. If water is lost by evaporation, re-temper only within two hours of mixing.
- L. Use mortar within two hours after mixing at temperatures of 26 °C, or two and one half hours at temperatures under 10 °C.

2.3 ACCESSORIES

- A. Anchors, Dowels, and Ties shall be steel, galvanized after fabrication to ASTM A 123, 380 g/m², of sizes and configurations required for support of stone and applicable superimposed loads.
- B. Bolts, Washers and Nuts: Galvanized steel.
- C. Spacers: Inorganic.

- D. Joint Filler: Closed cell foam.
- E. Bond Breaker: Sheet 10 mil (0.25 mm) thick plastic.
- F. Sealant: As specified, color to match stone color.

PART 3 - EXECUTION

3.1 REQUIREMENTS AND WORKMANSHIP

- A. All stone shall be installed, grouted, cleaned, protected and cured in accordance with requirements as specified herein.
- B. All materials shall conform to the requirements of applicable Specifications of the American Society for testing Materials.
- C. Work shall be commenced only after grounds, anchors, plugs, hangers and bucks which are to be in or behind the stone work are installed. All surfaces shall be dry and clean before setting beds are applied.
- D. The stone setter shall co-operate fully with other trades to do all cutting, drilling and fitting to accommodate work of others.
- E. All cutting, drilling including cutouts to receive anchors, etc., shall be done accurately on site.
- F. Cutting at end conditions in the field regarding wall application of panels will be permitted.
- G. Stone Fabrication :
 - 1. Fabrication Tolerances:
 - a. Maximum Variation from thickness : 3 mm.
 - b. Maximum Variation from face size : 2 mm.
 - c. Maximum Variation from flat : 2 mm/m².
 - 2. Fabricate units for uniform coloration with adjacent units and over the full area of the installation.
 - 3. Veining pattern shall be in one direction (longest dimension of stone) except as otherwise shown or directed. Stone shall be selected and cut with consideration to the veining.
 - 4. Form external corners to square joint profile.

5. Slope exposed top surfaces of stone and horizontal sill surfaces for natural wash.
6. Cut drip slot in work projecting more than 13mm over edges. Size slot not less than 10mm wide and 6mm deep, full width of projection.

3.2 EXAMINATION

- A. Thoroughly examine all surfaces to receive work of this section, and notify Engineer in writing of all conditions which would adversely affect this work. Do not commence work in any area where such notice of adverse conditions has been sent to the Engineer until corrective work has been completed or waived.
- B. Starting of work in any area without issuance of such notice should constitute acceptance of conditions in the area by this applicator who shall from that time be responsible for the satisfactory results of his work and any defects occurring thereafter shall be corrected without additional charge to the Owner.
- C. Establish lines, levels, and coursing, protect from disturbance.
- D. Verify that items built-in under other sections are properly located and sized.
- E. Clean stone prior to erection. Do not use wire brushes or implements which will mark or damage exposed surfaces.

3.3 EXECUTION

- A. Stone Facing to Wall:
 1. General: Areas to receive stoneface shall be completed before commencement of any stonework. Stonework for risers and all vertical application shall be same as specified herein for walls.
 2. Scratch Coat:
 - a. Apply one (1) part Portland cement, three (3) parts damp sand, 1/5 part lime by volume. Prior to application saturate masonry evenly, do not leave surface water. Apply to approximately 6 mm (1/4") thick, finish shall be cross scratched ready to float coat.
 - b. Float Coat Mix: One (1) part Portland cement, three (3) parts damp sand, 1/5 part lime by volume. Prior to applying the float coat the scratch coat shall be thoroughly cured. Saturate the scratch coat evenly, do not leave surface water. Provided a plumb, true mortar surface the proper thickness from finished wall line. Total thickness of float coat shall be in accordance to details. Apply float coat over areas no greater than may be covered with tile while the bed remains plastic. While bed is still plastic, set stone as follows.

3. Setting : The float at walls and base shall be applied and rodded to a true and even surface. Trowel or brush a thin layer, 2-3 mm in thickness, of neat Portland cement paste over the back of stone. These areas (float coat and paste) shall be limited to what can be covered with stone before the mortar sets. Stones that exhibit drying along edges shall be soaked and drained. Allow no free moisture to remain on backs of stone when being set.
4. Stone slabs shall be pressed firmly into the float coat bed, tamping with wood blocks to obtain smooth surface. All tile shall be aligned properly with straight closed joints .2 mm wide. All edges of stone shall be buttered with coloured cement before closing joints, wipe off excess immediately with sponge and clear water. Tamping shall be completed within one (1) hour after placing stone. Adjusting stone out of line shall be done within the one (1) hour period.

B. Setting Standing Stonework:

1. Anchoring: Vertical stone facing shall be set with anchors attached to the stones by being hooked and embedded in holes 1.9 cm (3/4") deep in the edges of the piece, parallel to the face and equidistant from front and back faces. The hole shall be filled with mortar mixed in proportions as specified herein before for wall installation. Attachment to the back-up wall shall be done by inserting anchors into previously drilled wedge-shaped holes and filled with same mortar mix.
2. Jointing:
 - a. All joints shall be closed joints, 2 or 6 mm (1/32") wide, edges of stone shall be scuttered with non-staining coloured cement before closing joints, wipe off excess immediately with sponge and clear water. (C. Arrange stone coursing to bond with a consistent joint width of 6 mm.)
 - b. Arrange stone pattern to provide a consistent joint subject to Engineer's approval in accordance to samples or mockups.

C. General:

1. After stonework has thoroughly set, sponge and wash thoroughly. Remove all surface cement and take care not to damage stonework or adjacent materials. Do not use acid or abrasive cleaners. Type of cleaner shall be approved by the Engineer prior to application. Finally, clean all surfaces using soft, dry cloths. Cleaning shall be done with cleaning solution as approved by the Engineer.
2. Protect work after final cleaning and approval of stonework with non-staining heavy kraft paper or other approved coverage until acceptance of the building. The Contractor shall replace torn or worn papers after the stone setter has completed his work.

3. Clean Up: Remove from the site and legally dispose of at the end of each day, all cartons, rubbish and debris resulting from the work of this Section.

3.4 FINAL ACCEPTANCE OF WORK

- A. Upon completion of the work, the Engineer will inspect the work accompanied by the stone setter and General Contractor to point out all stone work in the judgment of the Engineer needing filler including other conditions which are not acceptable for final approval. All such work shall be properly logged as to its location and shall be replaced and/or corrected in satisfactory condition acceptable to the Engineer. All work shall be completed prior to final approval without additional cost to the Owner.

END OF SECTION 04

SECTION 05 TILE WORKS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Work included: Provide ceramic tile where shown on the Drawings, as specified herein, and as needed for a complete and proper installation.
- B. Related work: Drawings and general provisions of Contract, including General and Supplementary Conditions, Bills of Quantities and Specification sections, apply to work of this section.

1.2 QUALITY ASSURANCE

- A. Use adequate numbers of skilled workmen who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the work of this Section.
- B. Provide manufacturer's Master Grade Certificate stating type and location of each tile material in this Section.
- C. All tile shall have a Master Grade Certificate that all tile is of First Quality Standard Grade manufacturer, based on the requirements established under the American National Standards Institute (ANSI C-137), latest edition and revisions, and shall be furnished before proceeding with tile work. The certificate shall be in the approved form, shall certify as to the grade, class, kind and quality of the tile, and shall be signed by both the tile applicator and the tile manufacturer. Adequate information shall be included for identifying corresponding shipping packages.
- D. Method of installation of ceramic tile shall be in strict accordance with manufacturer's recommendations. All tile shall be pre-soaked, installed, grouted, cleaned, protected and cured in accordance with requirements of ANSI Standard Specifications as follows:
 - 1. ANSI 108.2 Conventional Set Ceramic Tile at Floors.
 - 2. ANSI 108.1 Conventional Set Ceramic Tile at Walls.
 - 3. ANSI 108.5 Portland Cement at Floors.
 - 4. ANSI 108.3 Conventional Set Quarry Tile at Floors and Base.
- E. Work shall be commenced only after grounds, anchors, plugs, hangers, bucks, electrical and mechanical work which are to be in or behind tile, are installed. All surfaces shall be dry and clean before setting beds are applied.

- F. The tile applicator shall install all tile using lighting conditions that will represent the proposed lighting required in the areas involved. This requirement will be insisted upon in order to achieve uniformity in laying out tile.
- G. Tile shall be applied at all wall areas where mirrors and surface mounted accessories are to be installed.

1.3 SUBMITTALS

- A. Product data: Within 45 calendar days after the Contractor has received the Owner's Notice to Proceed, submit:
 - 1. Materials list of items proposed to be provided under this Section.
 - 2. Manufacturers' specifications and other data needed to prove compliance with the specified requirements.
 - 3. Samples of each type, class, and color of ceramic tile required, not less than 12t' square, mounted on plywood or hardboard backing, and grouted as specified.
- B. Except when specifically exempted by the Engineer, submit Master Grade Certificates for each shipment of ceramic tile prior to arrival of the shipment as the job site.
- C. Samples: Submit samples of all grout, cement, waterproofing compound and other materials specified herein to the Engineer for selection and approval.
- D. Ceramic Tile: Submit duplicate samples of four tiles mounted on rigid panel board for each requested color range. Samples shall show full range of color variation that can be expected in the finished work. Board shall include grouted joints.

1.4 PRODUCT HANDLING

- A. All materials, insofar as practicable, shall be delivered in the manufacturer's original unopened containers and packages with seals unbroken and labels intact and shall be stored in a dry place. Materials such as limes and cements which are partially caked, the containers for which show water stains, of which are otherwise damaged or unsuitable for use shall be removed from the premises immediately. The containers for tile shall be marked with designations corresponding with the information given on grade certificates.

PART 2 - PRODUCTS

2.1 CERAMIC TILE

- A. General
 - 1. Tile as specified above for floors and walls shall be thoroughly and evenly matured and free from defects which affect appearance or

serviceability. Tile shall be free of fractures and rough spots. Tile shall be less than 1% absorption, stainproof, dentproof and frostproof.

2. Provide ceramic tile and accessories complying with Tile Council of America Specification 137.1, in colors and patterns selected by the Engineer from standard colors and patterns of the approved manufacturers.

B. Ceramic Floor and Wall Tile

1. Ceramic floor tiles shall be non-slip tiles from an approved source, and first quality. Wall tiles shall be white, glazed impervious ceramic tiles from an approved source and as shown on drawings. Include all special shapes such as caps, coves, coved base, corner pieces, etc., required to complete the work according to best trade practice, whether or not such special shapes are specifically called for.
2. Base shall be same finish as wall tile.

2.2 SETTING MATERIALS

- A. Comply with pertinent recommendations contained in the Tile Council of America "Handbook for Ceramic Tile Installation".
- B. Cement: Used for conventional setting beds shall be standard brand of Portland Cement, conforming to current ASTM C-150, Type II.
- C. Cement Setting Bed: For thin-set tile at floors shall be Portland Cement. Sand shall be added to mix in compliance with manufacturer's directions.
- D. Hydrated Lime: Shall be ASTM C-206, Type S.
- E. Sand: Shall be clean, sharp, durable bank sand, free from slit, loam, clay, soluble salts and/or vegetable matter, conforming to ASTM C-144 and graded fine to coarse within the following limits: 100% passing no. 8 sieve, 90% to 100% passing no. 16 sieve, 60% to 90% passing no. 30 sieve, 25% to 66% passing no. 50 sieve, and 0 to 15% passing no. 100 sieve.
- F. Prepared Grout: Portland Cement. Grout for tile at toilet room floors and shall be acid-resistant grout, mixed in strict compliance with manufacturer's directions. Color of grout shall be as selected by Engineer. Job mixing colors will not be permitted.
- G. Water: Shall be clean, fresh and suitable for domestic consumption.
- H. Latex-portland cement mortar:
 1. Provide a commercially prepared mixture of portland cement and special latex additive for use as a bond coat for setting tile.
 2. Comply with ANSI A118.4.

- I. Organic adhesive: Provide a prepared organic material, ready to use with no further addition of liquid or powder, which cures or sets by evaporation. Comply with ANSI A136.1, using type I where exposed to prolonged water presence and using type II at all other locations .
- J. Special tile setting mortars will be considered by the Engineer when complete technical data is submitted in advance.

2.3 GROUT

- A. Comply with pertinent recommendations contained in the Tile Council of America "Handbook for Ceramic Tile Installation" in colors selected by the Engineer from standard colors available from the approved manufacturers.
- B. Commercial Portland cement grout:
 - 1. Provide a commercially prepared mixture of Portland cement and other ingredients producing a water-resistant, dense, uniformly colored material.
 - 2. Secure the Engineer's specific approval of the proposed material prior to use.

2.4 OTHER MATERIALS

- A. Provide other materials, not specifically described but required for a complete and proper installation, as selected by the Contractor subject to the approval of the Engineer.
- B. Sealant: Sealant shall be based on silicone type recommended for tile work as approved by the Engineer. Color shall be "white" or "clear" as selected by the Engineer.

PART 3 - EXECUTION

3.1 PREPARATION OF SURFACES

Thoroughly examine all surfaces to receive work of this Section, and notify Engineer in writing of all conditions which would adversely affect this work. Do not commence work in any area where such notice of adverse conditions has been sent to the Engineer, until corrective work has been completed or waived. Preparation of respective areas shall be in accordance with requirements of the Tile Council of America, Inc.

3.2 CERAMIC TILE FLOOR INSTALLATION

- A. General: Concrete to receive setting beds, shall be completed and waterproofing where applicable shall be properly cured before commencement of floor tile installation.
- B. Setting Bed For Floors: Shall be composed of one-part Portland cement, six-parts damp sand by volume with waterproofed compound, mixed is

accordance with manufacturer's specifications. When mixed with water the mortar mix shall be of such consistency or work-ability as to promote maximum density, determined by stroking the mortar surface with a trowel. When of correct consistency the trowelled surface readily assumes a smoothed, slickened appearance. Screed and tamp setting bed firmly. Setting beds shall be in thickness as shown on the drawings. While the setting bed is still fresh but stiff enough to set tile, set tile as follows.

- C. Setting: The setting bed shall be applied and rodded to a true and even surface. Trowel or brush a thin layer, 8mm (1/32") to 1.6mm (1/15") in thickness, of neat Portland cement paste over the bed and/or the back of tile. A thin layer of dry Portland cement, 8mm (1/32") to 1.6mm (1/16") thick over the setting bed and working lightly with a trowel may be permitted. These area (setting bed and cement paste) shall be limited to what can be covered with tile before the mortar sets. Tile shall be pressed firmly into the bed tamping with wood blocks to obtain smooth surface. All tile shall be aligned properly, straight joints in even widths determined by the spacers on the ceramic tile; and in instances where ceramic tile is not manufactured with spacers, widths shall be 1.6 mm (1/16"). Tamping shall be completed within one (1) hour after placing tile. Adjusting work out of line shall be done within the one (1) hour period.
- D. Pattern: Floor ceramic tile shall be applied in stack pattern. Align floor joints with the joints at walls.
- E. Floor Grouting: Refer to "Grouting" Paragraph specified hereinafter.
- F. Sealant: Refer to "Sealant" paragraphs specified herein.

3.3 CERAMIC TILE WALL INSTALLATION

- A. General: Areas to receive tile shall be completed before commencement of any tile work.
- B. Scratch Coat: Apply one (1) part portland cement, four (4) parts damp sand, 1/5 part lime by volume. prior to application saturate concrete evenly, do not leave surface water. Apply to approximately 6mm (1/4") thick finish shall be cross scratched ready to receive float coat.
- C. Float Coat Mix: One (1) part portland cement, four (4) parts damp sand, 1/5 part lime by volume. Prior to applying the float coat the scratch coat shall be thoroughly cured. Saturate the scratch coat evenly; do not leave surface water. Provide a plumb, true mortar surface the proper thickness from finished wall line. Total thickness of float coat shall be in accordance to details. Apply float coat the bed remains plastic. While bed is still plastic, set tile as follows.
- D. Setting Tile:
 - 1. The float coat at walls and base shall be applied and rodded to a true and even surface. Trowel or brush a thin layer 0.8mm (1/32") to 1.6mm (1.16") in thickness, of neat Portland cement paste over the bed and/or the back of Tile. Where areas (float coat and paste) shall be limited to what

can be covered with tile before the mortar sets. Non-vitreous tile shall soak at least 1/2 hour in clean water and drain off excess water. Each tile must be completely immersed during the soaking period. Remove tile from water and stack on edge sufficiently long edges shall be re-soaked and drained. Allow no free moisture to remain on backs of tile when being set.

2. Tile shall be pressed firmly into the float coat bed, tamping with wood blocks to obtain smooth surface. All tile shall be aligned properly, straight joints in even widths determined by the spacers on the ceramic tile; 9.5mm (1/16") Tamping shall be completed within one (1) hour after placing tile. Adjusting tile out of line shall be done within the one (1) hour period.

3.4 SURFACE CONDITIONS

- A. Examine the areas and conditions under which work of this Section will be performed. Correct conditions detrimental to timely and proper completion of the Work. Do not proceed until unsatisfactory conditions are corrected.

3.5 INSTALLATION

- A. General:
 1. Comply with ANSI A108.1, ANSI A108.2, and the "Handbook for Ceramic Tile Installation" of the Tile Council of America, except as otherwise directed by the Engineer or specified herein.
 2. Maintain minimum temperature limits and installation practices recommended by materials manufacturers.
 3. Do not install tile floors over membrane until the membrane has been tested and accepted.
- B. Limits of tile:
 1. Extend tile into recesses and under equipment and fixtures to form a complete covering without interruptions.
 2. Terminate tile neatly at obstructions, edges, and corners, without disruption of pattern or joint alignment.
- C. Joining pattern:
 1. Walls shall be laid in stack bond.
 2. Lay tile in grid pattern unless otherwise indicated on the Drawings or directed by the Engineer.
 3. Align joints when adjoining tiles on floor, base, trim, and walls are the same size.
 4. Layout tile work, and center the tile fields both directions in each space or on each wall area.

5. Adjust to minimize tile cutting.
 6. Provide uniform joint widths.
- D. Provide expansion and control joints where shown on the Drawings, and where otherwise recommended by the "Handbook for Ceramic Tile Installation" of the Tile Council of America.

3.6 SEALANT APPLICATION

- A. Apply silicone sealant in joints where ceramic tile terminates at floor drains, control and expansion joints and other areas where shown on the Drawings. Co-ordinate with trades affecting these items.
- B. Application of sealant shall conform to applicable requirements set forth under Caulking Section. Requirements therein shall become a part of the work under this Section as though written out in full herein.

3.7 CLEANING AND PROTECTION

- A. Cleaning:
1. After grout has thoroughly set, sponge and wash tile thoroughly and diagonally across joints. Remove all surface cement and take care not to damage tile or adjacent materials. Do not use acid cleaners. Finally, clean all tile using dry cloths.
 2. Upon completion of placing and grouting, clean the work of this Section in accordance with recommendations of the manufacturers of the materials used.
 3. Protect metal surfaces, cast iron, and vitreous items from effects of acid cleaning.
 4. Flush surfaces with clean water before and after cleaning .
- B. Protection: Protect tile after cleaning with non-staining heavy kraft paper or other approved coverage until acceptance of the building. The Contractor shall replace torn or worn papers once tile setter has completed his work.

3.8 CLEAN UP

Remove from the site and legally dispose of at the end of each day, all cartons, rubbish and debris resulting from the work of the Section.

END OF SECTION 05

SECTION 06

GYPSUM BOARD

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Gypsum wall board.
- B. Fire-rated board.
- C. Water-resistant (W/R) backing board.
- D. Joint compound and tape.
- E. Accessories.
- F. Screws.
- G. Sealant.

1.02 RELATED SECTION

- A. Cementitious backer board for ceramic tile is specified in Section 09 30 00 - Tiling.

1.03 MEASUREMENT AND PAYMENT

- A. General: Gypsum drywall construction will not be measured separately for payment but will be paid for as part of the Contract lump sum price for Architectural Work.

1.04 DESCRIPTION

- A. When a fire resistance rating is indicated for a gypsum board assembly, details of construction shall be in accordance with reports of fire tests of assemblies which have met the requirements of the indicated fire rating.
- B. When a sound transmission class (STC) rating is indicated for a gypsum board assembly, details of construction shall be in accordance with reports of acoustical tests of assemblies which have met the requirements of the indicated acoustical rating.
- C. Details of construction not specified herein shall conform to applicable requirements of ASTM C840.

1.05 REFERENCES

- A. American Society for Testing and Materials (ASTM):
 - 1. ASTM C11 Standard Terminology Relating to Gypsum and Related Building Materials and Systems
 - 2. ASTM C36 Specification for Gypsum Wallboard

3. ASTM C475 Specification for Joint Compound and Joint Tape for Finishing Gypsum Board
4. ASTM C630 Specification for Water-Resistant Gypsum Backing Board
5. ASTM C840 Specification for Application and Finishing of Gypsum Board
6. ASTM C954 Specification for Steel Drill Screws for the Application of Gypsum Board or Metal Plaster Bases to Steel Studs From 0.033 in. (0.84 mm) to 0.112 in. (2.84 mm) in Thickness
7. ASTM C1002 Specification for Steel Drill Screws for the Application of Gypsum Board or Metal Plaster Bases
8. ASTM C1047 Specifications for Accessories for Gypsum Wallboard and Gypsum Veneer Base
9. ASTM E497 Standard Practice for Installing Sound-Isolating Lightweight Partitions

1.06 REGULATORY REQUIREMENTS

A. In addition to the foregoing referenced standards, the regulatory requirements which govern the work of this Section include the following governing code:

1. California Code of Regulations (CCR), Title 24, Part 2, California Building Code, Chapters 25 and 25A, "Gypsum Board and Plaster."

1.07 DEFINITIONS

A. Words and terms used in this Section and not defined herein shall be interpreted in accordance with the definitions given in ASTM C11.

1.08 QUALITY ASSURANCE

A. Installation and Finishing: Comply with applicable requirements of the California Building Code, Chapters 25 and 25A, and ASTM C840.

B. Installation of Sound-Retardant Partitions: Comply with applicable requirements of ASTM E497.

1.09 JOBSITE CONDITIONS

A. Maintain room temperature of not less than 40 degrees F during application of gypsum board, and 50 degrees F during application of joint treatment and for 48 hours thereafter. If temporary heat is provided, do not allow the temperature to exceed 95 degrees F.

B. Maintain adequate ventilation in the working area during installation and finishing.

1.10 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials to the site and store them in the work area if possible, so that materials will have a minimum period of 24-hours storage at the same temperature as the installation area.
- B. Store gypsum board in the horizontal position. When necessary to stack palettes, align blocking vertically to avoid distortion of boards.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Board Type and Thickness: Refer to indicated details and notes on the Contract Drawings for type and thickness of board. Where thickness is not indicated, provide 5/8-inch-thick board.
- B. Gypsum Wallboard: ASTM C36, furnished with tapered longitudinal edges and in lengths which will result in a minimum footage of joints.
 - 1. Provide foil-backed gypsum wallboard for interior facing of exterior walls where gypsum wallboard is scheduled for the interior finish and for gypsum wallboard furred over concrete or masonry.
- C. Fire-Rated Board: Provide Type X board for assemblies indicated to have a fire-resistance rating.
- D. Water-Resistant (W/R) Backing Board: ASTM C630, 5/8-inch thick. Provide Type X water-resistant gypsum backing board where water-resistant gypsum board walls and ceilings are indicated to have a fire-resistance rating.
- E. Joint Compound and Tape: ASTM C475, joint tape, taping compound, and finishing compound. All-purposed compound may be substituted for taping compound and finishing compound.
- F. Accessories: ASTM C1047, galvanized steel. Provide metal corner bead for all external corners and angles and metal edge trim at all junctions of gypsum wallboard and walls of other materials and for all exposed edges.
- G. Screws: ASTM C954 or ASTM C1002, as applicable for type of metal framing, of required lengths.
- H. Sealant: Sealant for holes or penetrations in acoustical and damp-service partitions shall conform to applicable requirements of Section 07 90 00 - Joint Protection.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Apply gypsum wallboard in accordance with applicable requirements of ASTM C840.
- B. Before applying gypsum board, verify that corners and framing are plumb, true, and solid. Apply no gypsum board until conduits, boxes, pipes, ducts, vents, supports, fixture frames,

blocking and backing, and the like are in place and inspected, tested, and approved as required. All edges and ends of gypsum board shall have solid bearing.

C. Apply wallboard over metal framing and furring with self-drilling, self-tapping screws installed with an electric screw-gun equipped with adjustable screw depth control. Drive screw heads slightly below the surface of the wallboard, taking care to avoid breaking the paper face or fracturing the gypsum core. Space screws a maximum of 12 inches on center in the field of boards and 8 inches on center staggered along the abutting edges for walls, and 7 inches on center along abutting edges for ceilings. Do not drive screws closer than 3/8 inch from edges and ends.

D. Apply wallboard first to ceilings and then to walls, using maximum practical lengths to minimize end joints. End joints will not be permitted on walls or partitions less than 16 feet in height. Wallboard shall be applied vertically to walls. Joints on opposite sides of the same wall or partition shall occur on different studs. Boards shall be installed in moderate contact, not forced in place.

E. In two-ply gypsum board construction, apply the base ply perpendicular to framing members and the face ply parallel to framing members. Laminate face-ply to base-ply with adhesive or all-purpose compound. Fasten with a sufficient number of screws to hold the board in place until the laminating adhesive or compound has set, but not less than 12-inch spacing on ceilings and 16-inch spacing on walls. Joints in the face ply shall be offset from joints in the base ply by not less than 16 inches.

F. Provide metal corner bead at all vertical and horizontal external corners and angles. Provide metal edge trim at all junctions of gypsum wallboard and walls of other materials or where there are exposed edges.

G. At acoustical or sound walls, penetrations of walls shall have a minimum clearance of 1/4 inch along their perimeters at wallboard, which shall be filled with sealant. Fill all voids completely with sealant. Install wallboard 1/4 inch to 3/8 inch above floor and fill resultant space with sealant. Achieve maximum sound insulation through careful installation work in jointing, sealing, taping, and staggering of joints.

H. Gypsum wallboard surfaces shall have a maximum variation of 1/8 inch in 8 feet when a straightedge is laid on the surface in any direction.

3.02 TAPING AND FINISHING

A. Tape and finish all joints, corners, metal accessories, screw heads, damaged or abraded surfaces, and cutouts for the work of other trades in accordance with ASTM C840 and the drywall materials manufacturer's instructions and recommendations.

B. Joints, wall and ceiling angles, and inside vertical corners shall be reinforced with tape embedded in taping compound and finished with not less than two applications of finishing compound, allowing each application to dry thoroughly and sanding between coats as required. Dimples at screws heads and other imperfections shall be similarly treated.

C. External corners, edges, and ends with metal beads and edge trim shall have the flanges completely spackled and feathered off smooth from the nose.

D. Final application of finishing compound and sanding shall leave gypsum wallboard surfaces uniformly smooth and in proper condition to receive a painted finish.

END OF SECTION 6

SECTION 07

CARPENTRY AND JOINERY

0101. SCOPE

This specification covers Carpentry and Joinery works intended for use in the Works in accordance with the Drawings, and/or Bills of Quantities and as instructed in writing by the Engineer. Carpentry and Joinery works are under Provisional Sums.

0102 MATERIALS

0102A. Timber (Softwood & Hardwood)

Timber shall comply in all respect with BS 7359:1990 for Nomenclature of Commercial Timber, including sources of supply and BS 1186 latest edition, Timber for and Workmanship in Joinery.

Timber shall be of an approved variety and quality suitable for the purpose for which it is to be used and equal to samples 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, splits, ring shakes, soft pith.
- Checks exceeding 300 mm in length.
- Checks exceeding 6 mm in width.
- Checks exceeding one quarter of the thickness of the timber in depth.
- Knots of any description in surfaces for staining or polishing.
- Knots of any description in glazing bars.
- Knots exceeding one half the width of the surface.
- Knots exceeding 20 mm mean in diameter.
- Decayed or dead knots unless cut out and plugged.
- Loose knots or knot holes unless cut out and plugged.
- Pith pocket.
- Decay and insect attack including pinworm holes.

All timber shall be treated with a wood preservative as per "Cuprinol" or approved equal.

In jointed panels each piece shall be of the same species. Joinery for staining or polishing shall have all surfaces of the same species and same character of grain running in the same direction.

All plugs inserted after cutting out defects shall be the full depth of the hole and the grain of the plug shall run in the same direction as the grain of the piece.

Timber connectors where used shall be two single-sided toothed plates (round or square) for demountable joints or one double sided toothed plate (round or square) for permanent joints to conform with B.S. 1579 latest edition.

01602B. Moisture Content of Timber

- The softwood generally shall have a moisture content limit of 12%.
- The hardwood shall have a moisture content limit 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.

0103. Plywood

Plywood shall consist of an odd number of plies arranged so that the grain of each layer is at right angles to the grain of the adjacent layer or layers. The plies shall be hot pressed during adhesion and shall have a finished thickness as shown on the Drawings, or shall be prefinished plywood obtained from an approved supplier.

In the case of plywood having 3 plies the core shall be not more than 60 percent of the total thickness.

In plywood having more than 3 plies the faces and all plies with the grain running in the same direction as the faces shall have a combined thickness of between 40 percent and 65 percent of the total thickness of the plywood.

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

The Contractor will not be allowed to make up thickness by gluing or otherwise fixing together sheets of thinner previously formed plywood.

Plywood adhesives shall comply with BS 1203, Grade 1.

All plywood shall be of Exterior Grade and shall conform to the applicable requirements of BS 6566: Part 1-8, "Plywood" latest edition.

0104. Block Board and Lamin Board

Block board and lamin board shall be external WBP quality resin bonded from an approved manufacturer and guaranteed not to warp or change in size or suffer any kind of deformation. It shall be of timber specified and glued with anti insect synthetic resin waterproof glue all through. All strengthening boards shall be fixed during manufacture.

Blockboard and lamin board shall conform to the requirements of BS 3444:1972 "Blockboard and Lamin board".

Blockboard and Lamin board shall be free from defects as specified under 'Plywood'.

0105. Veneers

Timber for face veneer shall generally be first grade hardwood as indicated on the Drawings and/or in the Schedule of Doors and obtained from an approved supplier.

The minimum thickness of timber face veneers shall be 0.6 mm thick.

The face veneers 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, dots, glue stains, filling and inlay of any kind or other defects.

The face veneers shall be applied to one or both sides of wood panels as shown on the Drawings.

Where veneers are shown to be applied to one face only, the other side shall have a balancing veneer applied to prevent warping.

Adhesives shall comply with the requirements of BS 1203:1991 Synthetic resin adhesives for plywood (Phenolic and aminoplastic) and shall ensure proper adhesion between plies.

0106. Plastic Laminate

The plastic laminate facings shall conform to BS 2572:1990 Phenolic laminated sheet and shall be a minimum 0.9 mm thick.

Colour and pattern shall conform to the sample approved by the Engineer.

Plastic laminate sheets shall be applied with a water proof, heat- resistant adhesive of a type recommended by the plastic laminate manufacturer and applied in accordance with the manufacturer's instructions.

MANUFACTURE AND WORKMANSHIP

0107. General

All Carpenter and Joinery Work shall be accurately set out, framed and executed in accordance with the detailed Drawings.

Joinery work shall be constructed to detailed drawings. Joints shall be made so as to comply with BS 1186, part 2:1988.

Joinery shall be cut and framed at an early stage, but shall not be glued or wedged until the structure is ready to receive it.

Framed work shall be properly mortised and tenoned, wedged, glued and cramped together and doweled where necessary. All external joinery work shall be put together with waterproof glue.

The use of nails for fixing any items of joinery will not be permitted. Sprigs may be used for glazing beads only.

All screws shall be countersunk and pelleted or puttied and all sprigs shall be punched and puttied.

All joinery such as architraves, beads etc.. required to fit against the contour of irregular surfaces shall be accurately scribed to ensure a close connection.

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

0108. Inspection

Facilities shall be given to the Engineer for the inspection of all Joinery works in progress in the shops and on the Site.

0109. Making Good all Defects

Should any shrinkage or warping occur or any other defects appear in the Joinery work before the end of the defects liability period, all defective work shall be taken down and renewed to the entire satisfaction of the Engineer and any work disturbed made good at the Contractor's expense.

End of Section 07

SECTION 08

METAL WORK

0101. Scope

This specification covers ferrous and non-ferrous metal intended to be used in the Works all in accordance with the Drawings and as directed by the Engineer.

MATERIALS

0102. Steel

Steel plates and structural steel shaped sections shall conform to the requirements of BS 4: Part 1: 1993 for Hot-rolled sections, BS 4848: Part 2: 1991 for Hot Finished Hollow Sections and BS 4848: Part 4: 1986 for Equal and Unequal Angles.

0103. Bolts and Nuts

Bolts and nuts shall conform to the requirements of BS 4190:1967 for "ISO metric black hexagon bolts, screws, and nuts."

0104. Washers

Plain washers shall be made of galvanized steel. Taper or other specially shaped washers shall be made of steel or malleable cast iron and shall conform to the requirements of BS 4320:1968 Metal washers for general engineering purposes.

0105. Galvanized Steel Pipes

Galvanized steel pipes shall conform to the requirements of BS 1387:1985 (1990) ISO "Medium Series".

0106. Paint

Paint for Metal Worker shall comply with the applicable requirements as specified under "PAINTING AND DECORATING".

0107. Aluminium

All aluminium elements shall be manufactured of extruded sections of aluminium alloy, to BS 1474:1987 Type HE9 or ISO Al, Mg.Si 6063 or AA 6063 T5 mechanically jointed.

All parts and members shall be of aluminium commercial quality like (A1-Mg-Si) heat-treated, free from defects impairing their strength and durability and containing not more than 0.1% copper.

All exposed surfaces shall be polished to a mirror-like surface, free from defects, and shall be light etched and anodized or polyester powder coated or duranar coated to colours and/or finishes as shown on Drawings and/or as directed in writing by the Engineer.

Aluminium shall be treated to comply with BS 1615:1993 and BS 3987:1991 to provide an anodization not less than 20 microns thickness or polyester powder coated by electrostatic spraying and hard stoved to not less than 60 micron thickness to comply with BS 6496:1984 (1991) or duranar coated to not less than 30 micron thickness as indicated on drawings to comply with AAMA 605.2-90 and BS 4842:1991.

All aluminium sections shall present clear straight and sharply defined lines and shall be free from defects and imperfections that may impair their strength.

All screws, bolts and other necessary accessories shall be of aluminium or stainless steel or other non-corrodible material and shall match in colour and consistency of the finish of the anodization or the polyester powder coating or duranar coating as applicable.

Aluminium elastic glazing beads shall be provided to all windows and doors which are assembled by pressure to fit with the relevant groove in the profile.

The glazing bars shall be threaded or interlaced at points of intersections and machine tenoned to frame.

0108. Stainless Steel

Stainless steel sections, sheets and strips shall be of austenitic non-magnetic steels to BS 3100: 1991 and BS 1449:Part 2:1983: 18/10/3 chromium-nickel-molybdenum group, Grade 316 or Grade 304 as detailed on drawings as applicable and as approved by the Engineer.

MANUFACTURE

0109. General

The Contractor shall be responsible for the correctness and accuracy of the dimensions of the finished articles.

He shall carefully check the dimensions indicated on the Drawing, verify any changes, and ascertain the sizes at Site which will enable him to prepare Final Working Drawings for fabrication and erection purposes. Such Drawings shall be submitted to the Engineer for his verification and approval.

Fabrication Orders can only be placed after the contractor has obtained in writing the approval of the Engineer on the above Drawings.

The steel sections where specified to be factory rustproofed shall be rust-proofed by hot dip galvanizing, metalizing or sheradizing process. The rust-proofing shall be sufficient to withstand the 72 hours salt-spray test as provided for in BS 7479:1991 If the rustproof coating

suffers any damage during the progress of work, the damaged part shall be recoated to a min. of the original thickness to the satisfaction of the Engineer.

0110. Aluminium Windows, Doors, Railings, etc.

Aluminium windows, doors, staircase balustrades, etc.. with all necessary accessories and fitting shall be of the pattern, design, dimensions and thicknesses shown on the Drawings and obtained from an approved manufacturer and shall comply with the following standards:

- American Aluminium Associations (AA)
- American Architectural Aluminium Manufacturer's Association
- American Institute of Steel Construction (AISC)
- American Iron and Steel Institute (AISI)
- American National Standards Institute (ANSI)
- American Society of Testing Materials (ASTM)
- American Federal Specifications (FS)
- American Insulating Glass Certification Council
- American Flat Glass Marketing Association (FGMA)

Air and Water Infiltration:

All aluminium units shall be designed and installed to resist leakage of air and water through the system in accordance with the following:

Air Infiltration:

Air leakage shall not exceed 0.0183 cubic meters per minute per square meter of unit area when tested in accordance with ASTM E 283 at a minimum static air pressure differential of 30 kg. per sq. meter.

Water Penetration:

There shall be no uncontrolled water leakage as defined in AAMA 501, when tested in accordance with ASTM E331 at a minimum differential pressure of 20 percent of inward design wind load but not less than 30 kg. per sq. meter or more than 60 kg. per sq. meter.

Structural Performance:

Design, engineer, fabricate and install the Aluminium works to withstand effects of the following:

- Design Wind Velocity (wind resistance) as defined in British Standard CP3, Chapter V (1972) of 160 kph.
- Design wind pressure shall be calculated based on the above windspeed, height of the buildings, etc., acting inward and outward, normal to the plane of the wall. When tested in accordance with ASTM E330, no material failures or permanent deformation of structural members shall occur.

Thermal Movements:

Shall be capable of withstanding thermal movements resulting from an ambient temperature

differential of 50 degree C, without causing buckling, stresses on glass, failure of sealants, damaging loads on fasteners, or other detrimental effects.

Prints of shop Drawings for aluminium windows, doors, frames, etc., showing the dimensions, sizes, thicknesses, materials, finishes, joinings, attachments, fasteners and the relation to adjoining work, shall be submitted to the Engineer for approval before ordering any material. All work shall be fabricated and erected in accordance with the approved Drawings.

All aluminium windows, doors, frames, etc., shall be factory assembled and reinforced according to the Drawings, complete with hinges, glazing gaskets and anchors. The only Site work allowed on aluminium units is fixing in position and glazing. The finished surfaces shall present a clear surface free from alloy defects, scratches, or other surface blemishes.

All aluminium windows, doors, etc.. shall be provided with all necessary Ironmongery required for its efficient functioning.

0111. Aluminium Louvres

Aluminium louvres shall be from a proprietary manufacturer and shall be to the Engineer's approval. The surface coating shall be as detailed on the drawings and as specified herein to colours approved by the Engineer.

0112. Sand Louvres

Sand louvers shall be manufactured from extruded aluminium sections from 6063-T52 alloy, thickness as recommended by the manufacturer. Total louvre panel thickness shall be as detailed on drawing to match the adjoining details.

The vertical louvre efficiency shall be as specified in the mechanical engineering drawings and specifications. Panels shall be fixed to the outer side of walls or doors with matching sealed architraves. All louvres, frames, visible fixings, etc. shall have the finish as detailed on drawings.

Unless otherwise indicated all louvres, shall be provided with mesh screens in appropriate frames as detailed on drawings.

0113. Cat Ladders

Cat ladders shall be fabricated of mild steel aluminium flats and round bars and anchored/fixed to walls as shown on Drawings and to dimensions indicated therein. Cat ladders shall be galvanized and painted as specified. The Contractor shall be responsible to ensure that the sections and anchoring/fixing are sufficient for carrying a minimum load of 75 kg with a factor of safety of two (2). Shop drawings indicating details of materials, fabrication including any surface treatment required, anchoring/fixing, etc., shall be submitted to the Engineer for approval before fabrication and placing orders. Approval accorded by the Engineer shall not absolve the Contractor from any of his contractual obligations and responsibilities.

0114. Polyester Powder Coating

Aluminium extruded sections, curtain walling units, etc. where indicated on drawings shall be treated and polyester powder coated by electrostatic spraying and hard stoved to not less than 60 micron thickness to comply with BS 6496:1991 to colours shown on drawings and/or to the approval of the Engineer. As far as possible the assembled units as a whole shall be coated to avoid joint heat build-up, scratches, touching up joints, etc. Powder coating shall be carried out under quality controlled conditions in a well established factory fully equipped for such works and shall be subject to the approval of the Engineer.

Warranty: The Coating shall be warranted for a period of 10 years. The contractor shall pass on executed copies of warranty for the above period signed and counter-signed by the Contractor and the applicator against any defects in metal coating and workmanship and shall undertake to remove and replace the damaged work without any extra cost to the Client.

0115. Stainless Steel Rungs

Stainless steel rungs shall be of Grade 304 to sizes indicated on the drawings. Rungs shall be cast into concrete walls by splitting ends to form anchors. The Contractor shall ensure that the rungs are capable of sustaining the load of one man (75 Kg.) with a factor of safety of 2 without bending/working loose.

0116. Aluminium

The Contractor shall furnish and install all aluminium units as indicated on the Drawings. Workmanship and installation shall be in accordance with recommended standards of first class Aluminium Manufacturers.

All aluminium work shall be performed in a shop where the grade of metalwork is of recognized quality acceptable to the Engineer. All items shall be installed plumb, straight, square, level and in proper elevation, plane location and alignment with other work. All work shall be designed for adjustment to field variations, fitted with proper joints and intersections, adequately anchored in place, strictly in accordance with best practice.

Where aluminium surfaces come in contact with metals other than stainless steel, zinc, white bronze or small areas of other metals compatible with aluminium surfaces, they shall be kept from direct contact with such parts by painting the dissimilar metal with a prime coat of zinc chromate primer or other suitable primer, followed by one or two coats of aluminium metal and masonry paint or other suitable protective coating, excluding those containing lead pigments, or a non-absorptive tape or gasket shall be placed between aluminium and dissimilar metals. Steel anchors and connecting members shall be hot dip galvanized or zinc plated after fabrication.

Aluminium surfaces in contact with lime mortar, concrete, plaster or other masonry materials, shall be painted with alkaline- resistant coatings such as heavy-bodied bituminous paint or water- white methacrylate lacquer.

Aluminium in contact with wood or absorptive materials which may become repeatedly wet shall be painted with two coats of aluminium metal and masonry paint or a coat of heavy-bodied bituminous paint. Alternatively paint the wood or other absorptive material with two coats of aluminium house paint and seal joints with a good quality of caulking compound.

Where aluminium is in contact with treated wood, wood shall be treated with pentachlorophenol, 5% minimum concentration or approved equal, followed with the protective measures described for aluminium in contact with wood or other absorptive materials.

The aluminium work shall be designed and anchored so that the work will not be distorted nor the fasteners overstressed from the expansion and contraction of the metal.

Before shipment from factory, aluminium surfaces requiring protection shall be given a coating which will protect the metal during construction. In areas where appearance of the finish on aluminium items is important, a coating of methacrylate type lacquer shall be applied as specified hereinafter.

Apply two sprayed coats of water-white methacrylate lacquer having a total minimum thickness of 0.015 mm, which when applied to the aluminium surface shall be capable of withstanding the action of lime mortar for a period of at least one week in an atmosphere of 100% relative humidity at 40 degree centigrade, the action of 10% (by weight) muriatic acid for a period of six hours at 20 degree centigrade, and the action of atmospheric weathering for a period of 12 months. The coating shall be applied in the manufacturer's plant to the exposed surfaces of all aluminium components subject to staining from alkaline mortar and plaster, abrasion and other construction abuses. Before application of lacquer, the manufacturer shall remove all fabrication compounds, moisture, dirt, accumulations and other foreign materials to ensure proper lacquer adhesion.

Upon completion, the Contractor shall clean all aluminium work as required by removing protective tape or other coating, using mild soap or detergents and clear petroleum spirits.

Acids, caustics and abrasives shall not be used. Where cleaners are used to remove excess sealing compounds care shall be exercised to prevent damage to seals or staining or damage to adjacent work.

The Contractor shall be responsible for the protection of all aluminium work until the completion of the works, and only units in perfect working order and in perfect condition shall be accepted.

0117. Aluminium Door Ironmongery

All aluminium doors and windows shall be provided with a complete set of ironmongery with the intended use and the efficient performance of the doors and window they are designed for.

As far as possible all ironmongery shall be from the chosen system/manufacturer. Floor spring shall be from Dorma or Briton or equal and approved.

All locks shall be provided with a set of 3 keys. Where necessary panic devices shall be provided as required by the Civil Defense Authorities as part of the Ironmongery. Aluminium doors shall have the following minimum ironmongery provisions unless otherwise described:

Single Glazed or infilled Doors single swing:

- 1 1/2 Pairs of hinges.
- 1 Rebated mortice deadlock.

- 1 Pair 38 mm dia. semi-circular pull handles.
- 1 Heavy duty surface mounted door closer
- 1 Door stop.

Double doors, infilled or glazed; single swing:

- 3 Pairs of hinges.
- 1 Rebated mortice deadlock
- 2 Pairs 38 mm dia. semi-circular pull handles.
- 1 Pair rebated flush bolts
- 1 Pair heavy duty surface mounted door closers.
- 2 Door stops.

Single Glazed or infilled doors; double swing.

- 1 Set of springs with cover plate
- 1 Rebated mortice deadlock
- 1 Pull handle
- 1 Push plate

Double Door; infilled or Glazed; Double Swing.

- 2 Pairs of floor springs with cover plates.
- 1 Rebated mortice deadlock.
- 2 Pairs of pull handles.
- 2 Push plates.

0118. Steel Expanded Mesh for Shafts

Expanded mesh for shafts shall be similar to "WK4896" of Expamet or equal approved in galvanized steel to sizes indicated on drawings. The mesh shall be supported on suitable steel "I" or channel or Tee or angle sections through clips and bolts. The sizes and spacing of the supports shall be as required to meet the location and end use, as recommended by the manufacturer and as approved by the Engineer. The mesh and support structure shall be painted with epoxy paint as specified in Section 11 - Painting & Decoration.

Shop drawings, fixing details, samples and surface treatment, along with design calculation shall be submitted to the Engineer before ordering materials. Approved shop drawings shall form part of the Contract. However any approval accorded shall not relieve the Contractor of any of his contractual obligations and responsibilities.

0119. Aluminium Extruded Expansion Joints

Extruded aluminium expansion joints shall be of a proprietary make, and of types as indicated on the drawings complete with all fixings and fixtures, from a manufacturer approved by the Engineer. Extruded aluminium expansion joints shall be installed strictly in accordance with the manufacturer's instructions.

Floor and wall joints shall be sealed with an elastomer filled proprietary joint seal with galvanized steel or stainless steel retaining profiles on each side securely bolted to the

structure for internal or external applications respectively. Retaining profiles shall be set below the plaster or screed so that only the elastomer and the edges of the profiles show.

Joint width shall be 20 mm and the joint cover shall be capable of absorbing $\pm 35\%$ free movement of the joint width. All corners, cross connections, curbs, tee joints or other special accessories shall be shop fabricated.

0120 GLAZED CURTAIN WALL SYSTEM

0120A. General Requirements

Curtainwalls shall be designed, manufactured and installed by an approved sub-contractor as qualified under Quality assurance herein.

0120B. Scope of Work

These specifications cover the materials, manufacture, workmanship, design and installation of the Aluminium Glazed Curtainwall System as detailed on the drawings and to the approval of the Engineer. All work shall be performed in accordance with the applicable Building Codes, and/or the requirements of this specification, whichever are more stringent.

The work shall include but not be limited to the following:

- Aluminium glazed curtainwall
- Operating windows
- Louvred Panels/doors including sand trap louvres
- Entrance doors
- aluminium sandwich panel cladding
- Related glass and glazing
- Finishes of all curtainwall components
- Insulation - Fire safing
- Sealants and caulking
- Preparation of shop drawings, construction details and structural calculations stamped and sealed by Professional Engineer.
- In-plant quality control testing programme.

0120C. Design Parameters and Responsibilities

The curtainwall shall be two sided structurally glazed with pressure plates and stainless steel cover plates as detailed on drawings.

The curtainwall system shall be capable of accommodating:

- Thermal movement of the curtainwall itself.
- Building movement, thermal and dynamic.
- Structural loading due to wind pressure.
- Building construction variation
- Building settlement/shrinkage both short and long term.

It is recognized that the architectural drawings and design details do not cover all conditions, and/or that some modifications may be required. Also the details are indicative. It is intended that details shall be developed through the Contractor's shop drawings to the designed level of aesthetics and in compliance with the performance criteria.

0120D. Quality Assurance

The work in this section shall be designed and performed by an experienced Contractor who has been regularly engaged in the Engineering, manufacture, glazing, and installation of multi-storey high-rise curtainwalls and has a minimum of five (5) years experience in Glazed Curtainwall Systems.

All fabrication shall be done in the Contractor's own plant under full time quality controlled conditions.

The Contractor shall submit for approval a Quality Control Program covering all aspects of production and glazing, that has been reviewed and approved in writing by the approved silicone manufacturer.

A full-time in plant test programme as herein specified, is to be implemented and maintained for the full duration of the project, with weekly reports submitted to the Engineer covering all aspects of the Glazing operation.

Sub-contracting of any work included hereunder is specifically prohibited, except when approved in writing by the Engineer.

0120E. Performance Requirements

Structural, Thermal, and Weather Resistance requirements are to comply with the following standards:

- | | |
|---|---------|
| - American Aluminium Associations | (AA) |
| - American Architectural Aluminium Manufacturer's Association | (AAAMA) |
| - American Institute of Steel Construction | (AISC) |
| - American Iron and Steel Institute | (AISI) |
| - American National Standards Institute | (ANSI) |
| - American Society of Testing Materials | (ASTM) |
| - American Federal Specifications | (FS) |
| - American Insulating Glass Certification Council | (AIGCC) |
| - American Flat Glass Marketing Association | (FGMA) |

General:

Curtainwall system as erected shall meet or exceed the structural and weather resistance requirements detailed below:

Air and Water Infiltration:

Design and install the manufacturer's curtainwall system to permanently resist leakage of air and water through the system in accordance with the following:

Air Infiltration:

Air leakage through the curtainwall system shall not exceed 0.0183 cubic meters per minute per square meter of wall area when tested in accordance with ASTM E 283 at a minimum static air pressure differential of 30 kg. per sq. meter.

Water Penetration:

There shall be no uncontrolled water leakage through the curtainwall system, as defined in AAMA 501, when tested in accordance with ASTM E331 at a minimum differential pressure of 20 percent of inward design wind load but not less than 30 kg. per sq. meter or more than 60 kg. per sq. meter.

Structural Performance:

Design, engineer, fabricate and install the curtainwall system to withstand effects of the following:

- Design Wind Velocity (wind resistance) as defined in British Standard CP3, Chapter V (1972) of 160 kph.
- Design wind pressure shall be calculated based on the above windspeed, height of the buildings, etc., acting inward and outward, normal to the plane of the wall. When tested in accordance with ASTM E330, no material failures or permanent deformation of structural members shall occur.
- Structural Test pressure shall be equal to 150 percent of the inward and outward acting design pressures.

Deflections:

The curtainwall system shall be capable of withstanding building movements and weather exposures including wind loading and of performing within the following limitations, under the required design load both positive and negative:

Perpendicular Deflection:

Deflection of framing members, measured perpendicular to the plane of wall, shall not exceed 1/180 of the unsupported span (defined as the distance between anchor center lines) but deflection shall not exceed what is permitted by code.

Thermal Movements:

The curtainwall system shall be capable of withstanding thermal movements resulting from an ambient temperature differential of 50 degree C, without causing buckling, stresses on glass, failure of sealants, damaging loads on fasteners, or other detrimental effects.

Provision for Movement of the Structure

The curtainwall system shall be designed to accommodate dead load and live load deflection, thermal expansion, creep, elastic shortening and/or sway and torsion of the building frame, and resist seismic forces as may be anticipated, which shall be reduced to the minimal

expression without accumulation in a manner such that no undue stresses are created that may distort, overstress or otherwise jeopardize other components such as glass, metal panels, anchors, fasteners, etc.

To this end, the Contractor shall obtain all necessary projected data and make such provision in the Work as may be necessary. The amount of such movement that is accommodated in the Contractor's design shall be identified on the Contractor's submittal drawings.

Differential movements shall be accommodated by way of specifically designed two piece horizontals and interlocking sections in the Curtainwall System. Stacking joints shall not be located within the spandrel zone and should not involve movements of glass edges in their rebates.

0120F. Submittals

Prior to proceeding with any production, the following shall be submitted for review, approval, and selection by the Engineer:

Product Data:

The Contractor shall submit manufacturer's specifications for materials and fabrication, installation instructions, and recommendations for maintenance for the approval of the Engineer. Certified test reports showing compliance with project requirements where test methods are indicated shall be included. Procedures for reglazing individual components shall also be submitted.

Shop drawings:

-Wall elevations

- * Full size details of all conditions, anchorage, glazing details, including provisions for vertical and horizontal expansion and contraction.
- * Floor plans detailing lay-out and relationship of curtainwall to the structure.
- * Building sections coordinating wall to structure.

Structural Calculations

Door hardware schedule and descriptive literature: Structural Calculations and shop drawings shall bear the seal and signature of a Professional Engineer.

Samples

- Glass Samples for each type and thickness.
- Paint Colour Chip Samples.
- Gaskets and Caulking Color Samples.
- Aluminum powder coated samples of joint cover strips for eachwidth.

Quality Control programme

- Quality Control assurance programme covering production, assembly, and glazing procedure.

Glass stress analysis certifications.

- Certification from glass manufacturer covering stress analysis including wind loading, thermal and, bond line.

0120G. Material

G1. Aluminium

Sizes, shapes, and profiles are to be basically as shown on the drawings.

Wall thicknesses and profile depths to be as required by calculations, to comply with structural loading.

Alloy shall be to BS 1474 type HE9 or ISO Al,Mg S1 6063 or AA 6063 75.

G2. Stainless Steel

Stainless steel shall be Austenitic Stainless Steel as specified elsewhere in this Section.

G3. Operating Windows

Design and profile must be such that in the closed position, the vent and frame marry so as to match and have the same "sight line" and be basically imperceptible from the exterior and the interior of the curtainwall.

Two (2) "safety latch locks" per vent are to control and limit opening of vent to 100 mm with ability of mechanical over-ride to allow vent to open further to 400 mm.

Operating hinge mechanism to be continuous the full width of the vent, and to provide positive vent positioning both horizontally and vertically.

Glass to match adjacent fixed glass area.

Vent framing members to be a hollow tubular extrusion with reinforcement mitered corners.

Vents to have a double line of sponge rubber weatherseal, continuous one-piece around perimeter with no joinery or mitering at corners.

G4. Finish

The Contractor shall submit samples of the Powder coating/Duranar coating to aluminium range of colour for selection and approval by the Engineer.

Polyester powder coating and Duranar coating shall be as specified elsewhere in this Section.

G5. Glass

Glass shall be of the types and minimum thickness, as shown on the drawings and specified herein, and as specified under relevant clauses in SECTION 08 - GLAZING.

The contractor shall provide certification from the glass producer/fabricator that the glass producer/fabricator has reviewed glass thickness and finds it suitable for the purpose intended in accordance with his published literature and in accordance with these specifications.

Certification shall include a written wind load and thermal stress analysis showing a probability of failure of no greater than 8 lights per thousand at the design loads and local climatic thermal conditions.

Insulating glass units shall be installed in such manner as to prevent possible water accumulation within the glazing rebate.

G6. Gaskets and Weather stripping

All gaskets and weather stripping shall have continuous mechanical engagement to framing members.

Gaskets and weather-stripping shall be, EPDM or silicone rubber, as required for particular application. Where in contact with sealants compatibility shall be as established by ASTM C1087.

G7. Glazing Accessories

Provide setting blocks at the sill quarter points of insulated glass units. Setting blocks shall meet ASTM C864.

Continuous, resilient spacer between glazing and aluminum framing members at sealant joints shall be provided. Spacers shall have continuous mechanical engagement to framing members and be tested for compatibility with structural sealant as per applicable ASTM procedures.

G8. Miscellaneous Materials

Provide straps, plates and brackets, as required for support and anchorage of the fabricated items to adjacent surfaces.

Where steel reinforcement is required for strength, the pieces after fabrication and cleaning shall have all surfaces painted with two heavy coats of zinc chromate primer.

G9. Fasteners

Provide type and size shown, or as required, for proper support and performance. Structural calculations to provide verification of sizes and grades of fasteners.

G10. Insulating and Firesafeing

Where specifically indicated on drawings, U.S. Gypsum Co., "Thermafiber" wall insulation or approved equal with integral aluminum roll vapor barrier to room side shall be provided.

All joints, edges, punctures, and tears in foil vapor barrier shall be sealed with self-adhesive foil tape as recommended by insulation manufacturer.

100 mm deep compacted (in width) U.S. Gypsum Co., "Thermafiber" 4 lb. density firestop or approved equal shall be provided, between edge of floor slabs and interior faces of exterior walls. Support shall be provided by impaling clips.

Fire proof sealant shall be used at fire stop joints.

0120H. Fabrication

H1. Workmanship

All work shall be done by competent workmen thoroughly skilled in the trade. Use no materials, equipment or practices that may adversely affect the functioning, appearance and durability of the completed work and related construction.

The work shall be accomplished in compliance with the specified criteria without buckling, opening of joints, undue stress on fasteners, sealants, and gaskets, opening of welds, cracking of glass, leakage, noises or other harmful effects.

H2. Joints in Metalwork

All exposed work shall be carefully matched to produce continuity of line and design with all joints, unless otherwise shown or specified, being accurately fitted and rigidly secured.

H3. Shop Assembly

All cutting, fitting, assembly, and glazing work shall be done in the shop.

H4. Exposed Fasteners

Exposed fasteners on finished surfaces will not be permitted unless otherwise shown on drawings, or specified.

H5. Protection of Metals

Protection against galvanic action shall be provided wherever dissimilar metals are in contact, except in the case of aluminum in contact with galvanized steel or nickel silver (white bronze) or stainless steel. This protection shall be provided by either painting the contact surfaces with two heavy coats of zinc chromate primer in different colors or by application of an appropriate sealant or tape or other approved galvanic isolator.

All metals, except galvanized or stainless steel, which are to be in contact with concrete, mortar, or plaster, shall have the contact surfaces protected with bituminous paint.

0120I. Installation

I1. Qualification of Workmen

All work shall be performed by skilled workmen, especially trained and experienced in this type of work.

I2. Lines and Grades

Bench marks for elevations and building lines and offset marks for alignment shall be established on each floor level by General Contractor.

I3. Inspection of the Structure

After lines and grades have been established, and before beginning installation, Contractor shall examine all parts of the structure on which the works is to be placed. Should any conditions be found which, in his opinion, will prevent the proper execution of his work, he shall report such conditions in writing to the General Contractor. Installation work shall not proceed in that area until conditions have been adjusted to permit proper installation of the work.

I4. Workmanship

All parts of the work shall be erected, plumb and true, in proper alignment and relation to established lines and grades, and as shown on accepted shop and/or erection drawings.

I5. Use of Sealing Materials

Sealing materials specified in this section shall be used in strict in accordance with the manufacturer's printed instructions and shall be applied only by mechanics specially trained or experienced in their use. Before applying sealing materials, all mortar, dirt, dust, moisture and other foreign matter shall be completely removed from surfaces it will contact.

Adjoining surfaces shall be masked, when required, to maintain a clean and neat appearance. Sealing compounds shall be tooled to fill the joint and provide a smooth finished surface.

I6. Anchorage

Anchorage of the work to the structure shall be by approved methods in strict accordance with approved shop and/or erection drawings. Supporting brackets shall be so designed as to provide three dimensional adjustment and accurate location of all components. After the unit is properly positioned, all connections so designated on approved shop drawings shall be properly fixed, while still allowing for horizontal thermal expansion and contraction.

I7. Protection and Cleaning

The Contractor shall be responsible for the protection of the work against damage by other trades as well as cleaning of the glazed curtainwalls upon erection and attachment into place on the structure, shall be the responsibility of the General Contractor.

This Contractor is to provide to the General Contractor and Owner specific written instructions from the glass and paint manufacturers on the proper method of cleaning and maintenance.

18. Tests.

On site testing shall be carried out to demountable that the requirements of air permieability, water permieability, structural performance, dynamic water penetration are meet in accordion with the relevant ASTM/AMMA requirements.

0120J. Warranties

J1. General

Submit a written warranty signed by the Contractor, the manufacturer and installer warranting that portions of the work involving the glazed curtainwall are of good quality, free from defects, and in conformance with the requirements of the Contract Documents and further undertake to repair or replace defective work, at no cost to the Client, during a 10-year period following the date of issue of the Provisional Acceptance Certificate.

Defective materials and workmanship is hereby defined to include, but not be limited to, the following:

- a) Glass breakage.
- b) Glass discolouration.
- c) Failure of the sealants.
- d) Failure of operational parts to function normally.
- e) Deterioration or discoloration of finishes.
- f) Failure of the system to meet performance requirements, including water penetration, air infiltration and structural failure of components resulting from forces within the specified limits.

0121 Skylight

Skylight shall be of double glazing fixed to powder coated aluminium sections to shape and size indicated on drawings. The relevant clauses in this section shall be applicable to this work also. The Contractor shall provide the details of reactions of the skylight on the structural concrete supports for verifications of design sufficiency. If any modifications are to be made to the concrete structure due to loads/reaction of the skylight the same shall be carried out by the Contractor. All necessary waterproofing shall be provided. All tests needed to ensure water and air tightness shall be carried out by the Contractor to the satisfaction of the Engineer.

0122 Corner Guards

Corner guards shall be manufactured from synthetic rubber or PVC and shall be mounted on galvanized steel continuous retainers not less than 1.5 mm thick plugged and screwed to the wall with suitable anchor bolts.

Retainer assembly and the rubber/PVC facing shall not be installed until after painting.

Shop drawing indicating details of materials method of fixing along with manufacturers literature and samples of the material shall be submitted to the Engineer for approval.

End of Section 08

SECTION 09 ACOUSTICAL CEILINGS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Work included: Provide acoustical ceilings where shown on the Drawings, as specified herein, and as needed for a complete and proper installation.
- B. Related work: Drawings and general provisions of Contract, including General and Supplementary Conditions, Bills of Quantities and Specification sections, apply to work of this section.

1.2 QUALITY ASSURANCE

- A. Use adequate numbers of skilled workmen who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the work of this Section.
- B. Acoustical False Ceiling tiles shall be non-combustible conforming with the requirements of the American Federal Specifications SS-A 118b and shall be as described in the current Acoustical Materials Association Bulletin, Sound-Absorption Coefficients of Architectural Acoustical Materials.
- C. Acoustical ceiling tiles or panels shall be of the size, thickness, whether perforated or non-perforate, design and finishes shown on the Drawings and / or stated in the Bills of Quantities.

1.3 SUBMITTALS

- A. Product data: Within 45 calendar days after the Contractor has received the Owner's Notice to Proceed, submit :
 - 1. Materials list of items proposed to be provided under this Section.
 - 2. Manufacturer's specifications and other data needed to prove compliance with the specified requirements.
 - 3. Shop Drawings in sufficient detail to show suspension, layout, lateral restraint, installation, anchorage, and interface of the work of this section with the work of adjacent trades.
 - 4. Manufacturer's recommended installation procedures which, when approved by the Engineer, will become the procedures used on the work.
 - 5. Samples of each item, color and pattern available in the specified grades from the proposed manufacturers.

1.4 PRODUCT HANDLING

- A. All manufactured items shall be delivered in the original package, containers, etc. bearing the name of the manufacturer and the brand. Each piece of material shall bear the official grade and trade mark of the association under whose rules it is graded or the material shall be accompanied by a Certificate of Inspection issued by that association.
- B. During and after installation , acoustic tiles shall be protected by adequate measures from construction hazards that could interfere with its operation or damage its appearance or finish. Materials and manufactured items shall be stored in an approved manner and shall be protected from exposure to weather or dampness during transit and after delivery to Site.

1.5 EXTRA STOCK

- A. Deliver to the Owner for his use in future modifications, and extra stock of approximately 2% of each type of acoustical material installed , packaging each type of material separately, distinctly marked, and adequately protected against deterioration.

PART 2 - PRODUCTS

2.1 GRID SYSTEM

- A. General: The exposed metal grid system for suspended ceilings shall be made of aluminum sections or factory hot dipped galvanized steel sections and the concealed system shall be made of steel sections painted with approved rust inhibitive primer as recommended by the manufacturer of suspended ceilings and approved by the Engineer.
- B. Suspension system for lay-in tile suspended ceilings shall be an exposed interlocking metal and grid suspension system consisting of main runners and interlocking cross tees and shall be obtained from an approved manufacturer. Exposed suspension members shall be finished in white baked enamel.
- C. Provide a complete system of supporting members, anchors, wall cornices, adapters for light fixtures and grilles, and accessories of every type required for a complete suspended "T" grid system of the arrangements shown on the Drawings, in color or colors selected by the Engineer from standard colors of the approved manufacturer, and complying with pertinent requirements of UL, and the governmental agencies having jurisdiction
- D. The grid system shall be installed to provide 600X600mm module as required by light fixture and tile size. The main runners shall be hung by direct suspension from ceiling slab or structure by means of no. 12S.W.G. galvanized wire or shall be clipped to 2@ rolled steel channel anchored to concrete. Hangers and main runners shall be spaced in accordance with manufacturer's specifications and recommendations governed by exposed maximum load.

Main runners shall be accurately leveled and spaced. A baked white enamel finish metal angle moulding or trim matching the exposed grid shall be installed where border units abut the wall or other vertical surface.

E. Acceptable products:

1. Armstrong
2. Equal products of other manufacturers when approved in advance by the Engineer.

2.2 ACOUSTICAL CEILING PANELS

A. Acceptable products :

1. Armstrong 705 AEX
2. Equal products of other manufacturers when approved in advance by the Engineer.

2.3 OTHER MATERIALS

- A. All suspension members, hangers, wires, strips, clips, clamps, etc. shall be of the sizes and types recommended by the manufacturer of the suspended ceiling systems.
- B. Provide other materials, not specifically described but required for a complete and proper installation, including all suspension members, hangers, wires, strips, clips, clamps, etc. of the sizes and types recommended by the manufacturer of the suspended ceiling systems as selected by the Contractor subject to the approval of the Engineer.

PART 3 - EXECUTION

3.1 SURFACE CONDITIONS

- A. Examine the areas and conditions under which work of this Section will be performed. Correct conditions detrimental to timely and proper completion of the work. Do not proceed until unsatisfactory conditions are corrected.
- B. False ceiling materials shall be installed under temperature and humidity conditions similar to those which will exist when the building is occupied. They should not be installed when buildings are damp and cold or dry and hot. Plastering, floor and wall cladding shall be completed and allowed to dry before the installation of acoustical materials commences. All windows and doors shall be in place and glazed. Poured or precast concrete or similar roof decks shall be thoroughly dry.
- C. Buildings shall be examined before beginning work to determine that it is properly enclosed and the structure is in proper conditions to receive acoustical materials and/or suspended system. Areas shall be broom cleaned and uninterrupted for free movement of rolling scaffold.

3.2 INSTALLATION, GENERAL

- A. Except as modified by requirements of governmental agencies having jurisdiction, recommendations of the manufacturer as approved by the Engineer, or specific directions of the Engineer, install in accordance with ASTM C636 and the pertinent UL design requirements.
- B. Lateral bracing:
 - 1. Provide lateral bracing as required by pertinent codes and regulations.
 - 2. Secure lateral bracing to the direction of the partition and four ways in large ceiling areas.
- C. Hold down clips: Provide hold- down clips for ceiling boards only when so required by governmental agencies having jurisdiction.
- D. Levels: Make all grid level within a tolerance of one in 1000 and straight within a tolerance of one in 1000.
- E. Openings: Special care shall be taken by the Contractor to provide in the false ceilings openings were called for by the Engineer. Should the Contractor fail to make all the necessary openings required at the appropriate time he will be required to do so at his own expense.
- F. Defects: Damaged materials and manufactured items shall not be installed in the Works and any such materials or items damaged after installation shall be removed and replaced by the Contractor at his own expense and to the entire satisfaction of the Engineer.
- G. Protection: All false ceiling shall be protected from damage until the completion of the Works. Should any damage be caused it shall be made good to the satisfaction of the Engineer at the Contractor's expense.

3.3 INSTALLATION OF ACOUSTICAL MATERIALS

- A. "T" grid system: Install acoustical ceiling boards so linearity of facing is as directed by the Engineer..
- B. Sound walls: Set acoustical ceiling boards in four continuous beads of 1/4" diameter sealant, one at top of each edge of the gypsum drywall and tow on top of the top metal runner track.
- C. Special access hatches as required shall be provided next to air conditioning and ventilation units and wherever required by the Engineer. Mounting details shall be applied for the surrounding edge of lighting fixtures and air inlets and outlets and edge of ceiling.

3.4 CLEANING UP

- A. In addition to other stipulated requirements for cleaning, completely remove finger prints and traces of soil from the surfaces of grid and acoustical

materials, using only those cleaning materials recommended for the purpose by the manufacturer of the material being cleaned.

- B. Following installation, the Contractor shall clean soiled or discolored surfaces of units, remove and replace any unit which is damaged or improperly installed to the satisfaction of the Engineer.

END OF SECTION

SECTION 10

GLAZING

0101. GENERAL

Glass and glazing shall be provided as specified and as shown, including entrances, windows, spandrels, skylights, glazed doors, transoms, sidelights and mirrors.

0102. DEFINITIONS

Manufacturer as used in this section shall refer to a firm that produces primary glass or fabricated glass as defined in the referenced glazing standard.

Deterioration of Laminated Glass:

Defects developed from normal use that are attributed to the manufacturing and assembly process other than glass breakage and practices for maintaining and cleaning laminated glass contrary to manufacturer's directions. Defects include edge separation, delamination materially obstructing vision through glass, and blemishes exceeding those allowed by referenced laminated glass standard.

Deterioration of Insulating Glass:

Failure of the hermetic seal under normal use due to causes other than glass breakage and improper practices for maintaining, and cleaning insulating glass. Evidence of failure is the obstruction of vision by dust, moisture, or film on the interior surfaces of glass. Improper practices for maintaining and cleaning glass do not comply with the manufacturer's directions.

SYSTEM PERFORMANCE REQUIREMENTS

0103. General

Glazing systems that are produced, fabricated, and installed shall be provided to withstand normal thermal movement, wind loading, and impact loading (where applicable), without failure including loss or glass breakage attributable to the following: defective manufacture, fabrication, and installation; failure of sealants or gaskets to remain watertight and airtight; deterioration of glazing materials; and other defects in construction.

Glass Design

Glass thicknesses indicated on the drawings and herein are the minimum thicknesses required. Contractor shall confirm glass thicknesses by analyzing project loads, and in-service conditions. Provide glass lites for the various size openings in the thicknesses and strengths (annealed or heat-treated or tempered) to meet or exceed the following criteria:

- Minimum glass thicknesses for exterior conditions shall be determined utilizing the structural performance criteria and the test methods of ASTM E997 and E998. Minimum thickness shall be determined using the most stringent of these requirements.
- Minimum glass thicknesses of lites, whether composed of annealed or heat-treated or tempered glass, are selected so that the worst- case probability of failure does not exceed the following:
 - a) 8 lites per 1000 for lites set vertically or not over 15 degrees off vertical and under wind action. Minimum thickness of monolithic annealed glass shall be determined according to ASTM E1300. Thicknesses of glass other than monolithic annealed glass shall be determined as per glass manufacturer's standard method of analysis including applying adjustment factors to ASTM E1300 based on type of glass.
 - b) 1 lite per 1000 for lites set over 15 degree off vertical and under action of wind.
 - c) Normal thermal movement resulting from a maximum change (range) of 50 degree C in ambient and surface temperatures acting on glass-framing members and glazing components, based on engineering calculation on materials' actual surface temperatures due to both solar heat gain and night time sky heat loss.

0104. SUBMITTALS

The Contractor shall submit the following:

Product Data : Manufacturer's technical data for each glazing material and fabricated glass product required, including installation and maintenance instructions. Indicate glass thicknesses to be used.

Samples : 300 mm square samples of each type of glass indicated, and 300 mm long samples of each colour of gasket and sealant.

Certificates : Certificates from respective manufacturers attesting that glass and glazing materials furnished for project comply with requirements of agencies having jurisdiction.

- Separate certification will not be required for glazing materials bearing manufacturer's permanent labels that represent a quality control program of a certification agency or independent testing laboratory acceptable to authorities having jurisdiction.
- Certification that glass does not exceed the permissible stress by analysis.

Compatibility and Adhesion Test Report:

Statement from sealant manufacturer that glass and glazing materials have been tested for compatibility and adhesion, with interpretations and recommendations for primers and substrate preparation.

0105. QUALITY ASSURANCE

Glazing Standards:

Recommendations of Flat Glass Marketing Association (FGMA) "Glazing Manual" shall be complied with except where more stringent requirements are indicated. This publication shall be referred for definitions of glass and glazing terms not otherwise defined.

Safety Glazing Standard:

Required safety glass complying with ANSI Z97.1 and testing requirements of 16 CFR Part 1201 for Category II materials shall be provided,

Insulating Glass Certification Program:

Insulating glass units permanently marked with appropriate certification label of Insulating Glass Certification Council (IGCC) for inspecting and testing shall be provided.

Glazier Qualifications:

An experienced glazier who has completed glazing similar in material, design, and extent to that indicated for this project with a record of successful in -service performance shall be employed.

Single Source for Glass:

To ensure consistent quality of appearance and performance, materials produced by a single manufacturer or fabricator for each kind and condition of glass shall be provided.

0806. DELIVERY, STORAGE AND HANDLING

Glass and glazing materials shall be protected during delivery, storage and handling to comply with manufacturer's directions and to prevent damage to glass and glazing materials from moisture, temperature changes, direct exposure to sun and from other causes.

0107. PROJECT CONDITIONS

Environmental Conditions:

No glazing works shall be carried out when air and substrate temperatures are outside the limits permitted by glazing material manufacturer or when joint substrates are wet or dirty.

0108. WARRANTY

General:

The Contractor shall submit warranties to repair or replace defective glass and glazing materials or workmanship for a period of 10 years after date of issue of the Provisional Acceptance Certificate, or longer where specified. Defects include, but are not limited to the following:

- Glass breakage due to pressures up to specified values thermal stress, manufacturing defects and damage to glass.
- Spontaneous breakage of heat treated glass.
- Defects in spandrel glass opacifier material.
- Loss of effective glass bite due to shifting of glass.
- Loss of effective glass bearing on setting blocks due to shifting of glass and/or blocks.

Insulating Glass:

A warranty to replace defective insulating glass for a period of 10 years after date of issue of the Provisional Acceptance Certificate shall be submitted. Defects include, but are not limited to the following:

- Failure of insulating glass edge seal as shown by moisture, dust, corrosion or reflective coating damage within sealed air space.
- Insulating glass spacer migration.
- Failure to meet specified performance requirements.
- Failure of structural silicone seals.

Mirrors:

During warranty period, mirrors which develop defects in mirror coating due to normal conditions and not due to practices contrary to manufacturer's instructions shall be replaced at no extra cost to the Client.

Warranty period shall not be less than 5 years after date of issue of the Provisional Acceptance Certificate.

Laminated Safety Glass:

The Contractor shall replace laminated glass which develop edge separation or delamination which obstructs vision through glass.

Warranty period shall not be less than 10 years after date of issue of the Provisional Acceptance Certificate.

Spandrel Glass:

The Contractor shall arrange to provide a ten (10) year warranty from manufacturer against peeling, cracking, thermal breaking and deterioration of the metallic film and peeling or flaking of opacifiers as applicable.

0109. PRIMARY FLOAT GLASS PRODUCTS

Float Glass ASTM C1036, Type I (Transparent glass, flat Class as indicated below, and Quality q3 (glazing select).

- Class 1 (clear) unless otherwise indicated.
- Class 2 (tinted, heat-absorbing, and light-reducing where indicated).

Refer to coated glass product requirements for tint colour and performance characteristics of coated tinted glass for monolithic glazing relative to visible light transmittance, U- values, shading coefficient, and visible reflectance.

Refer to requirements for sealed insulating glass units for performance characteristics of assembled units composed of tinted glass, coated or uncoated, relative to visible light transmittance, U-values, shading, coefficient, and visible reflectance.

0110. HEAT-TREATED FLOAT GLASS PRODUCTS

Fabrication Process: by horizontal (roller-hearth) process with roll-wave distortion parallel to bottom edge of glass as indicated, unless otherwise indicated. Tong-held method is not acceptable.

Uncoated, Clear, Heat-Treated Float Glass: ASTM C 1048, Condition A (uncoated surfaces), Type I (transparent glass, flat), Class 1 (clear), Quality q3 (glazing select), kind as indicated below:

- Kind HS (Heat Strengthened) where indicated.
- Kind FT (Fully Tempered) where indicated.

Uncoated, Tinted, Heat-Treated Float Glass: ASTM C 1048, Condition A (uncoated surfaces), Type I (transparent glass, flat), Class 2 (tinted heat-absorbing and light-reducing), Quality q3 (glazing select), with tint colour and performance characteristics for 6 mm thick glass matching those indicated for annealed primary tinted float glass; kind as indicated below:

- Kind HS (Heat Strengthened) where indicated.
- Kind FT (Fully Tempered) where indicated.

0111. LAMINATED GLASS PRODUCTS

Comply with ASTM C 1172 for kinds of laminated glass indicated and other requirements specified.

- Kind LA : Two Lites of annealed Type I glass.
- Kind LHS : Two Lites of heat-strengthened Type I glass.
- Kind LT : Two Lites of full-tempered Type I glass.

Interlayer: Interlayer material as indicated below, and of thickness indicated with a proven record of no tendency to bubble, discolor, or lose physical and mechanical properties after laminating glass lites and installation.

- Interlayer-Material: Polyvinyl butyl sheets, 0.76 mm thick, clear.
- Laminating Process: Fabricate laminated glass to produce glass free of foreign substances and air or glass pockets as follows:

Laminate lites with polyvinyl butyl interlayer in autoclave with heat plus pressure.

0112. INSULATING GLASS PRODUCTS

Sealed Insulation Glass Units: Preamsembled units consisting of organically sealed lites of glass separated by dehydrated air spaces complying with ASTM E774 and with other requirements indicated.

- Provide heat-treated, coated float glass of kind indicated or, if not otherwise indicated, Kind HS (Heat Strengthened) where recommended by manufacturer to comply with system performance requirements specified and Kind FT (Fully Tempered) where safety glass is designated or required.

Sealing System: Dual seal; primary sealant (minimum width 3.0 mm): Polyisobutylene; secondary sealant: silicone.

Spacer Material: Manufacturer's standard metal.

Desiccant: Manufacturer's standard; either molecular sieve or silica gel or blend of both.

Corner Construction : Manufacturer's bent and welded construction.

Frosted Glass

Frosted glass shall be 100 percent sandblasted glass using 120 grit material.

Mirror Glass

Clear float glass conforming to specified standard, quality q1, silvering, 6 mm thick.

Cut glass to sizes indicated and complete edge treatment. Grind, polish and bevel mirror edges not framed. Coat back of glass with chemically deposited silver, covered by film of electrically or chemically deposited copper, and coated with manufacturer's standard 0.05 mm dry film of organic coating.

0113. GLAZING SEALANTS

General : Comply with the following requirements:

Elastomeric Sealant Standard : Provide elastomeric sealant which complies with ASTM C 920 requirements.

Colors : Provide color as selected by Engineer from manufacturer's standard colors.

0114. MISCELLANEOUS GLAZING MATERIALS

Compatibility:

Provide materials with proven record of compatibility with surfaces contacted in installation.

Cleaners, Primers and Sealers:

Type recommended by sealant manufacturer.

Setting Blocks:

Neoprene, EPDM or silicone blocks as required for compatibility with glazing sealants, 80 to 90 Shore A durometer hardness, 100 mm minimum length by width to suit glass thickness.

Shims and Spacers:

Shims and spacers used with setting blocks shall be of the same material, hardness, length and width as the setting blocks.

Edge Blocks:

Same material as setting blocks, of 50 to 60 Shore A durometer, of size to limit lateral movement of glass.

0115. GLASS TYPES

Provide the following glass types subject to compliance with the criteria specified herein and as detailed below:

a) Insulated Relective Glass Vision Panel

As a reference the performance characteristics of a 1" (24 mm) insulated glazed unit for typical vision panel with reflective glass is based on,

1/4" (6mm) Pyrolitic coated glass as Stopsol Supersilver green of Glaverbel or Eclipse Blue green of Libbey Owens Ford or Reflectasol Green of Saint Gobain or equal approved heat strengthened outer lite

1/2" (12 mm) Airspace.

1/4" (6 mm) Clear inner lite, tempered to minimum height of 800 mm from floor level as required to meet the safety standards.

The typical Characteristics shall be:

Light Transmittance	30%.
Light Reflectance out	33%
Solar Energy Trans	≤ 23%
Solar Energy Reflectance out	≥ 17%
Summar `U' value	≤ 0.58 Btu/hr.ft ² °F
Shading Coefficient	≤ 0.39
Relative Heat Gain	77 Btu/hr.ft ² °F

b) Insulated Clear Glass Vision Panel

As a reference the performance characteristics of a 1" (24 mm) insulated glazed unit for typical vision panel with reflective glass is based on,

1/4" (6mm) Clear float glass heat strengthened outer lite

1/2" (12 mm) Airspace.

1/4" (6 mm) Clear inner lite, tempered to minimum height of 800 mm from floor level as required to meet the safety standards.

The typical Characteristics shall be:

Light Transmittance	78%.
Light Reflectance out	15%
Solar Energy Trans	≤ 61%
Solar Energy Reflectance out	≥ 12%
Summar 'U' value	≤ 0.55 Btu/hr.ft ² °F
Shading Coefficient	≤ 0.81

c) Insulated Tinted Glass Vision Panel

As a reference the performance characteristics of a 1" (24 mm) insulated glazed unit for typical vision panel with reflective glass is based on,

1/4" (6mm) Tinted blue green heat strengthened outer lite

1/2" (12 mm) Airspace.

1/4" (6 mm) Clear inner lite, tempered to minimum height of 800 mm from floor level as required to meet the safety standards.

The typical Characteristics shall be:

Light Transmittance	67%.
Light Reflectance out	12%
Solar Energy Trans	≤ 40%
Solar Energy Reflectance out	≥ 8%
Summar 'U' value	≤ 0.57 Btu/hr.ft ² °F
Shading Coefficient	≤ 0.58

d) Spandrel Panel

- Exterior glass - minimum 6 mm thick heat strengthened tinted blue-green glass.
- Opacifier - Polyester film.
- Air space - as required.
- Insulation - 50 mm rigid rockwool insulation of density 50 kg/m³.

0116. WORKMANSHIP

Verify compliance with applicable tolerances; for functioning of weep system; for face and edge clearances; and for effective sealing of joinery. Report conditions detrimental to glazing work. Perform glazing work after unsatisfactory conditions have been corrected.

Clean glazing channels immediately before glazing. Remove coatings which are not firmly bonded to substrates.

0117. GENERAL

Comply with the combined recommendations of glass manufacturers, of manufacturers of sealants and other glazing materials, except where more stringent requirements are indicated by referenced glazing standards.

Glazing channels are intended to provide for necessary bite on glass, minimum edge and face clearances and adequate sealant thickness, with reasonable tolerances. Adjust as required by Project conditions during installation.

Project glass from damage. Remove and dispose of glass units with damage or imperfections of kind that impairs performance or appearance.

Prime joint surfaces as required for adhesion of sealant.

Install setting blocks one quarter of glass width from each corner but with edge nearest corner not closer than 150 mm from corner of 0.125 times glass width, whichever is greater. Install blocks to prevent movement.

Provide spacers of correct size and spacing for clearances, for glass sizes larger than 1200 united millimeters (length plus height), except where gaskets or glazing tapes are used for glazing. Provide 3 mm minimum bit of spacers on glass and use thickness equal to sealant width, or slightly less than final compressed thickness of tape.

Provide edge blocking to comply with referenced glazing standard. Install edge blocks securely, between the mid-height and top corner of the glass and antiwalk blocks as required.

Set units of glass in each series with uniformity of appearances.

Provide compressible filler rods as recommended by sealant and glass manufacturers, to prevent sealant from clogging weep systems and from adhering to joints back surface and to control depth of sealant.

Force sealants into glazing channels to eliminate voids and to ensure complete "wetting" or bond of sealant to glass and channel surfaces. Tool exposed surfaces of sealants to provide a "wash" away from glass.

0118. INSULATING GLASS

Insulating glass units shall be 24 mm thick, consisting of two panes of 6 mm glass separated by a desiccant filled metal spacer with bent, welded or fused corners, and welded or fused splices or joints to provide a continuous 12 mm hermetically sealed and dehydrated space. Insulating glass seal shall be dual seal with polyisobutylene and silicone sealants and

certified for compliance with seal classification "CBA" by the Insulating Glass Certification Council (IGCC) and shall meet the requirements of ASTM E774 when tested in accordance with the following ASTM test methods. Secondary seal for structural silicone glazed units shall be a silicone edge seal certified for use in structural silicone glazing applications over the temperature range and structural loading as called for by the performance criteria section of this specification.

- E773 Test Method for Seal Durability of Sealed Insulating Glass Units.
- E774 Specification for Sealed Insulating Glass Units.
- E546 Test Method for Frost Point of Sealed Insulating Glass Units.
- E576 Test Method for Frost Point of Sealed Insulating Glass Units in Vertical Position.

The glass shall be fully heat strengthened or tempered as specified to assure adequate glass performance at the design pressures specified under the performance criteria. Glass manufacturer's recommendations are to be accompanied by wind load and thermal stress analysis.

The contractor shall provide certification from the glass producer/fabricator that the glass producer/fabricator has reviewed glass thickness and finds it suitable for the purpose intended in accordance with his published literature and in accordance with these specifications.

0119. MIRRORS

Apply one additional coat of backing paint and allow to dry. Apply mirror mastic to cover not more than 25% of back of mirror. Set mirror on base support, on setting blocks or continuous gasket, and press against substrate to ensure bond of adhesive. Leave open ventilation space, 3 mm or more in thickness between mirror and substrate. Do not seal-off ventilation space at edge of mirror.

0120. TAPE GLAZING

Position tapes on fixed stops so that when compressed by glass their exposed edges are flush with or protrude slightly above sightline of stops.

Install tapes continuously but not in one continuous length. Do not stretch tapes to make them fit opening.

Where framing joints are vertical, cover these joints by applying tapes to heads and sills first and then to jambs. Where framing joints are horizontal, cover these joints by applying tapes to jambs and then to heads and sills.

Place joints in tapes at corners of opening with adjoining lengths butted together, not lapped. Seal joints in tapes with compatible sealant approved by tape manufacturer.

Do not remove release paper from tape until just before each lite is installed.

Apply heel bead of elastomeric sealant.

Center glass lites in openings on setting blocks and press firmly against tape by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings.

Apply cap bead of elastomeric sealant over exposed edge of tape.

0121. GASKET GLAZING (DRY)

Fabricate compression gaskets in lengths recommended by gasket manufacturer to fit openings exactly, with stretch allowance during installation.

Secure compression gaskets in place with joints located at corners to compress gaskets producing a weather-tight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended by gasket manufacturer. Gaskets shall have moulded corners.

Install gaskets so they protrude past face of glazing stops.

0122. SEALANT GLAZING (WET)

Install continuous spacers between glass lites and glazing stops to maintain glass face clearances and to prevent sealant from extruding into glass channel weep systems until sealants cure. Secure spacers in place and in position to control depth of installed sealant relative to edge clearance for optimum sealant performance.

Force sealants into glazing channels to eliminate voids and to ensure complete wetting or bond of sealant to glass and channel surfaces.

Tool exposed surfaces of sealants to provide a substantial wash away from glass. Install pressurized gaskets to protrude slightly out of channel to eliminate dirt and moisture pockets.

0123. HEAT SOAKING OF TEMPERED GLASS

All tempered glass shall be subject to heat soaking tested prior to delivery to site.

0124. PROTECTION AND CLEANING

Promptly protect installed glass from breakage with crossed streamers attached to framing and held away from glass. Do not apply markers to surfaces of glass. Remove non-permanent labels and clean surfaces.

Protect glass from contact with contaminating substances. If contaminating substances do come into contact with glass, remove immediately as recommended by glass manufacturer.

Remove and replace glass which is broken, chipped, cracked, abraded or damaged in other ways during construction period, including natural causes, accidents and vandalism.

Wash glass on both faces not more than 4 days prior to date scheduled for inspections to establish date of issue of the Provisional Acceptance Certificate in each area of the Project. Wash glass as recommended by glass manufacturer.

0125. GEORGIAN POLISHED WIRED GLASS

Georgian polished wired glass shall be 6 mm thick with an integral 13 mm square electrically welded wire mesh. The glass shall conform to the applicable requirements of BS 476, Part 8: 1972.

End of Section 10

SECTION 11

INTERNAL AND EXTERNAL FINISHES

IN SITU FINISHES

1001. Scope

This specification covers all in-situ floor, wall and ceiling finishes to be incorporated into the Works.

1002. General

The Contractor shall perform all attendance upon other trades and protect all Works specified under this Section from damage during subsequent operations, make good any defects, clear away upon completion, clean throughout and leave all Work in perfect condition to the approval of the Engineer.

MATERIALS

1003. Cement

Cement for all finishes shall be Ordinary Portland Cement complying with BS 12 as specified under "CONCRETE WORK". White cement, where required shall conform to the same specification standards.

1004. Coarse Aggregate

Coarse aggregate for use in screeds shall be as specified under "CONCRETE WORK", but with maximum size of aggregate 5 mm.

Aggregate for use in granolithic shall be selected granite or quartz between 5 mm and 10 mm in size.

1005. Fine Aggregate (Sand)

Sand for use in plaster Work shall be as specified under "CONCRETE WORK - SECTION 03" and BS 1199 & 1200: 1976. The total chloride content shall not exceed 0.06%. Fine aggregate for use in tyrolean shall be specially selected for that purpose.

1006. Water

Water shall be clean, free from any harmful matter, and free from any unusual proportions of dissolved salt. Sea water or brackish water shall not be used. Analysis by an independent testing body shall be made to determine the suitability of the water if required by the Engineer.

1007. Additives

Additives for use in in-situ finishes shall only be used with the approval of the Engineer.

1008. Metal Lathing

Internal Applications: Metal lathing for use in in-situ finishes shall be plain expanded metal type complying with BS 1369: Part 1:1987, (1994), weighing not less than 1.61 kg/m². All metal lathing shall be zinc coated steel conforming to BS EN 10143:1993 with a coating of at least grade G275.

Metal lathing shall be secured by means of galvanized steel nails and washers at 350 mm centres. If wire is to be used for securing metal lathing it shall be zinc coated and not less than 1.2 mm in diameter.

Metal lathing shall be provided over all junctions of concrete and blockwork or any other dissimilar materials which are to be rendered. The minimum width of the metal lath shall be 100 mm on each side of the joint.

External Applications: Metal lathing for use in in-situ finishes for external applications shall be of galvanized steel metal lathing as specified above except that the zinc coating shall be to grade G 450.

1009. Angle Beads, Stop Beads, Etc.

All external angles to plastered and rendered finishes shall have external angle beads to ensure a true straight arris. Plastered and rendered finishes brought up to door frames, window frames and the like shall have architrave beads and where finishes end but do not abut other materials stop beads shall be used.

All beads, stop beads, plaster stops, corner beads, etc., for internal application shall be of galvanized steel and for external applications shall be of austenitic stainless steel in accordance with BS 1449: Part 2: 1983, grade 304S15 and be of an approved type from an approved manufacturer. All beads shall be fixed in accordance with the manufacturer's instructions. Beads and stops shall be fixed plumb, square and true to line and level.

Metal angle beads shall be fixed to solid background with plaster dabs at all internal arrises, and shall be fixed to timber supports with 28 mm clout nails. Both types of fixing shall be on each side of angle at not more than 600 mm centres.

Metal plaster stops shall be fixed with plaster dabs or 38 mm clout nails at not more than 600 mm centres.

1010. Aluminium Cover Strips

Where indicated on the Drawings, junctions of different floor finishes shall be provided with extruded aluminium cover strips.

Cover strips shall be of a type, and from a manufacturer approved by the Engineer and shall be fixed in accordance with the manufacturer's instructions.

1011. Floor Hardener and Sealers

Exposed cement : sand screed floors and/or exposed concrete floors shall be treated with a sodium silicate based floor hardener which at the same time seals the floor against dust and renders it oil proof, from a manufacturer approved by the Engineer as detailed on drawings.

1012. Epoxy Coating to Services Rooms, Shafts, Treads and Risers

The epoxy floor coating to Pump room, FHC, Lift machine room, Shafts/OTS, etc., where indicated on drawings shall be Mastertop 1210 by MBT or Nitoflor FC150 by Fosroc or Rezex EP of Cormix.

The coating shall be applied in 2 coats to a minimum total dry film thickness of 200 microns.

Inert, hardwearing, anti-slip aggregate shall be incorporated between coats to provide a highly anti-slip surface.

The surface of the concrete/screed shall be lightly acid etched followed by rinsing with water and complete drying. All surface dust and debris shall then be removed by vacuum. The epoxy resin floor coating shall be mixed and applied strictly in accordance with the manufacturer's instructions and applied by roller in 2 coats to achieve a minimum total dry film thickness of no less than 300 microns.

The epoxy resin floor coating colour shall be to the approval of the Engineer from the manufacturer's available range.

The floor coating shall conform to the following minimum requirements:-

Volume solids - 100%, Absorption (ASTM C 413) - 0.06%,
Service Temperature - 55° C.

1013. Seamless Epoxy Screed

A. Materials

Multi-layer epoxy coating to industrial kitchen and other floorings where indicated in schedules and drawings shall be solvent free, pigmented, two or three component epoxy based screed system 6 mm thick with sealer coat similar to Asoguard FC of Shomburg or Master Top 1240, FEB Master Builders or equal and approved.

Typical Properties

- | | |
|--|-----------------------------|
| - Pot life at 20°C | 40 min. |
| - Compressive strength (BS 6319: Part 2) | 70 N/mm ² (min). |
| - Flexural strength (BS 6319, Part 71) | 25 N/mm ² (min.) |
| - Slip resistance (TRRL Pendulum Tester) | ≥ 50 |

The flooring shall be resistance to most common detergents, dilute acids, petrol, fruit juice, edible oil and common kitchen droppings.

The colour of the system shall be as directed by the Engineer.

The product shall have the approval of the concerned Municipality of the project area and the relevant health authorities in the country of manufacturer.

B. Workmanship

Epoxy coating system shall be carried out by an approved and qualified specialist sub-contractor, having not less than 5 years successful experience of similar works and fully trained in the applications and techniques involved and in strict compliance with the manufacturer's instructions.

The Contractor shall provide all necessary equipment, to enable the completion of work to the total satisfaction of the Engineer.

The surface to which the epoxy overlay is to be applied shall be prepared as specified by the manufacturer and to the approval of the Engineer. The concrete surface shall be at least 28 days old and the relative humidity at the surface shall be within acceptable levels recommended by the manufacturer when measured with a hygrometer (BS 8201-81).

The surfaces shall be prepared by any of the following methods as recommended by the manufacturer and as approved by the Engineer:

- a) Vacuum shot blasting.
- b) Grit blasting.
- c) Acid Etching.

The prepared surface should be dry, clean and free of oil, grease and loose materials. If acid etching has been employed the floor shall be rinsed copiously with clean water and allowed to dry. Dust and loose particles are to be vacuumed off the surface.

Any repairs to arises etc. shall be carried out with the appropriate compatible repair systems recommended by the manufacturer of the epoxy coating system.

A primer recommended by the manufacturer shall be applied before application of the coating.

Epoxy coating material shall be mixed and applied strictly as per his written instructions of the manufacturer ensuring that the rate of application is adequate to provide the required thickness and shall follow the timings laid down by the manufacturer. A sealer coat shall be applied to provide a clean neat surface for duration recommended to the manufacturer.

The application shall be allowed to dry and shall be protected against traffic, water and spillages for the duration recommended by the manufacturer.

1014. Protective Coating to Kitchens Walls

Protective coating to walls of kitchen and other areas indicated in the Schedule of Finishes shall be an interior coating system similar to Sanitile 550 or Wall glaze.

The surface preparation, rate of application and the number of coats shall be strictly in accordance with the manufacturer's written instructions.

The material shall have the approval of the concerned Municipality of the project area and the health authorities in the country of origin.

1015. Vehicular Traffic Deck Coating System

Carparking decks and ramps shall be coated with an approved traffic deck coating system which shall provide both waterproofing and car parking/ramp coating to provide protection to concrete, be resistant to abrasion, normal engine oils, gasoline, etc. The traffic deck coating system shall be similar to "QSC-5123" of "Carlisle coating and waterproofing of USA." The material shall be suitable for the extreme climates prevalent in the area and shall be UV resistant. Ramps shall be provided with an extra coat to provide additional traction as recommended by the manufacturer.

The coating shall be carried up parapets, walls, columns and other obstructions to a minimum height of 10 cm.

The surface preparation, mixing and rate of application shall be strictly in accordance with the manufacturers written instructions and to the approval of the Engineer.

The Contractor shall provide a method statement of how the surface preparation, mixing and application shall be carried out along with detailed shopdrawings, samples and the manufacturers catalogues and data sheets for the approval of the Engineer. Any approval accorded by the Engineer shall not relieve the Contractor of any of his contractual responsibilities or obligations.

The coating system shall be carried out by an approved and qualified specialist sub-contractor, having not less than 5 years successful experience of similar works and fully trained in the applications and techniques involved and in strict compliance with the manufacturer's instructions.

The Contractor shall provide all necessary equipment, to enable the completion of work to the total satisfaction of the Engineer.

The surface to which the coating is to be applied shall be prepared as specified by the manufacturer and to the approval of the Engineer. The concrete surface shall be at least 28 days old and the relative humidity at the surface shall not be more than 75% when measured with a hygrometer (BS 8201-81).

The surfaces shall be prepared by any of the following methods as prescribed by the manufacturers and/or as directed by the Engineer:

- a) Vacuum shot blasting.
- b) Grit blasting.
- c) Acid Etching.

The prepared surface should be dry, clean and free of oil, grease and loose materials. If acid etching has been employed the floor shall be rinsed copiously with clean water and allowed to dry. Dust and loose particles are to be vacuumed off the surface.

If contamination of oil or grease exists then the surface shall be cleaned using a degreaser specified by the manufacturer and approved by the Engineer.

Any repairs to arises etc. shall be carried out with the appropriate compatible repair systems recommended by the manufacturer of the coating system and approved by the Engineer.

The Contractor shall submit to the Engineer a guarantee stating that all they have been carried out in accordance with the drawings, the specifications and the manufacturers written instructions, and shall be guaranteed free from defects in material and workmanship. The guarantee shall be for a period of ten (10) years from the date of issuance of the completion certificate. The Contractor shall agree to repair/re-do (including any replacement of materials) any defects, leaks, etc. resulting from defective materials or workmanship during the guarantee period at no additional cost to the Client.

The Contractor shall also pass on to the owner any and all guarantees provided by the sub-contractor and manufacturers of individual members of the system.

1016. Mixing of Plaster/Render and Screed

Except where hand-mixing of small batches is approved by the Engineer, mechanical mixers of an approved type shall be used for mixing.

Mechanical mixers, mixing boxes and tools shall be cleaned after mixing each batch and kept free of material from previous mixes. All tools, implements, vessels and surfaces shall at all times be kept scrupulously clean and strict precautions shall be taken to avoid materials becoming contaminated by pieces of partially set material which would tend to retard or accelerate the setting time.

Retempering will not be permitted and all render or screed which has begun to stiffen shall be discarded. Frozen, caked or lumped materials shall not be used.

PREPARATION OF SURFACES

1017. Walls and Ceilings

All surfaces to be rendered shall be clean and free from dust and grease. Projecting mortar and concrete fins and runs shall be removed. Traces of salts shall be thoroughly sprayed with water and all free water shall be allowed to dry and disappear from the surface before the render is applied.

Rendering shall not commence until the background has been suitably prepared. Blockwork joints shall be deeply raked out, efflorescence brushed off and all dust and foreign matter removed. On all external surfaces and on all smooth internal surfaces a spatterdash of cement and sand which shall contain 500 kgs of cement per one cubic metre of sand shall be applied and allowed to dry before rendering is commenced. Alternatively, an approved bonding agent may be used. All surfaces of walls and ceilings shall be wetted immediately prior to applying the rendering.

The Contractor shall form vertical guide screeds 50 mm wide on walls. The spacing shall not exceed 1.50 meters. The screeds shall be plumb and shall all be in the same plane. The sides of the screed shall be left rough to bond with plaster. The finished surface shall be true to shape and angle, even in all directions, with straight arrises free from cracks and trowel marks and to the entire satisfaction of the Engineer.

1018. Floors

All surfaces to receive screeds shall be clean and free from projections, dust, grease and other deleterious matter. Free water shall be allowed to dry out before screeding commences. The surfaces to be screeded shall provide a good bond for the screed and if it is not to the standard required by the Engineer, it shall be hacked or otherwise treated to his satisfaction.

APPLICATION OF FINISHES

1019. Plaster/Render

Render shall not be applied within 24 hours of the spatter coat application, if used.

Render shall be floated to a true, even surface. If the surface is to be a smooth finish then it shall be further troweled in a manner which forces the sand particles down into the render.

All render surfaces shall be free from rough areas, trowel marks, checks or other blemishes. Work shall be executed in a neat workmanlike manner and internal and external angles shall be true, straight and plumb.

Render shall be made good to adjacent finishes, frames, skirtings, etc.. and around pipes sleeves and other fittings.

Render shall be worked into expanded metal lathing, where used, and into beads to form a neat edge or arris.

1020. Base-Coat Plaster/Render

The base coat shall not be applied before the elapse of 24 hours on the application of the spatterdash coat to ensure complete setting.

The base coat shall be lightly scratched in both directions to provide key for the finishing coat and shall be kept moist with a spray for two days and then allowed to dry out.

1021. Finishing Coat Plaster/Render

The finishing coat shall not be applied until the rendering or base coat has seasoned for 7 days. The finishing coat, rendering coat or base coat shall be wetted evenly with a fog spray. Where cement plaster with a smooth troweled finish is specified or indicated on the drawings, the finish coat shall be first floated to a true even surface, then troweled in a manner that will force the sand particles down into the plaster and with the final troweling, leave the surface finished smooth and free from rough areas, trowel marks, checks or other blemishes.

Cement plaster in all other spaces, where a smooth finish is not specified or noted on the Drawings, shall be given a sand float finish of a uniform texture, as approved by the Engineer.

Approved hydrated or slaked lime shall be added in the proportion hereinafter specified to the mix of the finish float coat to internal plaster which is to be lime washed.

1022. Gypsum Plaster

Gypsum plaster to walls shall be similar to “Gypsum Lime Plaster GLP IA” of Conmix or equal and approved. The plaster shall be applied by an approved agent of the manufacturer or shall be personnel trained and approved by the manufacturer. Gypsum plaster shall be applied by a plaster spray machine in a single coat of minimum 13 mm thickness and shall be fit enough to receive paint or wall paper.

The surface preparation, mixing and application shall be strictly in conformity with the written instructions of the manufacturer. The manufacturer's agent shall visit the site as required to ensure strict compliance of his procedures.

1023. Spray Plaster

Spray plaster to ceilings shall be proprietary ready to use compounds of inert filler material which shall provide a even finish without the need for any paint.

The thickness of the coating system shall not be more than 6 mm.

A fibre glass mesh shall be applied to the entire surface. The mesh shall be plain weave, 0.15 mm thick of density not less than 60 gm/m² and white in colour and shall be fixed with a filler coat.

This shall be followed with a leveling coat and finished with 2 finish coats to a fine texture to the approval of the Engineer.

No ceiling work shall be stated until all wet works on the floor above are completed.

The contractor shall ensure that the corners and edges of ceiling, meeting the walls, shall be straight without undulations.

The material, mixing, application and finish shall be as per the written instructions of the manufacturers of the system and as directed and approved by the Engineer.

1024. Screed

Screed shall be laid by competent workmen to the thicknesses indicated on the drawings or as directed by the Engineer. If required by the Engineer, screed shall be laid in bays and where possible joints shall coincide with those in the base.

Curing of screeds shall be carried out by covering with sacking, canvas, hessian or similar material kept constantly wet for a period of at least three days. The screed shall be protected from all traffic until set. To prevent pounding, screeds to falls shall be to perfect gradients.

Surfaces shall either be floated or troweled depending upon the nature of the finish to be applied and shall be as indicated on the Drawings or directed by the Engineer. Maximum allowable deviation in level shall be 3 mm in 3 m.

Sealing and leveling compounds for screeds shall be applied strictly in accordance with manufacturer's written instructions by skilled workmen to obtain a dust free, even and smooth surface to the complete satisfaction of the Engineer.

MIX PROPORTIONS

1025. Plaster/Render

Plaster/render to surfaces shall be mixed in the following proportions:

Internal plaster & backing to tiles -	1 part cement 4 parts sand	) Note: measured:
External render	- 1 part cement 4 parts sand	) by volume

1026. Screed

Screed to floors shall be mixed in the following proportions:

1	part cement
1 1/2	parts fine aggregate (sand)
3	parts coarse aggregate (maximum size 5 mm)

Water content shall be kept to a minimum with a maximum allowable slump of 50 mm.

TILE, SLAB AND SHEET FINISHINGS

1027. Scope

These specifications cover tile, slab and flexible sheet finishings to floors and walls intended to be used in the Works.

1028. General

The Contractor shall perform all attendance upon other trades and protect all works specified under this Section from damage during subsequent operations, make good any defects, clean throughout and leave all works in a perfect condition to the satisfaction of the Engineer. All materials and manufactured items that are liable to damage shall be delivered in the original package, containers, etc.. bearing the name of the manufacturer and the brand, and shall be carefully loaded, transported, unloaded, stored in an approved manner, protected from damage and exposure to weather or dampness during transit and after delivery to the Site.

Damaged materials and manufactured items shall not be used in the works specified under this Section. Any materials and manufactured items damaged during and after bedding or setting in position shall be removed and replaced by and at the Contractor's expense.

Although recommended sizes and thicknesses of tiles, slips and slabs will be indicated on the Drawings, the final choice of size colour and thickness shall be decided by the Engineer's Representative at Site.

MATERIALS AND MANUFACTURE

1029. Cement

Cement shall be ordinary Portland Cement to BS 12. White (non stain) cement shall conform to the same specification standards.

1030. Colour Pigments

Colour pigments shall conform to BS 1014.

1031. Sand (Fine Aggregate)

Sand (Fine Aggregate) for use in Tile and Slab finishings shall be as specified under CONCRETE WORK-SECTION 03 and 1199 & 1200: 1976.

1032. Water

Water shall be as specified under "CONCRETE WORK".

1033. Grout

Grout for tiling work shall be obtained from a manufacturer approved by the Engineer.

1034. Adhesive

Adhesive shall be a suitable cement based adhesive complying with BS 5980:1980, from a manufacturer approved by the Engineer.

1035. Joint Sealant

Sealant for movement joints shall be silicone based for internal use and 1 part polysulphide based for external use, from a manufacturer approved by the Engineer.

1036. SEALANTS

The treatment of external/internal, moving and static joints to prevent penetration of moisture.

Standards:

BS 2499	Hot applied joint sealants for concrete pavements.
BS 3712	Method of test for building sealants.
BS 3712: Part 1:1991	Homogeneity, relative, density and penetration.
BS 3712: Part 2:1994	Seepage, staining, shrinkage, shelf life and paintability.
BS 3712: Part 3:1994	Application life skinning properties and tack-free time.
BS 3712: Part 4:1991	Adhesion in peel.
BS 4254:1991	Two-part polysulphide-based sealants.
BS 5212:	Cold applied joint sealants systems for concrete pavements.
BS 5215:1986	One-part gun-grade polysulphide-based sealants.
Part 2:1991	Code of practice for design and installation of
External, ceramic wall tiling and mosaics.	

BS 5889:1989
BS 6100 Sec.
1.5.2:1987

One part gun grade silicone-based sealants.
Glossary of terms relating to joints & jointing

1036A General:

Joint fillers shall be cellular preformed and low density capable of 50 per cent compression at 4 newtons per sq. mm.

Backing strips shall be foamed polyethylene joint filler of suitable size and surface finish to act as bond-breaker.

Primers shall be fully in accordance with the requirements and recommendations of the sealant manufacturer.

Sealants shall be to dimensions shown placed against firm preformed backing strips.

Sealant shall have hard adhesion to parent material and shall not harden or become brittle over a temperature range of -5 to 55o C and shall not degrade in strong sunlight.

Sealant shall not slump, flow, stain adjacent surfaces or release toxic agents after application.

Joints shall be clean and dry at time of priming. Concrete shall be wire brushed and blown clean with oil free compressed air.

Metal surfaces shall be cleaned with an oil and paraffin free solvent to remove all surface oils. Such solvent shall be wiped dry by clean dry rags.

Joints shall be primed in accordance with the manufacturer's standards and requirements of the sealant manufacturers. Joints shall be sealed as soon as the primer is tack dry.

Joints shall be sealed at an ambient dry bulb shade temperature of 25 to 35o C. Protect adjacent surfaces as necessary.

Joints shall be fully filled and finished with a smooth even surface. To roads, hardstandings and ground slabs the sealant shall be placed such that when compressed they will not depress more than 3 mm below the surface.

1036B. Application of sealants:

- a) All external joints shall be sealed.
- b) All wet joints shall be sealed.
- c) All visible vertical joints between concrete and/or masonry elements shall be sealed.
- d) All joints between ceramic tiles and abutting materials such as cabinets, baths, sinks, door frames, floor drains shall be sealed.

Joints in offices and other accommodation shall be sealed as specified but with cover strips specifically designed to conceal expansion joints while allowing expansion to take place.

1036C. Sealant Type

Type A Structural expansion and isolation joints.
Floors and walls will have proprietary elastomeric joints. The sealant shall be a two part polysulphide sealant, to BS 4254:1991 and capable of plus or minus 25 % movement (minimum). The colour and sealant shall be to the Engineer's approval.

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

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

In areas subject to spillage of hydraulic fluid or other aggressive agents, suitable alternatives which will not be subject to attack shall be used as agreed with the Engineer, e.g.. to mechanical workshops.

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

The sealant shall be a one-part high-modules silicone sealant, type- B to BS 5889:1989 The colour shall be to the Engineer's approval.

Type D Glazing and Bedding compound.

The sealant shall be an oil-based material containing synthetic polymer, manufactured specifically for glazing bedding to be to the Engineer's approval.

Type E Roads and Hardstandings.

The sealant shall be a chemical-fuel-and-oil resistant cold-applied two-part elastomeric compound to BS 5212 to the Engineer's approval. It shall be capable of plus or minus 12.5 percent movement (minimum).

1037. Backing Strip/Backer Rod

Backing Strip/backer rod for joint sealant shall be round, closed cell, impermeable, extruded polyethylene foam, from a manufacturer approved by the Engineer. The diameter of the rod shall be about 25% greater than the width of the joint to provide a tight fit. As far as possible continuous length shall be used.

1038. Joint Filling Material

Filling material for movement joints shall be flexible bitumen impregnated mineral fiber board from a manufacturer approved by the Engineer.

1039. Liquid Applied Facade Dampproofing

For damp proofing to external facade surfaces refer to Section 05.

1040. Waterproofing of Bath, Toilets, Kitchen, Wet areas, etc.

For waterproofing to bath, toilets, kitchen, wet areas, etc. refer to Section 05.

1041. Waterproofing to Terraces, Pool Deck, Parking, Walkways and the like.

For waterproofing to terraces, pool deck, parking, walkways and the like refer to Section 05.

1042. Antiroot Waterproofing Membrane for Flower Boxes

For waterproofing membrane for flower boxes refer to Section 05.

1043. Waterproofing to Swimming Pool & Fountains

For waterproofing to swimming pool & fountains refer to Section 05.

1044. Plasticisers

Plasticisers shall be from a manufacturer approved by the Engineer.

1045. Mastic

Mastic for water proofing and damp proofing membrane shall be rubber/bitumen based from a manufacturer approved by the Engineer.

1046. Precast Terrazzo Tiles, Skirting, Etc..

The precast terrazzo tiles and skirtings shall conform to BS 4131:1973 and shall be formed of white cement and granular marble chippings of large grades in order to obtain a good wearing surfaces. The thickness of the wearing layer shall be around half tile thickness. Precast terrazzo skirtings shall have square top edges.

Precast terrazzo treads, risers, strings, thresholds, etc. shall be of the design, dimensions and thicknesses shown on the Drawings and they shall be formed in the same proportions and mixes as for tiles.

Where required, terrazzo units shall be reinforced with bars and treads shall have either a non-slip aggregate (carborundum) incorporated into the top surface or a non-slip nosing recessed into the surface near the edge as directed by the Engineer. Grinding shall be done wet by means of appropriate carborundum stones. Filling shall be with a neat cement grout of the same colour as the facing mix and this shall be worked into the surface with a wooden scraper to fill all voids and air holes. After a minimum period of 24 hours polishing shall be carried out as described in "Workmanship". Samples of terrazzo shall be provided for the Engineer to choose from.

1047. Ceramic Floor Tiles

Ceramic floor tiles shall be matt finish, vitrified plain clay tiles manufactured in accordance with BS 6431. Skirtings shall be coved edge type 100 mm high. Acid resistant tiles shall be used where specified. Tile pattern and colour shall be to the Engineer's approval. The tile sizes and make shall be as detailed on drawings.

1048. Glazed Wall Tiles

Glazed wall tiles shall conform to the requirements of BS 6431 and the size shall be as shown on the schedule of finishes or the Drawings and of an approved pattern and colour. Single edge and double edge rounded tiles, coves and corner pieces shall be of the same quality, colour, and finish. The tile sizes and make shall be as detailed on drawings.

1049. Marble or Granite Slabs

Marble or granite slabs for flooring, skirting, treads, risers, door thresholds, column and wall cladding shall be first quality, uniform in colour and texture, free from voids, earth veins and lamination or structural weakness and of an approved texture and colour. The pattern, dimensions and thicknesses of marble or granite slabs shall be as shown on the Drawings, or as stated in the Bills of Quantities. Samples of marble or granite slabs shall be submitted to the Engineer for approval prior to order.

All marble shall be applied with an approved non-yellowing penetrative protective sealant to back and sides.

Metal anchorage consisting of cramps, bolts, dowels, etc. shall be of approved proprietary make from stainless steel or phosphor bronze.

WORKMANSHIP

1050. Precast Cement and Terrazzo Tiles

The precast cement and terrazzo tiles shall be laid in accordance with BS 5385: Part 5: 1990, BS 8204: Part 4: 1993 and/or BS 8000: Section 11.1: 1989 as applicable and as directed by the Engineer. Precast cement and terrazzo tiles shall be laid on a (1:3) mix of cement and sand mortar and any admixtures approved by the Engineer. The finished floor level shall be maintained as indicated on drawings by providing an approved sand layers of required thickness. Approved PVC separator strips 8 mm thick of colour to the approval of the Engineer shall be provided for every 9m² area of the tile works.

All tiles shall be laid with square joints and 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 a No. 140 carborundum wheel. Any narrow surfaces which cannot be polished conveniently by the machine, 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 angles or arrises. Polishing shall be performed with addition of appropriate lead and salt pigments as approved by the Engineer to produce a mirror-like glossy finish.

Tiles shall be cut with a suitable cutting tool and rough edges shall be rubbed smooth. Cut-tile misfits shall be replaced with properly cut tiles. Straight edges shall be accurately set to the lines established and reset at suitable intervals to keep the joints parallel over the entire area.

Broken tiles or tiles showing the least signs of defects will not be accepted and if laid by the Contractor shall be removed and replaced with sound tiles, at his own expense.

Tiles shall be laid out from the centre line of each space outward and adjustment made along walls, partitions, and borders, so as to symmetrize the pattern with a minimum of cut tiles. Tiles of less than half of their full size along one side after cutting should be avoided.

1051. Ceramic Floor Tiles

Ceramic floor tiling shall be carried out in compliance with BS 5385: Part 3:1989 and/or BS 8000: Section 11.1 :1989 as applicable and as directed by the Engineer.

The overall thickness of tiles, mortar and screed shall be maximum of 80 mm.

Bedding shall consist of cement:sand mortar 1:3 of a stiff plastic consistency, spread, compacted and leveled to a thickness of 9-10 mm. Water content of mortar must be limited to prevent formation of surface water when mortar is compacted and surface water which does occur must be allowed to dry. Sufficient mortar for 2-3 hours work maximum shall be laid at any one time.

Tiles shall be dipped in water and surface water allowed to drain off. The back of the tiles shall be buttered with neat cement/water mix (or cement based adhesive), and the tiles laid on bedding and tapped down to form a level surface. All joints shall be as close as possible and shall in no case exceed half (0.5) mm in width on face for areas less than ten (10) square meters and one (1) mm for areas over ten (10) square meters.

Tiles shall be left for at least twelve (12) hours before joints are grouted.

White or tinted cement and water to 1:1 mix of paste consistency shall be worked into the joints until flush with face of tiles.

Acid resistant tiles shall be grouted in a suitable acid-resistant grout to the Engineer's approval.

The surplus grout from the floor surface shall be gently wiped with fine sand. Sawdust shall not be used.

Walking on tiles shall not be allowed for five (5) days after laying.

Perimeter movement joints shall be provided to the full depth of finish, bedding and screed in all tiled floors.

1052. Glazed Wall Tiles - Fixing with Adhesive

Wall tiling shall be carried out in compliance with BS 5385: Part 1: 1976 for Internal work and BS 5385: Part 2: 1976 for External work and/or BS 8000: Section 11.1 : 1989, as applicable and as directed by the Engineer.

The background for tiling shall be suitably prepared free from oil, grease, loose or friable materials and shall provide an adequate key for bedding.

The maximum deviation of background shall not exceed 3 mm when measured under a two metre straight edge.

Tiling work shall be carefully set out prior to starting to minimize the amount of tile cutting and to ensure alignment of vertical and horizontal joints.

Tiles shall be dry when fixed, using adhesive, mixed and used strictly in accordance with manufacturer's written instructions and within the stated working time of the adhesive. The manufacturer's recommendations for safe handling and ventilation of working area shall be carefully followed.

Adhesive shall be applied as a floated coat to a thickness of 5 to 6 mm. Tiles shall be firmly pressed into position within the stated working time of the adhesive.

Tiles and fittings shall be set in adhesive to true vertical face with continuous horizontal and vertical joints. Joints shall be straight, level, perpendicular and of even width not exceeding 1.5 mm. The vertical joints shall be maintained plumb for the entire true level and plane by uniformly applied pressure under a straight edge of a rubber faced block. Misfits as well as damaged or defective tiles shall be removed and replaced at the Contractor's own expense.

Special tile fittings shall be located as shown on detail drawings and as directed by the Engineer.

Bedding shall be allowed to set before grouting to avoid disturbance to tiles. Grout shall be applied in matching colour according to manufacturer's written instructions and worked in until joints are thoroughly filled flush with the finished face of joint. Surplus grout shall be removed with a damp cloth and joints tooled to a smooth finish. Acid resistant tiles shall be grouted with a suitable acid resistant grout to the Engineer's approval.

Immediately after the grouting has set, tiled surface shall be given a protective coat of non-corrosive soap or other approved method of protection and joints shall be cured for 72 hours.

Wall tiling operations shall not be started until the floor tiling in the same area has been completed.

1053. Glazed Wall Tiles - Fixing with Cement:Sand Mortar

Wall tiling shall be carried out in compliance with BS 5385: Part 1: 1976 for Internal work and BS 5385: Part 2: 1976 for External work and/or BS 8000: 11.1: 1989, as applicable and as directed by the Engineer.

Cement and sand mortar (1:4) ten (10) mm. thick shall be laid as base for wall tiling. The surface of the mortar so laid shall be scratched in an approved manner when nearly set, to form key and shall be cured for five (5) days before tiling starts. The surface shall be well wetted before the actual tiling operation is commenced.

Tiles and fittings shall be set in cement and sand mortar (1:4) mix, 6 mm. thick to a true vertical face with continuous horizontal and vertical joints. Joints shall be straight, level, perpendicular and of even width not exceeding 1.5 mm. The vertical joints shall be maintained plumb for the entire true level and plane by uniformly applied pressure under a straight edge of a rubber-faced block. Misfits as well as damaged or defective tiles shall be removed and replaced by and at the Contractor's expense.

The external and internal angles and side edges of glazed wall tiling shall be formed with angle beads whereas top edges of tiles, shall be formed with rounded edge tiles. Joints shall match the general tiling and special fittings shall be used.

Joints in glazed wall tiles and fittings, after the edges of tiles have been thoroughly wet, shall be grouted with a plastic mix of neat white or coloured cement immediately after a suitable area of tile has been laid.

The joints shall be tooled slightly concave and the excess mortar shall be cut off and wiped off with a damp cloth from the face of tile, before it sets hard. Interstices or depressions found in the mortar joints after the grout has been cleaned from the surface shall be roughened at once and filled to the spring line of the cushion edge before the mortar begins to harden.

Immediately after the grout has had its initial set glazed wall tile surfaces shall be given a protective coat of a non corrosive soap or other approved method of protection and joints cured for 72 hours.

Wall tiles operations in spaces requiring floor tiles shall not be started until the floor tiles installation had been completed.

1054. Marble or Granite Slabs

Marble or granite floor slabs shall be laid on a bed of cement:sand mortar 1:3 mix. The back of the slab shall be properly sealed to ensure good bonding between the slab and mortar.

All slabs shall be tight butt jointed. Joints shall be thoroughly grouted with matching coloured cement and wiped clean before setting hard.

All exposed faces and edges of marble or granite shall be polished smooth free from scratches or other defects.

Marble or Granite wall cladding shall be fixed in accordance with BS 8298:1989 and/or BS 8000: Section 11-2:1990 as applicable and as directed by the Engineer. Cladding shall be fixed to solid background by mechanical means such as cramps, dowels and similar fixings in accordance with the working drawings. The cladding shall be supported at its lower edge and securely tied back at the top. The thickness of the material behind the cramp should be 20 mm. The fixing cramps shall be adequately inset in to the supporting background, preferably with undercut holes and secured in place with 1:3 cement/sand or epoxy/polyester resin mortar dabs. The back surface of the cladding shall be coated with an approved quality sealant.

Cladding shall be butt jointed with maximum 3 mm gaps.

The length and height dimensions of individual slabs shall be worked to within plus or minus 1 mm from those specified. Thickness shall be within 3 mm from that specified. For wall cladding, all block work, concrete or other backing must be formed so as to allow a minimum of 20 mm clearance between the backing and the back of the cladding.

Cramp holes and mortises shall be carefully drilled or cut to avoid stunning or fracture of the material adjacent to the hole or mortise.

The Contractor shall be responsible for providing and fixing protection against weather or damage and staining by other trades. Particular care must be taken against staining from timber, oil, wet straw, washings from steel work or scaffolding or from any other injurious substances. On completion of adjacent building operations the completed marble work shall be cleaned down and any defects in the pointing and polishing shall be rectified.

The Contractor shall prepare fully dimensioned shop drawings from details shown on working drawings supplied by the Engineer and from site survey. Key numbers of each slab shall be shown, together with details of metal anchorages. No marble or granite shall be worked until these drawings are approved by the Engineer.

1055. Glass Mosaic Tiles

Glass mosaic tiles shall be of first quality tiles, 4 mm thick with bevelled edge finish, overall size 20 mm x 20 mm on paper sheets or netting, from OPIOCOLOR (France) or BIZZAZA (Italy) or equal and approved.

Tiles shall be fixed with thin bed adhesive using approved waterproof cement based adhesive from an approved manufacturer and shall comply with the performance requirements of BS 5385: Part 3: 1989. The Contractor shall ensure that the base to receive tiles shall be cement sand mortar bed/render of not more than 20 mm thickness. The base shall be clean, level and dry without loose or friable areas and surface dust.

Cement-based adhesive shall be prepared and used in accordance with the manufacturer's recommendations to form a bed not more than 5 mm thick with even joints not more than 3 mm wide. Joints shall be continuous both horizontally and vertically.

Tiles shall be laid dry and tamped well down into the adhesive to ensure a proper bond and a level surface.

Grout pointing material shall be as recommended by the tile manufacturer or tinted cement to match the tiles, as approved by the Engineer and shall be applied when adhesive has set sufficiently firm to prevent disturbance of the tiles. Surplus grout shall be cleaned off from faces of tiles.

Movement joints shall not be less than 6 mm wide where shown or as recommended by the tile manufacturer. Movement joints shall be carried through to the full depth of tile and bedding, partially filled with filling strip and finished flush with sealant to manufacturer's recommendations.

Where tiling abuts against wood or metal frames or the 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.

1056. Timber Flooring

Timber flooring shall be similar to resilient hardwood flooring system of Atkinson & Kirby Ltd. (UK) or equal and approved.

The system shall consist of the following:-

- 1000 gauge polythene sheet.
- Resilient rubber pads overall size 74 mm x 10 mm at 300 c/c.
- 50 x 75 softwood battens laid on rubber pads, 1800 long with 80 mm over lapping.
- Hardwood/rock hard maple strip flooring, secret nailed, tongued and grooved.
- Gap at perimeter 12-24 mm for curing.
- Ronaseal finish on surface/or Oleo-resinous sealer such as bourne seal.
- 1.5 mm expansion gap every 7th flooring board.

The top timber layer finish shall be to the approval of the Engineer.

The Contractor shall provide detailed shop drawings along with samples of the materials and product data sheets before ordering the materials for the approval of the Engineer.

The concrete surface on which the flooring is to be laid shall be prepared as recommended by the hardwood flooring manufacturer to provide the permissible tolerance and surface finish.

Flooring shall be prepared and laid strictly in accordance with the manufacturer's written instructions and to the approval of the Engineer.

1057. Demountable Partitions

Demountable partitions shall be of proprietary make similar to type "Omega 100" of Chicago metallic or equal and approved.

Demountable partitions shall be 100 mm thick, consisting of vertical galvanized steel Z-profiles placed in natural anodized aluminium rails at floor and ceiling, finished on both sides with 13 mm plaster boards covered with vinyl wall covering in approved colour and texture, connected with natural anodized aluminium profiles and snap on cover fillets.

Partitions shall be insulated with 50 mm thick mineral fiber. Fire rating shall be 60 minutes as per BS 476.

Doors shall be 45 mm thick solid core laminated finished flush doors with hardwood lipping at edges and intumescent strips. Doors shall be hung on aluminium hinges and supplied with stainless steel lever handles and steel locks or latches.

Glazed panels shall be provided as detailed on drawings in single clear glass.

All partitions shall be assembled and erected as detailed on drawings and as per manufacturer's instructions and to the approval of the Engineer.

SUSPENDED CEILINGS

1058. Scope

These specifications cover suspended ceilings and other proprietary finishing systems to be incorporated in the Works.

1059. General

The Contractor shall perform all attendance upon other trades and protect all works specified under this section from damage during subsequent operations, make good any defects, clear away upon completion, clean throughout and leave all work in perfect condition to the approval of the Engineer.

All materials and manufactured items shall be delivered in their original packages, containers, etc. bearing the name of the manufacturer and the brand. All items shall be carefully loaded, transported, unloaded and stored in an approved manner, protected from damage and exposure to weather or dampness during transit and after delivery to site. Damaged items shall be rejected.

The Contractor shall supply shop drawings to the Engineer prior to commencing the work for his approval and the Contractor shall modify or amend such drawings as directed by the Engineer. Such modifications, amendments and approval by the Engineer of shop drawings shall not relieve the Contractor of his responsibility for the design and sufficiency of those works.

1060. Gypsum Board Suspended Ceiling (C3)

Gypsum board suspended ceiling system shall be installed as detailed on the drawings to the approval of the Engineer.

Gypsum board suspended ceiling system shall be manufactured and installed as detailed on the drawings by an approved sub-Contractor who has successfully engaged himself in similar works for at least 7 years.

Plaster board ceiling shall comprise of 12.7 mm thick layer of approved proprietary plaster boards screw fastened to approved support framing at 600 mm centres both ways. Joints shall be sealed with vinyl based cement and perforated paper type and all caulking shall be with vermiculite plaster (1½ parts exfoliated vermiculite to 1 part plaster). The suspension system shall be designed to suit the layout, spans, and the design loads and all substantiating design calculations and details shall be submitted to the Engineer for his approval. Approval accorded by the Engineer shall not relieve the Contractor of his obligations to provide a safe and aesthetic ceiling.

Plaster boards shall be manufactured with gypsum plaster complying to BS 1191, Class A Plaster of Paris using necessary reinforcements fibers, hardeners and additives.

The suspended ceiling shall be provided with mouldings at all edges, corners, etc., to achieve the desired effect as detailed on the drawings and to the approval of the Engineer.

Fibrous gypsum suspended ceiling mouldings cornices, etc. shall be formed using the approved design mix with all constituent materials being gauged, batched or weighed accurately. Moulds shall be dimensionally and geometrically accurate and release agents/waxes that will allow a clean release of the casting without adversely affecting the component surfaces shall be used. The moulding and castings shall include all necessary

fixing holes, brackets, etc. Mouldings and coatings shall be individually inspected for any surface blemishes shall be rectified in an approved manner.

The components shall be true in shape and free from cup and bow. The dimensional accuracy shall be + or - 2 mm per m and the horizontal plane deviation shall not exceed 0.3% of the component length. The squareness of rectangular components shall be such that the difference between the diagonals shall not exceed 0.5% of the shorter diagonal.

The formed components shall be asbestos free, antistatic and shall have a density not exceeding 1500 kg/m³, be unaffected by ultra violet light and not support fungoid attack. Their thermal conductivity (k) value shall not be greater than 0.375 W/m²/deg C and shall have a thermal coefficient of expansion not exceeding 14.94 x 10⁻⁶ mm/deg. C. They shall not absorb moisture present in internal locations through excessive humidity.

Components shall have an ultimate tensile strength of not less than 8.27 N/mm².

Component thickness shall be as recommended by the manufacturer or as directed by the Engineer.

The contractor shall form necessary opening for various services including any access panels as required and finish them appropriately to the satisfaction of the Engineer.

The Contractor shall prepare detailed shop drawings after verifying the dimensions at site, of the components and fixings and submit them for the approval of the Engineer prior to casting. The shop drawings shall also detail the various suspension materials and the methods of fixing the casting along with his proposed method of erecting each compact. The Contractor shall prepare for the Engineers approval samples of the various mouldings cornices and decoration works.

The Contractor shall protect all Gypsum works from damage until the completion of the Works. Should any damages be caused it shall be made good to the satisfaction of the Engineer at the Contractors expense. All inlaid materials, mirrors, air conditioning grilles and the like shall be cleaned and left in perfect condition.

1061. Calcium Silicate Board Suspended Ceiling (C4)

Calcium silicate board suspended ceiling system shall be installed as detailed on the drawings to the approval of the Engineer.

Calcium board ceiling shall comprise of 6 mm thick boards screw fastened to approved support framing/suspension system at 600 mm centres both ways. Joints shall be sealed scrimmed and taped to provide a jointless ceiling. The suspension system shall be designed to suit the layout, spans, and the design loads and all substantiating design calculations and details shall be submitted to the Engineer for his approval. Approval accorded by the Engineer shall not relieve the Contractor of his obligations to provide a safe and aesthetic ceiling.

Calcium silicate non-combustible boards shall be produced from a laminar board consisting of a calcium silicate matrix reinforced with vermiculite and natural organic fibres. It shall not contain any asbestos or other inorganic materials. The board shall be semi-compressed and cured in a high pressure autoclave to provide a high degree of dimensional and chemical stability.

The contractor shall form necessary opening for various services including any access panels as required and finish them appropriately to the satisfaction of the Engineer.

The Contractor shall submit detailed shop drawings after verifying the dimensions at site and coordinating with all other connected works.

1062. Calcium Silicate Suspended Ceiling (C-5)

Calcium silicate suspended ceiling shall consist of 600 x 600 x 6 mm thick calcium silicate plain painting grade tiles laid in to a proprietary exposed grid metal suspension system with matching edge trims as indicated on drawings.

Calcium silicate non-combustible boards shall be produced from a laminar board consisting of a calcium silicate matrix reinforced with vermiculite and natural organic fibres. It shall not contain any asbestos or other inorganic materials. The board shall be semi- compressed and cured in a high pressure autoclave to provide a high degree of dimensional and chemical stability. The calcium silicate tiles shall be vinyl faced factory finished and of pattern approved by the Engineer.

The suspended ceiling including the suspension system shall be installed strictly accordance with the manufacturer's written instructions and to the approval of the Engineer.

1063. Mineral Fibre Tile Suspended Ceiling (C6)

Mineral fibre ceiling tiles shall be 600 x 600 x 18 mm thick with a face pattern as shown on drawings or as directed by the Engineer and laid into a pre-decorated, proprietary galvanized steel suspension system with suspenders, main bars, carrying channels, cross channels, splicer bars, connecting clips, anchors, matching edge trims, etc., fixed and spaced strictly in accordance with the manufacturer's instructions and/or as directed by the Engineer providing 100% easy access.

The tiles shall be painted with emulsion paint to an approved colour.

1064. Aluminium Tiles Suspended Ceiling (C7)

Aluminium ceiling tiles shall be 600 x 600 mm plain tiles manufactured from 0.7 mm thick aluminium sheets and shall be factory finished with baked enamel paint to a colour shown on the Drawings or as directed by the Engineer. The ceiling shall be fire rated to class 1, when tested in accordance with BS 476: Part 7: 1987 surface spread of flame and classified as Class 0 in accordance with BS 476: Part 6: 1989 fire propagation.

The tiles shall be fixed direct to a cold rolled galvanized sheet clip-in runner coupler, in a clip in runner, suspended by a proprietary suspension system comprising galvanized rigid tension spring hangers, runner and wall brackets, matching perimeter trims with hold down clips, etc., fixed and spaced strictly in accordance with the manufacturer's instructions and/or as directed by the Engineer.

The suspended ceiling system shall be from a manufacturer with a proven record of at least 5 years and to the approval of the Engineer.

1065. Refuse Containers

Refuse containers/trolleys shall be hot dip galvanized and shall comply with BS 5832:1987 and/or DIN 30700. The containers shall be provided with acceptor pegs for lift and tip devices and should be suitable and compatible to the local Municipal disposal vehicles and to the satisfaction of the Municipal authorities.

The containers shall run on wheels with rubber tyres and shall be constructed from heavy duty galvanized steel.

The capacity and size of the containers shall be as dictated by the local municipality requirements.

1066. Refuse Compactor

Refuse compactor shall be from an approved manufacturer meeting the following requirements similar to model No. HVC-600 or HV -600 to suit the garbage chute location in the garbage room (hydraulic compactor) as manufactured by Ostermier (Germany) or equal approved.

- Charging box dimension - 600 x 600 mm
- Charging box capacity - 500 liters.
- Compaction force - 250 bars or 219 kN.
- Cycle time - 30 sec.
- Power requirement - 3 Phase.
- Automatic by light barriers (photo electric cell) by push bottom Single stroke with hammering action.

The compactor shall preferably discharge to the refuse container from the top instead of bottom connections.

End of Section 11

SECTION 12

PAINTING AND DECORATING

1101. Scope

This specification covers paint work to exposed concrete and plastered/rendered surfaces, wood work, gypsum and other ceilings, ferrous and non-ferrous surfaces in accordance with the Schedule of Finishes, Drawings, Bills of Quantities and as directed in writing by the Engineer.

The term "Paint" as used herein includes emulsions, enamels, lacquers, sealers, varnishes and other coatings, organic or inorganic, whether used as prime, intermediate or finish coats.

All painting works shall be applied by skilled workmen experienced in this work.

MATERIALS

1102. Materials in General

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

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

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

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

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

The colour of the paint shall match the approved sample.

1103. Knotting

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

1104. Fillers

Fillers Shall be "Polyfilla", "Alabastine" or approved equal.

1105. Stopping

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

1106. Putty Filler

Putty filler Shall be a ready mix acrylic co-polymer based filler obtained from an approved supplier.

1107. Thinners

Thinners shall be as recommended by the paint manufacturer. Where the paints are specified to be water thinned, fresh water shall be used.

1108. Pigments

Pigments shall be pure tint colours that will easily dissolve and mix with the various coatings and shall conform to the requirements of the relevant BS suitable for the type of paint to the approval of the Engineer. In general external coatings shall have inorganic or natural pigments suitable for exterior use.

1109. Rust Inhibitor

Shall be "Galvafruid" primer, manufactured by "Secomastic Ltd. Bracknell, Berks, England" or Crown Chlorinated Rubber Zinc Rich Primer - Product Data Sheet No. 56, manufactured by the Walpamur Co. Ltd., Darwin Lancs" and/or approved equivalent.

Rust inhibitor for non ferrous surfaces shall be a two pack primer from an approved manufacturer.

1110. Primers

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

- | | |
|--|--|
| a) Interior or exterior surfaces plastered |) Alkali resistant primer recommended by the manufacturer of the finishing paint |
| Ferrous surfaces containing zinc phosphate |) Alkyd based primer
min 40 μ Dft or epoxy primer. |
| c) Non-Ferrous surfaces |) Rust inhibiting primer. |
| d) Woodwork surfaces |) Leadless grey primer in accordance to BS 5082:1986. |

1111. Undercoating Paints

For exterior or interior shall be as follows:

- White lead based undercoating in accordance with BS 4310: 1979. Colours shall be similar to the finishing paint.

- Other undercoating paints to be applied as recommended by the manufacturers of the finishing paint.

1112. Finishing Paints

Interior rendered/concrete surfaces)
Approved Acrylic copolymer based, highly washable emulsion paint.

Interior rendered/concrete surfaces)
Approved decorative lead free, non yellowing synthetic enamel paint, matt finish.

Interior concrete/rendered surfaces)
Approved Acrylic resin based paint.

d) Interior concrete surfaces of water tank) Approved two component non-toxic epoxy paint to DFT 300 micron.

Calcium silicate board surfaces)
Approved Acrylic copolymer based, highly washable emulsion paint.

Mineral fibre)
Approved Acrylic copolymer based, highly washable emulsion paint.

Exterior concrete/rendered surfaces)
Approved 4 coats full epoxy tile system paint.

h) Interior or exterior ferrous and non-ferrous surfaces.) Chlorinated rubber paint in interior or exterior grade epoxy paint.

j) Interior woodwork surface other than hardwood) Oil paint semi-gloss finish from an approved manufacturer.

WORKMANSHIP

1113. General

The Contractor shall submit to the Engineer for approval the brand and quality of the paints he proposes to use.

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

All paints to be used under this Contract shall be delivered and stored on the Site in sealed, labeled containers, a minimum of 30 days prior to application. Upon notification by the Contractor that the material is at the site, samples of each material shall be obtained at random from sealed container by the Engineer in the presence of an authorized representative of the Contractor. Samples shall be clearly identified by commercial name,

type of paint and intended use. If judged necessary by the Engineer the paint samples may be tested in a laboratory designated by the Engineer at the Contractor's expense.

Complete colour charts for the paints to be used shall be submitted to the Engineer for approval.

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

Mixing and application of paint 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.

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

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

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

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

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

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

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

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

Painting Work shall comply with BS 6150: 1982.

1114. Emulsion or Enamel Paint

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

applied in the summer shall be at least five weeks old before commencing painting operations.

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

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

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

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

All rendered and concrete surfaces shall be twice stopped with approved putty filler. The first coat of stopping shall be applied after the primer coat dries out completely and the second coat

after the first undercoat application. Each coat of stopping shall be allowed to dry and harden thoroughly and shall then be rubbed by sandpaper until a smooth surface is achieved.

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

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

1115. Ferrous Surfaces

Surfaces shall be thoroughly cleaned to remove grease and dirt, wire brushed and scraped to remove scale and rust. One coat of approved putty shall be applied on the surfaces and left to dry for at least twenty four (24) hours. Surfaces shall then be rubbed by sandpaper or other approved means before primer is applied.

One coat of rust inhibiting "Galvafrid" primer or other approved equal shall be applied by brushing well into the surface and shall be allowed to dry and harden thoroughly before the application of subsequent coats.

If ferrous works are delivered primed, the surfaces shall be examined to ascertain that the primer coat is hard. If not satisfactory the primer coat shall be removed and the surfaces cleaned to remove grease and dirt and re-primed as described above. Abraded spots on shop-coated surfaces shall be wire-brushed and touched up with same material as the shopcoat.

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

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

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

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

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

Painting of Ferrous surfaces shall comply with BS 5493: 1977.

1116. Non-Ferrous Surfaces

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

1117. Wood Surfaces

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

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

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

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

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

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

1118. Full Epoxy Paint

Full epoxy paint shall comprise of four coats as under:

First Coat : 2 pack high performance epoxy resin based primer.

Base Coat : 2 pack high performance epoxy resin based textured base coat.

Top Coats : 2 coats of 2 pack first grade polyurethane finishing top coat.

The surface preparation, application rates and methods of application shall be strictly in accordance with the written instructions of the manufacturer.

The colour and texture shall be as indicated on drawings or as directed by the Engineer.

End of Section 12

SECTION 13

MECHANICAL WORKS

DEFENITIONS AND STANDARTS

Part 1 - General

1.1 Description

A. Work included:

1. Extent of mechanical related work required by this section is indicated on drawings and/or specified in other sections of the Specifications.
2. Types of mechanical related work specified in this section include the following:
 - a. Access to mechanical work:
 1. Access doors in walls, ceilings, and floors.
 2. Removable cover plates in walls, ceilings, and floors.
 - b. Excavating for mechanical work:
 1. Underground mechanical utilities and services.
 2. Underground tanks, basins, and equipment enclosures.
 3. Exterior water circulation and distribution systems.
 4. Drainage and distribution fields.
 - c. Concrete for mechanical work:
 1. Lean concrete backfill to support mechanical work.
 2. Encasement of mechanical work.
 3. Underground structural concrete to accommodate mech. work.
 4. Tanks and vaults of mechanical work.
 5. Basins and curbs for mechanical equipment.
 6. Mechanical equipment foundations and housekeeping pads.
 7. Inertia bases for isolation of mech. work.
 8. Rough grouting in and around mech. work.
 9. Patching concrete cut to accommodate mech. work.
 - d. Painting of mechanical work:
 1. Exposed concrete provided as part of mechanical work.
 2. Exposed piping systems.
 3. Exposed ductwork systems.
 4. Exposed mechanical insulation.
 5. Exposed mechanical equipment.
 6. Louvers.
 7. Color-coded work.
3. Access requirements within mechanical work, to mechanical or electrical components within work, are specified in other sections; not work of this section.

4. Quality control testing for concrete work is required as work of this section.

B. Related Work:

1. Drawings and general provisions of Contract, including General and Supplementary Conditions, Bills of Quantities and Specification sections, apply to work of this section.
2. This section is a part of each Mechanical section making reference to mechanical related work specified herein.

1.2 QUALITY ASSURANCE

A. Codes and standards:

1. Concrete work codes and standards: Comply with governing codes and standards.
 - a. ACI 301 "Specifications for Structural Concrete for Buildings".
 - b. ACI 311 "Recommended Practice for Concrete Inspection".
 - c. ACI 318 "Building Code Requirements for Reinforced Concrete".
 - d. ACI 347 "Recommended Practice for Measuring, Mixing, Transporting and Placing Concrete".
 - e. Concrete Reinforcing Steel Institute, "Manual of Standard Practice".

- B. Painting work:** In general and where applicable, comply with indicated Federal Specifications for paint quality, and use only paint from original containers which bear manufacturer's labels indicating compliance with required Federal Specifications.

- C. Access units fire-resistance ratings:** Where fire-resistance rating is indicated for construction penetrated by access units, provide UL listed-and-labeled units, except for units which are small than minimum size ratings as recognized by governing authority.

1.3 SUBMITTALS

- A. Product data, access units: Submit manufacturer's technical data and installation instructions for each type of access door assembly, including setting drawings, templates, instructions and directions for installation of anchorage devices.
- B. Shop drawings, mechanical concrete work: Submit shop drawings for structural type concrete work (tanks, vaults, basins, foundations and other supports), showing dimensions of formed shapes of concrete; bending, placement, sizes and spacing of reinforcing steel; location of anchors, isolation units, hangers and similar devices to be integrated with concrete work; and piping penetrations, access openings, inlets and other accessories and work to be accommodated by concrete work.

- C. Manufacturer's data, mechanical concrete work: Submit data on products, including cements, special, form-coating compound, admixtures, moisture barriers, waterstops, expansion joint fillers, sealants, and curing products. Product manufacturer's certification where indicated.
- D. Manufacturer's data, paint for mechanical work: Submit manufacturer's technical information, including analysis of ingredients and application instructions for products used in painting work.
- E. Access door construction: Except as otherwise indicated, fabricate wall/ceiling door units of welded steel construction with welds ground smooth; 16-gauge frames and 14-gauge flush panel doors; 175 degree swing with concealed spring hinges .

1.4 PRODUCT HANDLING

- A. Deliver painting materials to job site in original, new and unopened packages and containers bearing manufacturer's name label showing the following information :
 - 1. Name and title of material.
 - 2. Manufacturer's stock number and date of manufacture.
 - 3. Contents by volume, for major pigments and vehicles.
- B. Project conditions:
 - 1. Existing utilities:
 - a. Locate and protect existing utilities and other underground work in manner which will ensure that no damage or service interruption will result from excavating and backfilling.
 - b. Protect property from damage which might result from excavating and backfilling.
 - c. Coordinate excavations with weather conditions, to minimize possibility of washouts, settlements and other damages and hazards.
- 2. Environmental conditions, painting work: Comply with governing regulations concerning use of and conditions for application of paint. Comply with manufacturer's recommendations and instructions. Do not apply paint in unfavorable conditions of temperature, moisture (including humidity) or ambient contamination (dust and other pollutants).

Part 2 - Products

2.1 Access To Mechanical Work

- A. Access doors:
 - 1. General: Where floors, walls and ceilings must be penetrated for access to mechanical work, provide types of access doors indicated, including floor doors if any. Furnish sizes indicated or, where not otherwise indicated, furnish adequate size for intended and necessary access. Furnish

manufacturer's complete units, of type recommended for application in indicated substrate construction, in each case, complete with anchorages and hardware.

2. Access door construction: Except as otherwise indicated, fabricate wall/ceiling door units of welded steel construction with welds ground smooth; 16-gauge frames and 14-gauge flush panel doors; 175o swing with concealed spring hinges; flush screw-driver-operated cam; factory-applied rust-inhibitive prime-coat paint finish.
3. Units set at grade: Except as otherwise indicated, provide manufacturer's standard round or square cast-iron units, complete cast-iron pipe extension protect mechanical element being accessed; designed to be set slightly above finish grade, and to be either supported by compacted soil or to be encased in concrete; secure plate to body with bronze screws; natural mill finish on plate and body.
4. Available manufacturers: Subject to compliance with requirements, manufacturers offering removable access plates which may be incorporated in the work include, but are not limited to, the following.
Manufacturer: Subject to compliance with requirements, provide removable access plates of one of the following:
 - a. Josam Mfg. Co.
 - b. Smith (Jay R.) Mfg. Co.
 - c. Wade Div., Tyler Pipe.
 - d. Zurn Industries Inc., Hydromechanics Div.

2.2 Excavating For Mechanical Work

- A. Backfill materials:
 1. Subbase material: Graded mixture of gravel, sand, crushed stone or crushed slag.
 2. Finely-graded subbase material: Well graded sand, gravel, crushed stone or crushed slag, with 100% passing 3/8" sieve.
 3. Backfill material: Soil material suitable for compacting to required densities, and complying with AASHTO Designation M145, Group A-1, A-2-4, A-2-5 or A-3.

2.3 General Painting Product Requirements

- A. Pigments: Provide paint with pure, non-fading pigments, recognized to be safe, durable and environmentally acceptable, and containing not more than 0.5 percent lead (by weight in total dry film).
- B. Vehicles and thinners: Comply with governing regulations and recognized safe practices in handling, use and drying of paint vehicles and thinners. Compatibility of paint products is the Contractor's exclusive responsibility. Select paint products to ensure freedom from problems relating to

vehicles and thinners of type and within limits recommended by paint manufacturer.

- C. Undercoat paints: Use paint produced by same manufacturer as paint to be used for finish coats.
- D. Colors: Provide colors as indicated or established by Architect/ Engineer, by color schedule or by other indication or, where not otherwise indicated, as selected by Architect/Engineer from manufacturer's standard (non-premium cost) colors available for type of paint to be provided in each case.
- E. Color-coded finishes: For finishes indicated to be color-coded for identification, provide paint complying with the color requirements of ANSI A13.1 "Scheme for the Identification of Piping Systems", except where another specific color requirement is indicated.
- F. Standards: In the following designated paint systems (example: "IPS-22") the descriptions similar to "... (TT-P-55, Type II) ..." refer to Federal Specifications of that number, and indicate required compliance with that publication as minimum standard of quality for paint product as named. Product of recognized higher quality can be used, provided either label indicates compliance with required standard, or manufacturer submits proof and certification that product meets or exceeds standard in every significant measure of quality.

Part 3 - Execution

3.1 Access To Mechanical Work

- A. Comply with manufacturer's instructions for installation of access doors, floor doors, and removal access plates.
- B. Set frames accurately in position and securely attach to supports with face panels plumb or level in relation to adjacent finish surfaces.
- C. Adjust hardware and panels after installation for proper operation.
- D. Remove or replace panels or frames which are warped, bowed, or otherwise damaged.

3.2 Excavating For Mechanical Work

- A. General: Do not excavate for mechanical work until work is ready to proceed without delay, so that total time lapse from excavation to completion of backfilling will be minimum.
- B. Excavate with vertical sided excavations to greatest extent possible, except where otherwise indicated. Where necessary, provide sheeting and cross-bracing to sustain sides of excavations. Remove sheeting and cross-bracing during backfilling wherever such removal would not endanger work or other property. Where not removed, cut sheeting off at distance below finished grade to not interfere with other work.
- C. Width: Excavate for piping with 6" to 9" clearance on both sides of pipe, except where otherwise shown or required for proper installation of pipe joints, fittings, valves and other work. Excavate for other mechanical work to provide minimum practical but adequate working clearances.
- D. Depth for direct support: For work to be supported directly on undisturbed soil, do not excavate beyond indicated depths, and hand-excavate bottom cut to accurate elevations. Except as otherwise indicated, support the following work on undisturbed soil at bottom of the excavations:
 - 1. Piping of 5" and less pipe/tube size.
- E. Cast-in-place concrete:
 - 1. Depth for subbase support: For large piping (6" pipe size and larger), tanks, and where indicated for other mechanical work, excavate for installation of subbase material in depth indicated or, if not otherwise indicated, 6" below bottom of work to be supported.
 - 2. Depth for unsatisfactory soil conditions: Where directed (because of unsatisfactory soil condition at bottom of indicated excavation), excavate additional depth as directed to reach satisfactory soil-bearing condition. Backfill with subbase material, compacted as directed, to indicated excavation depth.

3. Depth for exterior piping: Except as otherwise indicated, excavate for exterior water-bearing piping (water, steam condensate, drainage) so that top of piping will not be less than 2' vertical distance below finished grade.
4. Excavate near large trees (within drip line) by hand, and protect root system from damage or dryout to greatest extent possible. Maintain moist condition for root system and cover exposed roots with burlap. Paint root cuts of 1" diameter and larger with asphaltic tree paint.
5. Store excavated material (temporarily) near excavation, in manner which will not interfere with or damage excavation or other work. Do not store under trees (within drip line). Retain excavated material which complies with requirements for backfill material.
6. Dispose of excavated material which is either in excess of quantity needed for backfilling or does not comply with requirements for backfill material. Remove unused material from project site, and dispose of in lawful manner.

3.3 Dewatering

- A. Maintain dry excavations for mechanical work, for removing water. Protect excavations from inflow of surface water. Pump minor inflow of ground water from excavations; protect excavations from major inflow of ground water, by installing sheeting and waterproofing. Provide adequate barriers which will protect other excavations and below-grade property from being damaged by water, sediment or erosion from or through mechanical work excavations.
- B. Install and operate well-point dewatering system to maintain water at level approximately 2'-0" below mechanical work excavations, until backfilling is completed.

3.4 Base Preparation

- A. Subbase installation:
 1. Where indicated, install subbase material to receive mechanical work, and compact by tamping to form firm base for work. For piping, horizontal cylindrical tanks, and similar work, shape subbase to fit shape of bottom 90 deg. of cylinder, for uniform continuous support.
 2. Provide finely-graded subbase material for wrapped, coated, and plastic pipe and tanks.
 3. Shape subbases and bottoms of excavations with recesses to receive pipe bells, flanged connections, valves and similar enlargements in piping systems.
- B. Concrete encasement: Where piping under roadways is less than 2'-6" below surface of roadway, provide 4" base slab of concrete to support piping. After piping is installed and tested, provide 4" thick encasement

(sides and top) of concrete before backfilling. Provide Class 2500 concrete for encasement and slab.

- C. Previous excavations:
 - 1. Where piping crosses over area more than 5'-0" wide which has been previously excavated to greater depth than required for piping installation, provide suitable subsidence-proof support for piping. Comply with details shown or, where not otherwise shown, provide one of the following support systems.
 - 2. Excavate to undisturbed soil, in width equal to pipe diameter plus 2'-0". Install 8" courses of subbase material, each compacted to 95% of maximum density, as required to fill excavation and support piping.
 - 3. Excavate to undisturbed soil, in width equal to pipe diameter plus 1'-0". Install lean concrete fill to required elevation for support of piping.

3.5 Backfilling

- A. Do not backfill until installed mechanical work has been tested and accepted, wherever testing is indicated.
- B. Install drainage fill where indicated, and tamp to uniform firm density.
- C. Backfill with finely-graded subbase material to 6" above wrapped, coated, and plastic piping and tanks, and to centerline of other tanks.
- D. Condition backfill material by either drying or adding water uniformly, to whatever extent may be necessary to facilitate compaction to required densities. Do not backfill with frozen soil materials.
- F. Backfill simultaneously on opposite sides of mechanical work, and compact simultaneously; do not dislocate work from installed positions.
- G. Backfill excavations in 8" high courses of backfill material, uniformly compacted to the following densities (% of maximum density, ASTM D 1557), using power-driver hand-operated compaction equipment.
- H. Lawn and landscaped areas: 85% for cohesive soils; 90% for cohesionless soils.
- I. Paved areas, other than roadways: 90% for cohesive soils; 95% for cohesionless soils.
- J. Roadways: 90% for cohesive soils; 95% for cohesionless soils.
- K. Backfill to elevations matching adjacent grades, at time of backfilling excavations for mechanical work.
- L. Compaction tests: Where compaction tests indicate lower of backfill than specified, continue compaction (and re-excavation and backfilling where

necessary) and provide additional testing as directed by Architect/Engineer. Allowable density tolerance is not more than one-test-out-of-5 falling more than 2 percentage points below specified density.

3.6 Performance And Maintenance, Excavation Work

- A. Subsidence: Where subsidence is measurable or observable at mechanical work excavations during general project warranty period, remove surface (pavement, lawn or other finish), add backfill material, compact, and replace surface treatment. Restore appearance, quality, and condition of surface or finish to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

3.7 Surface Preparation For Painting

- A. General: Clean surfaces before applying paint products. Remove oil and grease prior to mechanical cleaning. Comply with paint products manufacturer's instructions for surface cleaning and preparation. Remove surface-applied accessories which are not to be painted, and reinstall after completion of painting. Protect non-removable items not to be painted, by covering with paper or plastic film.
- B. Cementitious surfaces: Remove efflorescence, chalk, dust and glaze to ensure good bond of paint products. Clean concrete with muriatic acid (one part diluted with 6 to 8 parts water) and flush with water, where necessary to ensure good paint bond. Perform appropriate tests to determine that both alkalinity and moisture content of concrete surfaces are below maximum allowable levels for painting, as recommended by paint manufacturer.
- C. Ferrous metal surfaces:
 - 1. Remove mill scale and loose rust on surfaces which are not zinc-coated or shop/factory prime coated.
 - 2. Clean shop-applied prime coats on metal surfaces, and repair (touch-up) prime coats wherever abraded or otherwise damaged, prior to application or paint system.
- D. Zinc-coated surfaces: Clean with non-petroleum based solvent. Wash with copper sulfate solution and flush with water, unless surface has been pretreated, or unless treatment is not recommended by manufacturer of prime coat.

3.8 Paint System Application

- A. Mixing: Comply with manufacturer's recommendations for mixing or stirring paint products immediately before application.
- B. Application limitations:

1. Except as otherwise indicated, paint every accessible surface of each unit of work indicated to be painted, regardless of whether in location recognized as "concealed" or "exposed".
 2. Omit painting of ductwork and insulated piping above removable ceilings, but apply paint system to uninsulated steel piping, exposed threads of galvanized piping, pipe hangers, duct hangers, and similar work.
 3. Omit painting on machined sliding surfaces and rotating shafts of equipment, and on nonferrous finished metals including chrome plate, stainless steel, special anodized aluminum, brass/bronze and copper, and on plastics and similar finished materials, except where specifically indicated to be color-coded by painting.
 4. Omit painting on required name plates, labels, identification tags, signs, markers, printed instructions, performance ratings, flow diagrams and similar text and graphics, located within the scope of work indicated to receive paint application.
 5. Omit specified prime coat of paint system for metal surfaces where surface has shop-applied prime coat of equivalent quality. Apply prime coat on other surfaces to be painted.
 6. Comply with paint manufacturer's instructions for prime coating where not otherwise indicated. Apply additional prime coats where suction spots or unsealed areas appear.
 7. Omit painting on surfaces located in service shafts and tunnels and above non-removable ceilings and in similar place where space is too limited or services are too congested to allow access for painting.
- C. General application requirements:
1. Apply paint in accordance with manufacturer's directions. Use applicators and techniques best suited for substrate, for type of material being applied, and for ambient conditions. Apply additional coats when undercoats, stains or other conditions show through final coat of paint, until paint film is of uniform finish, color and appearance. Apply paint at edges, corners, joints, welds and exposed fasteners in manner which will ensure dry-film thickness equal to that of flat surfaces. Allow sufficient time between successive coats for proper drying (comply with manufacturer's drying instructions).
 2. Number of coats: Number indicated is minimum number; apply as many coats as are necessary to comply with dry-film thickness requirements.
 3. Coating thickness: Apply uniform coats to produce dry-film thickness indicated or, if not otherwise indicated, apply paint without thinking in application thickness recommended by manufacturer for each coat.
 4. Textured finishes: Where indicated, roll and redistribute paint of final coat to even texture. Match adjoining textured paint finishes if any, and roll to

eliminate evidence of roll or lap marks and other unevenness and imperfections.

5. Exterior stacks: Paint the top 18" of stacks black, regardless of color selected for general painting of equipment and accessories on roof.
6. Smooth finishes: Except as otherwise indicated, apply paint in smooth finish without noticeable texture, cloudiness, spotting, holidays, laps, brush marks, runs, sags, ripples, ropiness and other surface imperfections.

3.9 Clean-Up And Protection, Painting

- A. general clean-up:
 1. During progress of work, remove from site discarded paint materials, rubbish, cans and rags at end of each work day. When directed by Architect/Engineer, retain paint containers from application of coatings on particular unit or area of work, until average dry-film thickness has been calculated.
 2. Splattered Surfaces: Upon completion of painting work, clean paint-splattered surfaces. Remove splattered paint by proper methods of washing and scraping, using care not to scratch or otherwise damage finished surfaces.
- B. Protection:
 1. Protect work of other trades, whether to be painted or not, against damage by painting work. Correct damage by cleaning, repairing or replacing and repainting as directed. Provide "Wet Paint" signs as required to protect newly-painted finishes.
 2. Remove temporary protective wrappings installed for protection of work not to be painted, after completion of painting operations. At completion of work by other trades, touch-up and restore damaged or defaced painted surfaces.

EXCAVATION AND EARTHWORK

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Work Included: Furnish all labor, materials and equipment necessary for and incidental to the completion of excavating, grading, micropiles drilling, filling, backfilling, and grading work shown on the drawings and specified herein, pertaining to the execution of all the earthworks normally carried out for the erection of buildings, underground piping, underground structures, retaining walls, trenches, etc., complete in every respect, including all related items necessary to complete the work shown on the drawings, described in this specification and as directed by the Engineer.
- B. Related work: Drawings and general provisions of contract, including General and Supplementary Conditions, Bills of Quantities and Specification sections, apply to work of this section.

1.2 QUALITY ASSURANCE

- A. Use adequate numbers of skilled workmen who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the work of this Section.
- B. Use equipment adequate in size, capacity, and numbers to accomplish the work of this Section in a timely manner.
- C. Codes and Standards: Perform excavation work in compliance with applicable specifications and Local Codes. Further to the requirements of the general conditions regarding the compliance of all materials and products with the latest issue or revisions of all standards, the following is a list of the standards that are applicable to this specification.
 - 1. ASTM-C-136 Sieve or screen analysis of fine and coarse aggregates.
 - 2. ASTM-C-127 Specific gravity and absorption of coarse aggregates.
 - 3. ASTM-D-854 Specific Gravity of Soils.
 - 4. ASTM-C-142 Friable particles in aggregates.
 - 5. ASTM-D-1556 Density of soil in place by the sand-cone method.
 - 6. B.S.1377 Methods of tester soil for Civil Engineering purposes.
 - 7. ASTM-D-2216 Laboratory determination of moisture content of soil.
 - 8. ASTM-D-423 Liquid limit of soils.
 - 9. ASTM-D-424 Plastic limit and plasticity Index of soils.
 - 10. ASTM-D-427 Shrinkage factors of soils.
- D. In addition to complying with requirements of governmental agencies having jurisdiction, comply with the directions of the soil engineer.

E. Materials Testing:

1. In general, the quality control of materials and workmanship shall be carried out as specified in the "Special Conditions" section. An approved independent and authorized materials testing office shall carry out all necessary testing and reporting.
2. Preliminary series of tests such as Density/Moisture/CBR, etc., shall be carried out in an authorized laboratory. The results of completed tests that are in accordance with the specification shall require the approval of the Engineer, prior to the contractor's making use of the material or product tested.
3. Compacting Testing
 - a. Sampling:
 1. After a layer has been correctly graded and made even it shall be sampled for testing the quality of the workmanship. The Engineer will determine the points where samples shall be taken. Sampling shall be performed regularly for the approval of each layer. The above shall be carried out in accordance with the relevant requirements of the Specification.
 2. In every case where the quality of a layer does not meet the requirements, it shall be corrected or demolished and executed anew, as laid down in the specification. After these corrections have been completed, the layer shall be retested. The Contractor shall keep a check on the performance of tests and any objections shall immediately be brought to the attention for the Engineer. Objections lodged at a later time will not be considered. Work shall not start on a new layer until the previous one has been approved. For any work or layer, the Engineer will determine the area for testing and approval shall be obtained before a new layer may be placed thereon.
 3. The cost of all above testing shall be met by the contractor whether the test results are satisfactory or not.
- b. Rate of density
 1. The rate of density is the percentage ratio between the field density (without correction for material passing the 3/4" sieve) and the calculated density multiplied by 100, as follows:

$$D = \frac{100}{\frac{P_c}{G_s} + \frac{P_f}{rD_f}}$$

The value of the compaction will be a percentage rounded off to a whole number. Where,

D - Calculated density T/cu.m.

P_c - Percentage of aggregates larger than 3/4"

P_f - Percentage of aggregates smaller than 3/4"

D_f - Maximum density obtainable according to ASTM-D-1557-70 (method D0 T/cu.m.)

G_s - Bulk specific Gravity of aggregates larger than 3/4", according to

ASTM-C-127-59.

r- Correction factor, given in the following table:

Table of Correction Factors:

<u>Pc%</u>	<u>R</u>
20 or less	1.00
21-25	0.99
26-30	0.98
31-35	0.97
36-40	0.96
41-45	0.95
46-50	0.94
51-55	0.92
56-60	0.89
61-65	0.86
66-70	0.63

Table extracted from AASHTO-T-224-67

c. Compliance With Requirements:

1. All works shall be done in accordance with the design levels and dimensions without exceeding vertical deviations, as follows:
 1. Subgrade and ditches - minus 30mm.
 2. Fill under slab - minus 20mm.
2. The deviations shall apply to each layer and shall not be cumulative. Any increase in this of one or more structural layers (above the subgrade) necessary because of the a/m deviations shall be at the Contractor's expenses.
3. Repairs shall be made in areas where the deviations exceed the permissible limit. At bulges the surplus material shall be removed and the rolling executed again. At depressions the deficient material shall be added after diskings the underlying layer to a depth of 20cm and the rolling shall be executed again.

1.3 SUBMITTALS

If excavation is over 1.5 meters in depth it shall be sheeted and shored, submit working drawings and calculation for the design of the sheeting and shoring.

1.4 JOB CONDITIONS

- A. Existing Utilities: If utilities are to remain in place, provide adequate means of protection during earthwork operations.
- B. Should unanticipated utilities be encountered during excavation, cease work and consult the Engineer immediately.

Resume work only after agreement has been reached as required by the General Conditions. Repair damaged utilities to the satisfaction of the Engineer.

- C. Demolish and completely remove from site existing underground utilities indicated to be removed.

1.5 SITE CLEARING

- A. The Contractor shall carry out site clearance which shall include clearing out the whole site area of all kinds of vegetation, debris rubbish, etc., including the grubbing out of roots, including loading and carting away to an approved dumping area prior to any site preparation and/or setting out is begun.

1.6 SITE INSPECTION AND INVESTIGATION

- A. The Contractor shall visit the site prior to submittal of his tender price and make all investigation which he deems necessary to ascertain the nature of the existing ground and the sub-soil to be excavated. Permit to drill boreholes will be granted to Contractor.
- B. The Contractor shall examine the contract drawings and other contract documents and promptly notify the Engineer of any discrepancy, error or omission that he may discover. Correction instructed in this respect will be compiled with all in accordance to the provisions of the contract documents.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

- A. Sub-base material: AASHTO M 147, Grade B or equivalent Local standards.
- B. Drainage Fill: Washed, uniformly graded mixture of crushed stone, or crushed or uncrushed gravel, with 100% passing a 38mm sieve and not more than 5% passing a sieve No. 200.
- C. Backfill and Fill Materials Classified as A-1, A-2, or A-3, in accordance with AASHTO M 145 or equivalent Local Standards. All materials shall be free of rock or gravel larger than 50 mm in any dimension, debris, waste, organic material, and other deleterious matter. Do not use material with particles larger than 25 mm within 600 mm of structures and in the bottom 200 mm of trenches. The following tests shall be used to ensure the fill meets the above requirements:

ASTM-D 2487 : Classification of soils for Engineering purposes.
ASTM-D 422 : Particle - size analysis of soils.
ASTM-D 423 : Liquid limits of soils.
ASTM-D 424 : Plastic limit and plasticity index of soil.

PART 3 - EXECUTION

3.1 WORKMANSHIP

A. Levels:

1. The Contractor shall satisfy himself of the accuracy of the existing ground levels as shown on the drawings before commencing work on the site and no claim will subsequently be allowed because of his failure to do so. All excavations shall be made to the depths, levels and dimensions shown on the working drawings submitted by the Contractor and approved by the Engineer all as may be directed.

B. Excavation Generally:

1. This work shall comprise excavation to any depth, as shown on the drawings, in unclassified ground including all hard and rock layers, temporary earthwork supports and any work below the normal water table. It includes also the satisfactory removal and the position of all materials excavated, regardless of their nature and consistency and including grubbing up old roots, drain pipes, hardcore and all other obstruction below ground level. No extras will be allowed either on account of the condition of the materials at the time it is excavated, the manner in which it is excavated or any other cause whatsoever.
2. Excavation shall be carefully planned to ensure the adjacent ground and works are adequately supported at all times, and their safety shall be Contractor's responsibility.
3. Excavation may be by machine or by hand at the discretion of the Contractor. Under no circumstances will a claim be entertained for the extra cost of one type of excavation over the other. Rock shall be removed with compressed air hammers or other special plant. Blasting will not be allowed without written permission from the Engineer, who must be fully informed by the Contractor as to steps taken to safeguard the surrounding property, and the Contractor must take all responsibility for any damage or annoyance caused by reason of blasting. In case permission is not granted to use explosives, no claims for any additional costs or delays whatsoever shall be considered.
4. Where excavation works are carried out by power excavating equipment such as mini power shovels and mini back-hoes, jack hammers, power drills, or any other equipment which the trade Contractor may propose to use, sufficient depth shall be left unexcavated to enable the exact depth required to be obtained by hand excavation.

C. Engineer's Approval:

1. The setting out shall be approved before work is commenced and the Contractor is to notify the Engineer when the excavations are ready to receive the concrete foundation and these shall not be laid until Engineer has signified his approval in writing that a proper foundation strata has been obtained.

2. Covering up of foundations is not to be carried out until the foundations have been inspected and approved. The Contractor is to give the Engineer three days notice of his intention to cover up any foundation.
- D. Shoring and Bracing:
1. Provide materials for shoring and bracing such as sheet piling, up rights, stringers and cross-braces in good serviceable condition. Provide permanent steel sheet piling wherever subsequent removal of sheet piling might permit lateral movement of soil under adjacent structures. Cut-off tops at 400 mm below final grade and leave permanently in place.
- E. Drainage:
1. The Contractor shall be responsible, and shall provide all necessary equipment, for keeping all excavation and subsequent concreting operations dry.
- F. Liability of Excavation:
1. Any excavation which have been excavated in good ground beyond the level and sizes shown on the drawings or required by the Engineer are to be filled by the Contractor with the same mix as specified for the foundations at the Contractor's own expense. Any soft pockets which in the Engineer's opinion should be excavated shall be filled with concrete of characteristic strength 15 N/mm^2 and measured and valued at contract rates.
 2. No heavy plant or equipment shall be placed adjacent to excavations unless by written agreement of the Engineer. No such agreement given or implied shall relieve the Contractor of his contractual responsibility.
- G. Trimming excavations:
1. The bottom and sides of excavations shall be sufficiently trim, clean, and dust free prior to pouring any concrete.
 2. Importance is attached to keeping dry and clean the excavated surfaces upon or against which concrete or brickwork is to be deposited or built. Adequate precautions are to be taken to prevent water from washing out cement or particles falling in, or in any other way injuring the work.
- H. Backfilling:
1. No backfilling is to be done until construction below ground has been approved, underground utilities systems have been inspected, tested and approved, forms removed and the excavation cleaned of debris and rubbish.
 2. Where floor slabs are designed as ground bearing it is particularly important that the backfilling beneath these should be uniformly and thoroughly compacted to 95% Proctor, this stipulation applies to trenches for retaining walls and foundations.
 3. Filling behind basement or retaining walls shall not be placed in position until 14 days after they have been constructed unless otherwise

approved, or until the suspended floor abutting the wall at the top or at intermediate levels has been cast and set, and shall be placed with very great care to insure that the water-proofing membrane is not damaged.

4. All materials used for back filling shall, unless otherwise ordered, be selected hard, dry, material from the excavations or imported thoroughly compacted in 20 cm layers with a heavy roller or other approved mechanical plant. The Contractor shall submit his proposals for compacting the fill for approval before commencing work.
 5. If the excavated material is not approved for use as fill, then clean well graded hardcore or other granular fill shall be provided by the Contractor. Details of all imported filling materials shall be submitted for approval before starting work, no material will be approved which does not comply with the specifications.
 6. If directed the top surface shall be well brushed and blinded with fine material to receive concrete.
- I. Trench Excavation and Filling:
1. Trenches for underground utilities systems and drain lines shall be excavated to the required alignments and depths. The bottoms of trenches shall be tamped to secure the required slope and shall be tamped if necessary to provide a firm pipe bed. Recesses shall be excavated to accommodate bells and joints so that pipe will be uniformly supported for the entire length. Rock, where encountered, shall be excavated to a depth 15 cm below the bottom of the pipe, and the over depth shall be back filled with approved material. Bottoms of trenches to receive PVC pipes shall be excavated for sewer and water pipes, and underground electrical and communication services unless otherwise indicated. Care shall be exercised to minimize disturbance to the compacted subgrade.
 2. The Contractor is to provide all timbering, steel sheets piling or other approved supports, and support the sides of excavations, trenches and pits in such a way as well be sufficient to secure them from falling and to prevent any movement.
 3. The Contractor shall submit for approval details of his scheme and methods of excavation shoring and filling before starting work. Such approval shall in no way relieve the Contractor of his responsibilities for the sufficiency of his methods. The Contractor is to be responsible for timing and removal of timber, steel sheet piling or other materials ensuring and trenches.
 4. Care must be taken in excavating service trenches etc., along side foundations. Particular attention shall be given to all excavations and fillings which extend to depths sufficient to fall within a dispersion angle of 45° from the underside of any foundations.

5. Lower portion of trenches shall be backfilled in 15 cm maximum thickness layers and compacted with suitable tampers to the density of the adjacent ground until there is a cover of not less than 80 cm over drain pipe and 30 cm over other utilities unless otherwise noted. The backfill in this portion of the trench shall consist of a selected material at moisture content that will facilitate compaction, free from stones larger than 2.5 cm in any dimension and hard clods and conglomerates larger than 15 cm in any dimension.
- J. Crushed Stone Filling:
1. The stone for filling is to be clean, dry, hard stone broken to pass 5 cm mesh, free from all foul materials, vegetable matter and rubbish and is to be deposited in layers not exceeding 15 cm thickness each layer well rammed and consolidated.
 2. The surface of crushed stone filling or beds are to be leveled or other graded and blinded with approved fine material to fill all interstices.
 3. Should any crushed stone filling or beds be damaged by water, mud or other cause before being covered they are to be cleaned of and reformed as directed at the Contractor's own expense.
- K. Settlement:
- The Contractor shall be responsible for making good any settlement of filling that may occur and for any consequential damage up to the end of the period of maintenance. The slopes, backfilled areas, etc., shall be formed to such levels as to ensure that the final lines and levels after settlement shall be as shown on the drawings or directed.
- L. Disposal of Surplus Material:
- Load and cart away from the site all surplus excavated materials and deposit on tip to be provided by the Contractor and pay all charges in connection therewith.

PART 4 - EXCAVATIONS FOR UNDERPINNING

- A. All underpinning excavations under existing foundations if deemed necessary after performance of the requisite investigations shall be undertaken by well experienced personnel in this type of excavation.
- B. All methods, sequences, temporary supports including calculations shall be submitted by the Contractor for the approval of the Engineer prior to commencement.

SEWER COLLECTION SYSTEM

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Work included: Extent of sewer collection system work is shown on drawings. Sewer collection system work includes, but is not limited to, the following:
 - 1. Sanitary sewer conduits.
 - 2. Storm sewer conduits.
 - 3. Manholes, frames and covers.
 - 4. Catch basins, frames and gratings.
 - 5. Excavation and backfilling for sewer collection system is specified in a separate section.
- B. Related Work: Drawings and general provisions of the Contract, including General and Supplementary Conditions, Bills of Materials and Specification sections, apply to work of this section.

1.2 QUALITY ASSURANCE

- A. Installer: The Contractor or a firm specializing and experienced in sewer collection system work for not less than 5 years.

1.3 SUBMITTALS

- A. Shop drawings: Submit shop drawings for system, showing conduit types and sizes, locations, elevations and slopes for horizontal runs. Include details of underground structures, accessories, fittings, and connections.

PART 2 - PRODUCTS

2.1 CONDUIT MATERIALS

- A. General: Furnish ells, tees, reducing tees, wyes, couplings, increasers, crosses, transitions and end caps of same type and class of material as conduit, or of material having equal or superior physical and chemical properties as acceptable to the Architect/Engineer.
- B. Cast Iron Soil pipe (CISPP): ANSI/ASTM A 74, bell and spigot type with neoprene rubber gaskets conforming to ANSI/ASTM C 564, or to BS437

and BS416. Furnish service weight (CISPP-SW) class or equivalent when exposed on external walls.

- C. Concrete pipe (CPp): Ministry of Public Works Standards, unless otherwise indicated, for buried outside pipes larger than 100mm.
- D. Poly (Vinyl Chloride) Pipe (PVCPP): ANSI/ASTM D 3033, Type PSP or ANSI/ASTM D 3034, Type PSM, or equivalent and as indicated on drawings for all internal pipes to BS standards, BS 4514 for exposed pipes and to BS 4660 or to DIN 8062 and or equivalent for buried pipes and connection pieces to manholes.

2.2 CONCRETE MANHOLES

- A. Concrete base: Precast or cast-in-place, at Contractor's option. Use concrete which will attain a 28-day compressive strength of not less than 3000 psi.
- B. Precast concrete manholes:
 - 1. Ministry of Public Works Standards, or as acceptable by the local Water Authority, or to ANSI/ASTM C 478. Standard prefab rings, for manholes deeper than 1.2 meters with
 - 2. Eccentric cone precast top for deep manholes as practical as possible.
 - 3. Flat slab top for shallow manholes.

2.3 MASONRY MATERIALS FOR SHALLOW MANHOLES

- 1. Manhole brick: ANSI/ASTM C 32, Grade MS.
- 2. Sewer brick: ANSI/ASTM C 32, Grade SS.
- 3. Masonry mortar: ANSI/ASTM C 270, Type M. For minor amounts of mortar, packaged materials complying with ANSI/ASTM C 387, Type M, will be acceptable.

2.4 METAL ACCESSORIES

- A. Manhole frames and covers: Gray cast iron, ANSI/ASTM A 48. Heavy duty at roads, medium duty at sidewalks and other areas outside the buildings and at warehouses and forklift passages. Otherwise light duty covers. All shall be cast iron covers. Furnish covers with cast-in legend ("STORM" or "SANITARY" to suit installation in ARABIC) on roadway face.
- B. Manhole steps: Gray cast iron, ANSI/ASTM A 48, Class 30 B, integrally cast into manhole sidewalks, unless otherwise indicated.
- C. Catch basin frames and gratings: Gray cast iron, ANSI/ASTM A 48, Class 30 B.

PART 3 - EXECUTION

3.1 INSTALLATION OF CONDUIT

- A. General:
 - 1. Install conduit in accordance with Water Authority instructions, except where more stringent requirements are indicated.
 - 2. Inspect conduit before installation to detect apparent defects. Mark defective materials with white paint and promptly remove from site.
 - 3. Lay conduit beginning at low point of a system, true to grades and alignment indicated with unbroken continuity of invert.
 - 4. Place bell ends of clay conduit or groove end of concrete conduit facing upstream.
 - 5. Install gaskets in accordance with manufacturer's recommendations for use of lubricants, cements, and other special installation requirements.
- B. Concrete pipe: Install in accordance with Water Authority instructions, or applicable provisions of American Concrete Pipe Association "Concrete Pipe Field Manual", unless otherwise indicated.
- C. Cast Iron Soil pipe: For buried pieces, after inspection and at least 48 hours before installation, apply high-build bituminous coating to external surfaces. Apply single coat in accordance with manufacturer's recommendations to attain dry-film thickness of not less than 12 mils.
- D. Plastic pipe: Install plastic piping in accordance with pipe manufacturer's instructions. Use joint adhesives as recommended by manufacturer to suit basic pipe materials.
- E. Cleaning conduit:
 - 1. Clear interior of conduit of dirt and other superfluous material as work progresses. Maintain swab or drag in line and pull past each joint as it is completed.
 - 2. Place plugs in ends of uncompleted conduit at end of day or whenever work stops.
 - 3. Flush lines between manholes if required to remove collected debris.
- F. Joint adapters: Make joints between cast iron pipe and other types of pipe with standard manufactured cast iron adapters and fittings.
- G. Grout joints between cast iron pipe and concrete pipes thoroughly with cement mortar to make watertight joint.
- H. Closing abandoned utilities:

1. Close open ends of abandoned underground utilities which are indicated to remain in place. Provide sufficiently strong closures to withstand hydro-static or earth pressure which may result after ends of abandoned utilities have been closed.
2. Close open ends of concrete or masonry utilities with not less than 8" thick brick masonry bulkheads.
3. Close open ends of plastic conduit with threaded caps, plastic plugs, or other acceptable methods suitable for size and type material being closed. Wood plugs are not acceptable.

3.2 INTERIOR INSPECTION

- A. Inspect conduit to determine whether line displacement or other damage has occurred.
- B. Make inspections after lines between manholes, or manhole locations, have been installed and approximately two feet of backfill is in place and at completion of project.
- C. If inspection indicates poor alignment, debris, displaced pipe, infiltration or other defects, correct such defects to satisfaction of Architect/Engineer.

3.3 UNDERGROUND STRUCTURES

- A. Masonry construction manholes:
 1. Mix mortar with only enough water for workability. Retempering of mortar will not be permitted. Keep mortar mixing and conveying equipment clean. Do not deposit mortar upon, or permit contact with, the ground.
 2. Lay masonry in mortar so as to form full bed with ends and side joints in one operation, and with full bed and vertical joints, not more than 5/8" wide. Protect fresh masonry from too rapid drying.
 3. Apply a 1/2" thick mortar coating on both interior and exterior wall surfaces.
 4. Where manholes occur in pavements, set tops of frames and covers flush with finish surface. Elsewhere, set tops 3" above finish surface, unless otherwise indicated.
 5. Use an epoxy bonding compound where manhole steps are mortared into masonry walls.
- B. Precast concrete manholes:
 1. Place precast concrete sections as shown on drawings. Where manholes occur in pavements, set tops of frames and covers flush with finish surface. Elsewhere, set tops 3" above finish surface, unless otherwise indicated.

2. Use epoxy bonding compound where manhole steps are mortared into manhole walls.
 3. Provide rubber joint gasket complying with ASTM C 443.
- C. Catch basins:
1. Construct catch basins to the sizes and shapes indicated.
 2. Use concrete which will attain a 28-day compressive strength of not less than 3000 psi.
 3. Set cast iron frames and gratings to elevations indicated.
- D. Backfilling: General: Conduct backfill operations of open-cut trenches closely following laying, jointing and bedding of pipe, and after initial inspection and testing are completed.
- E. Testing: Perform testing of completed conduit lines in accordance with Water Authority authorities having jurisdiction.

WATER SERVICES PIPING

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Work included:
 - 1. Extent of water service piping work is shown on drawings.
 - 2. Exterior water service piping work includes, but is not limited to, the following:
 - a. Yard piping.
 - b. Control valves.
 - c. Water meter.
 - 3. Excavation and backfilling for exterior water service piping is specified in a separate section.
- B. Related Work: Drawings and general provisions of the Contract, including General and Supplementary Conditions, Bills of Materials and Specification sections, apply to work of this section.

1.3 QUALITY ASSURANCE

- A. Codes and standards
 - 1. Code compliance: Comply with applicable portions of National Standard Plumbing Code and local plumbing codes where more stringent.
- B. Installer: The Contractor or a firm with at least 5 years of successful installation experience on exterior water service piping projects similar to this project.

1.4 SUBMITTALS

- A. Product data: Submit manufacturer's product data and installation instructions for each product specified for water service piping.

PART 2 - PRODUCTS

2.1 PRESSURE PIPE

- A. Steel pipes shall be to ASTM A-120 and A-53, schedule as clearly stated in the BOQ, or to BS 1387 class as specified in the BOQ with fitting to BS 143 and threads to BS 21 and galvanization to BS 1387 appendix A.

2nd. General: Provide ells, tees, reducing tees, wyes, couplings, and other required piping accessories of same type and class of material as conduit, or of material having

3rd. equal or superior physical and chemical properties as acceptable to Architect/ Engineer. See Drawings.

2.2 CONTROL VALVES

A. General:

1. Minimum working pressure, 16 bars unless otherwise indicated.
2. Provide valves and flow control devices as indicated.

B. Gate valves: Standard shut-off valves with maximum working pressure cast into body, outside-screw-and-yoke type complying with AWWA C 500.

C. Check valves: Gravity-operated, regular type, iron-bodied, bronze fitted with metal-to-metal or rubber faced checks, complying with AWWA C 506.

D. Butterfly valves: Rubber seated, equipped with gear or travelling nut accuator to minimize water hammer, complying with AWWA C 504.

2.3 ACCESSORIES

A. General:

1. Provide anchorages for tees, plugs, caps, and bends.
2. After installation, apply a full coat of asphalt or other acceptable corrosion-retarding material to surfaces of rods and clamps.

B. Clamps, straps and washers: Steel, ANSI/ASTM A 506.

C. Rods: Steel, ANSI/ASTM A 575.

D. Rod couplings: Malleable iron, ANSI/ASTM A 197.

E. Bolts: Steel, ANSI/ASTM A 307.

F. Cast iron washers: ANSI/ASTM A 126, Class A.

F. Thrust blocks: 2500 psi concrete.

G. Water service identification: Plastic line markers, nomenclature "Caution, Buried Water Line Below".

PART 3 - EXECUTION

3.1 INSTALLATION

- A. General: Install exterior water service piping system in compliance with local governing regulations.
 - 1. Water Service Piping: Extend water service piping of size and in location indicated to water service entrance at building. Provide sleeve in foundation wall for water service entry;
 - 2. Steel pipe: Install in accordance with AWWA M 11.
 - 3. Control valves: Install in accordance with manufacturer's instructions.
 - 4. Joint adaptors: Make joints between cast iron pipe and other types of pipe with standard manufactured cast iron adaptors and fittings.
 - 5. Grout joints between cast iron pipe and concrete pipes with cement mortar to make watertight joint.
- B. Interior inspection: Inspect conduit to determine whether line displacement or other damage has occurred. If the inspection indicates poor alignment, debris, displaced pipe, infiltration or other defects, correct such defects to satisfaction of Architect/Engineer.
- C. Cleaning conduit: Clear interior of conduit of dirt and other superfluous material as work progresses. Maintain swab or drag in line and pull past each joint as it is completed. Place plugs in end of uncompleted conduit at end of day or whenever work stops.
- D. Sterilization: At completion of water service line installation, flush and sterilize in conformance with AWWA C-601, to the satisfaction of local authorities having jurisdiction.

3.2 TESTING

- A. Perform hydrostatic testing of completed conduit lines in accordance with local authorities having jurisdiction.
- B. Perform operational testing of valves by opening and closing under water pressure to insure proper operation.

3.3 BACKFILLING

Conduct backfilling operations of open-cut trenches closely following laying, jointing and bedding of pipe, and after initial inspection and testing are completed.

TERMINAL UNITS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Work included:
 - 1. Extent of terminal unit work is indicated by drawings and schedules, and by requirements of this section.
 - 2. Types of terminal units required for project include the following:
 - a. Radiation.
 - b. Fan-coil units.
 - c. Unit ventilators.
 - d. Coils.
 - 3. Refer to other Mechanical sections for piping; ductwork; wiring and testing, adjusting and balancing of terminal units for the following work; not work of this section:
 - a. Power supply wiring from power source to power connection on terminal unit. Include starters, disconnects, and required electrical devices, except where specified as furnished, or factory-installed, by manufacturer.
 - b. Interlock wiring between electrically-operated terminal units; and between terminal units and field-installed control devices.
 - 4. Interlock wiring specified as factory-installed is work of this section.
 - 5. Provide the following electrical work as work of this section, complying with requirements of Electric standards and specifications:
 - a. Control wiring between field-installed controls, indicating devices, and terminal unit control panels.
- B. Related work: Drawings and general provisions of Contract, including General and Supplementary Conditions, Bills of Quantities and Specification sections, apply to work of this section.

1.2 QUALITY ASSURANCE

- A. Codes and standards:
 - 1. Radiators shall be in compliance with international Standards engraved on every section of the radiators, (or any equivalent standards)
 - 2. ARI compliance: Provide coil ratings in accordance with AIR Standard 410 "Forced-Circulation Air-Cooling and Air-Heating Coils".

3. ASHRAE compliance: Test coils in accordance with ASHRAE Standard 33 "Methods of Testing Forced Circulation Air Cooling and Heating Coils".
4. ARI compliance: Test and rate fan-coil units in accordance with ARI Standard 440 "Room Fan-Coil Air-Conditioners".
5. UL compliance: Construct and install fan-coil units in compliance with UL 883 "Safety Standards for Fan Coil Units and Room Fan Heater Units.
6. UL Compliance: Provide electrical components for terminal units which have been listed and labeled by UL.

1.3 SUBMITTALS

- A. Product data: Submit manufacturer's specifications for terminal units showing dimensions, capacities, ratings, performance characteristics, gauges and finishes of materials, and installation instructions.
- B. Shop drawings: Submit assembly-type shop drawings showing unit dimensions, construction details, and field connection details.
- C. Samples: Submit 3 samples of each type of cabinet finish furnished.
- D. Maintenance data: Submit maintenance instructions, including lubrication instructions, filter replacement, motor and drive replacement, and spare parts lists. Include this data, product data, and shop drawings in maintenance manuals; in accordance with requirements of Division 1.

1.4 PRODUCT HANDLING

- A. Handle terminal units and components carefully to prevent damage, breaking, denting and scoring. Do not install damaged terminal units or components; replace with new.
- B. Store terminal units and components in clean dry place. Protect from weather, dirt, fumes, water, construction debris, and physical damage.
- C. Comply with Manufacturer's rigging and installation instructions for unloading terminal units, and moving them to final location.

PART 2 - PRODUCTS

2.1 STEEL PANELS RADIATORS

- A. General: Provide steel panel radiators in locations as indicated on Drawings, and of capacities, style, and having accessories as scheduled.
- B. Accessories:
Provide the following accessories:
 - 1. Blank end caps.
 - 2. Vent
 - 3. Supply and Return valves.
 - 4. Hangers.
- C. Available manufacturers: Subject to compliance with requirements, manufacturers offering baseboard radiation which may be incorporated in the work include, but are not limited to, the following:
 - 1. Banit
 - 2. Maktekklor

2.2 FAN-COIL UNITS

- A. General: Provide fan-coil units having cabinet sizes, and in locations indicated, and of capacities, style, and having accessories as scheduled. Include in basic unit chassis, coils, fanboard, fans, housing, motor, filter, and insulation.
- B. Chassis: Construct chassis of galvanized steel with flanged edges.
- C. Insulation: Faced, heavy density glass fiber.
- D. Cabinet: Construct of 18-ga. steel removable panels, 16-ga. front. Provide insulation over entire coil section. Clean cabinet parts, bonderize, phosphatize, and flow-coat with baked-on primer.
- E. Coils: Seamless copper tubes mechanically bonded to configured aluminum fins. Design for 300 psi working pressure, and leak test at 300 psi under water.
- F. Drain pans: Construct of galvanized steel. Insulate with polystyrene or polyurethane insulation. Provide drain connection.
- G. Fans: Provide centrifugal forward curved double width wheels of reinforced fiberglass, in galvanized steel fan scrolls.
- H. Motors: Provide motors with integral thermal overload protection. Run test motors at factory in assembled unit prior to shipping. Provide quickly detachable motor cords.
- I. Filters: Provide 1" thick throwaway type filters in fiberboard frames.

- J. Dampers: Provide 18-ga. steel damper blades with polyurethane stop across entire blade length. Provide factory-mounted electric operators for 25% open cycle.
- K. Accessories:
Provide the following accessories as indicated and/ or scheduled:
 - 1. Wall boxes: Provide aluminum wall boxes with integral eliminators and insect screen.
 - 2. Discharge grill panels: Provide 18-ga. galvanized steel, stamped integral grilles, with access doors.
 - 3. Sub-bases: Provide 18-ga. steel sub-base, height as indicated.
 - 4. Extended oilers: Provide plastic motor oiler tubes extending to beneath top discharge grille.
 - 5. Recessing flanges: Provide 18-ga. steel flanges for recessing fan-coil units into wall or ceiling.
- L. Available manufacturers: Subject to compliance with requirements, manufacturers offering fan-coil units which may be incorporated in the work include, but are not limited to, the following:
 - 1. Electra
 - 2. Pereg

PART 3 - EXECUTION

3.1 INSPECTION

- A. Examine areas and conditions under which terminal units are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.2 INSTALLATION OF BASEBOARD RADIATION

- A. General: Install radiators as indicated, and in accordance with manufacturer's installation instructions.
- B. Locate radiators on outside walls as indicated. Coordinate with window height for model selection.
- C. Center elements under windows. Where multiple windows occur over units, divide element into equal segments centered under each window.
- D. Install end caps where units butt against walls.

3.2 INSTALLATION OF FAN-COIL UNITS

- A. General: Install fan-coil units as indicated, and in accordance with manufacturer's installation instructions.
- B. Locate fan-coil units as indicated, coordinate with other trades to assure correct recess size for recessed units.
- C. Install piping as indicated.
- D. Protect units with protective covers during balance of construction.

3.4 ELECTRICAL WIRING

- A. General: Install electrical devices furnished by manufacturer but not specified to be factory-mounted. Furnish copy of manufacturer's wiring diagram submittal to Electric Installation.
- B. Verify that electrical wiring installation is in accordance with manufacturer's submittal and installation requirements of Electric standards and specifications. Do not proceed with equipment start-up until wiring installation is acceptable.

3.5 ADJUSTING AND CLEANING

- A. General: After construction is completed, including painting, clean unit exposed surfaces, vacuum clean terminal coils and inside of cabinets.
- B. Retouch any marred or scratched surfaces of factory-furnished cabinets, using finish materials furnished by manufacturer.
- C. Install new filter units for terminal requiring same.

SUPPORTS AND ANCHORS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Work included: Extent of supports and anchors required by this section is indicated on drawings and/or specified in other Division-15 sections.
1. Types of supports and anchors specified in this section include the following:
 - a. Horizontal-Piping Hangers and Supports.
 - b. Vertical-Piping Clamps.
 - c. Hanger-Rod Attachments.
 - d. Saddles and Shields.
 - e. Spring Hangers and Supports.
 - f. Miscellaneous Materials.
 - j. Roof Equipment Supports.
 - h. Anchors.
 - i. Equipment Supports.
 2. Supports and anchors furnished as part of factory-fabricated equipment, are specified as part of equipment assembly in other Mechanical sections.
- B. Related Work:
1. Drawings and general provisions of Contract, including General and Supplementary Conditions, Bills of Quantities and Specification sections, apply to work of this section.
 2. This section is Basic Mechanical Materials and Methods section, and is a part of each section making reference to supports and anchors specified herein.

1.2 QUALITY ASSURANCE

- A. Manufacturer's qualifications: Firms regularly engaged in manufacture of supports and anchors, of types and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.
- B. Codes and standards:
1. Code compliance: Comply with applicable plumbing codes pertaining to product materials and installation of supports and anchors.
 2. UL and FM compliance: Provide products which are UL-listed and FM approved.
 3. MSS standard compliance:

- a. Provide pipe hangers and supports of which materials, design, and manufacture comply with MSS SP-58.
- b. Select and apply pipe hangers and supports, complying with MSS SP-69.
- c. Fabricate and install pipe hangers and supports, complying with MSS SP-89.
- d. Terminology used in this section is defined in MSS SP-90.

1.3 SUBMITTALS

- A. Product data: Submit technical product data, including installation instructions, and drawings for each type of support and anchor. Submit pipe hanger and support schedule showing Manufacturer's figure number, size, location, and features for each required pipe hanger and support.
- B. Shop drawings: Submit manufacturer's assembly-type shop drawings for each type of support and anchor, indicating dimensions, weights, required clearances, and methods of assembly of components.
- C. Maintenance data: Submit maintenance data and parts list for each type of support and anchor. Include this data, product data, and shop drawings in maintenance manual.

PART 2 - PRODUCTS

2.1 HORIZONTAL - PIPING HANGERS AND SUPPORTS

- A. General: Except as otherwise indicated, provide factory-fabricated horizontal-piping hangers and supports complying with MSS SP-58, of one of the following MSS types listed, selected by Installer to suit horizontal-piping systems, in accordance with MSS SP-69 and manufacturer's published product information. Use only one type by one manufacturer for each piping system. Select size of hangers and supports to exactly fit pipe size for bare piping, and to exactly fit around piping insulation with saddle or shield for insulated piping. Provide copper-plated hangers and supports for copper-piping systems.
 - 1. Adjustable steel clevis hangers: MSS Type 1. (To suspend insulated or noninsulated stationary pipes)
 - 2. Yoke type pipe clamps: MSS Type 2. (To suspend pipes requiring 100mm insulation thickness)
 - 3. Steel double bolt pipe clamps: MSS Type 3. (As above but flexibility of clamp is required)
 - 4. Steel pipe clamps: MSS Type 4. (To suspend pipes without insulation)

5. Adjustable steel band hangers: MSS Type 7.
6. Adjustable band hangers: MSS Type 9.
7. Adjustable swivel rings, band type: MSS Type 10.
8. Split pipe rings: MSS Type 11. (Last four are acceptable for noninsulated stationary pipes suspension)
9. Clips: MSS Type 26. (To support noninsulated pipes not subject to expansion or contraction)
10. Pipe stanchion saddles: MSS Type 37, including steel pipe base support and cast-iron floor flange. (For noninsulated pipes on floor or roofs).
11. Single pipe rolls: MSS Type 41. (To suspend pipe subject to expansion and contraction)

2.2 VERTICAL-PIPING CLAMPS

- A. General: Except as otherwise indicated, provide factory-fabricated vertical-piping clamps complying with MSS SP-58, of one of the following types listed, selected by Installer to suit vertical piping systems, in accordance with MSS SP-69 and manufacturer's published product information. Select size of vertical piping clamps to exactly fit pipe size of bare pipe. Provide copper-plated clamps for copper-piping systems.
- B. Two-bolt riser clamps: MSS Type 8.

2.3 HANGER-ROD ATTACHMENTS

- A. General: Except as otherwise indicated, provide factory-fabricated hanger-rod attachments complying with MSS SP-58, of one of the following MSS types listed, selected by Installer to suit horizontal-piping hangers and building attachments, in accordance with MSS SP-69 and manufacturer's published product information. Use only one type by one manufacturer for each piping service. Select size of hanger-rod attachments to suit hanger rods. Provide copper-plated hanger-rod attachments for copper-piping systems.
- B. Steel Clevises: MSS Type 14. (For high temperature piping)

2.4 SADDLES AND SHIELDS

- A. General: Except as otherwise indicated, provide saddles or shields under piping hangers and supports, factory-fabricated, for all insulated piping. Size saddles and shields for exact fit to mate with pipe insulation.
- B. Protection saddles: MSS Type 39; fill interior voids with segments of insulation matching adjoining insulation.

- C. Protection shields: MSS Type 40; of length recommended by manufacturer to prevent crushing of insulation.
- D. Thermal hanger shields: Constructed of 360o insert of high density, 100 psi, water-proofed calcium silicate, encased in 360 deg. sheet metal shield. Provide assembly of same thickness as adjoining insulation.
- E. Available manufacturers: Subject to compliance with requirements, manufacturers offering thermal hanger shields which may be incorporated in the work include, but are not limited to, the following:
 - 1. Elcen Metal Products Co.
 - 2. Pipe Shields, Inc.

2.5 MISCELLANEOUS MATERIALS

- A. Metal framing: Provide products complying with NEMA STD ML 1.
- B. Steel plates, shapes and bars: Provide products complying with ASTM A 36.
- C. Cement grout: Portland cement (ASTM C 150, Type I or Type III) and clean uniformly graded, natural sand (ASTM C 404, Size No. 2). Mix at a ratio of 1.0 part cement to 3.0 parts sand, by volume, with minimum amount of water required for placement and hydration.
- D. Pipe guides: Provide factory-fabricated guides, of cast semi-steel or heavy fabricated steel, consisting of bolted two-section outer cylinder and base with two-section guiding spider bolted tight to pipe. Size guide and spiders to clear pipe and insulation (if any), and cylinder. Provide guides of length recommended by manufacturer to allow indicated travel.

2.6 ROOF EQUIPMENT SUPPORTS

- A. General: Construct roof equipment supports using minimum 18-ga galvanized steel with fully mitered and welded corners, internal bulkhead reinforcing, integral base plates, pressure treated wood nailer, and 18-ga galvanized steel counterflashing.
- B. Configuration: Construct to sizes as needed for equipment, compensate for slope in roof so top of support is dead level.

2.7 MANUFACTURERS OF HANGERS AND SUPPORTS

- A. Available manufacturers: Subject to compliance with requirements, manufacturers offering hangers and supports which may be incorporated in the work include, but are not limited to, the following:
 - 1. B-Line Systems, Inc.
 - 2. Carpenter and Patterson, Inc.
 - 3. Corner & Lada Co., Inc.
 - 4. Elcen Metal Products Co.
 - 5. Fee & Mason Mfg. Co.; Div. Figgie International.
 - 6. ITT Grinnel Corp.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Examine areas and conditions under which supports and anchors are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.2 PREPARATION

- A. Proceed with installation of hangers, supports and anchors only after required building structural work has been completed in areas where the work is to be installed. Correct inadequacies including (but not limited to) proper placement of inserts, anchors and other building structural attachments.
- B. Prior to installation of hangers, supports, anchors and associated work, Installer shall meet at project site with Contractor, Installer of each component of associated work, inspection and testing agency Representatives (if any), Installers of other work requiring coordination with work of this section and Architect/Engineer, for purpose of reviewing materials selection and procedures to be followed in performing the work in compliance with requirements specified.

3.3 INSTALLATION OF HANGERS AND SUPPORTS

- A. General:
 - 1. Install hangers, supports, clamps and attachments to support piping properly from building structure; comply with MSS SP-69. Arrange for grouping of parallel runs of horizontal piping to be supported together on trapeze type hangers where possible. Install supports with maximum spacings complying with MSS SP-69. Where piping of various sizes is to be supported together by trapeze hangers, space hangers for smallest pipe size or install intermediate supports for smaller diameter pipe. Do not use wye or perforated metal to support piping, and do not support piping from other piping.
 - 2. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers and other accessories. Except as otherwise indicated for exposed continuous pipe runs, install hangers and supports of same type and style as install for adjacent similar piping.
 - 3. Support fire-water piping independently of other piping.
- B. Provisions for movement:
 - 1. Install hangers and supports to allow controlled movement of piping systems and to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends and similar units.

2. Load distribution: Install hangers and supports so that piping live and dead loading and stresses from movement will not be transmitted to connected equipment.
3. Pipe slopes: Install hangers and supports to provide indicated pipe slopes, and so that maximum pipe deflections allowed by ANSI B31 Pressure Piping Codes are not exceeded.
4. Insulated piping: Comply with the following installation requirements.
 - a. Clamps: Attach clamps, including spacers (if any), to piping with clamps projecting through insulation; do not exceed pipe stresses allowed by ANSI B31.
 - b. Shields: Where low-compressive-strength insulation or vapor barriers are indicated on cold or chilled water piping, install galvanised protective shields. For pipe 8" and over, install wood insulation saddles.
 - c. Saddles: Where insulation without vapor barrier is indicated, install protection saddles.

3.4 INSTALLATION OF ANCHORS

- A. Install anchors at proper locations to prevent stresses from exceeding those permitted by ANSI B31, and to prevent transfer of loading and stresses to connected equipment.
- B. Fabricate and install anchor by welding steel shapes, plates and bars to piping and to structure. Comply with ANSI B31 and with AWS standards.
- C. Where expansion compensators are indicated, install anchors in accordance with expansion unit manufacturer's written instructions, to limit movement of piping and forces to maximums recommended by manufacturer for each unit.
- D. Anchor spacings: Where not otherwise indicated, install anchors at ends of principal pipe-runs, at intermediate points in pipe-runs between expansion loops and bends. Make provisions for preset of anchors as required to accommodate both expansion and contraction of piping.

3.5 EQUIPMENT SUPPORTS

- A. Provide concrete housekeeping bases for all floors mounted equipment furnished as part of the work of this contract. Sized bases to extend minimum of 4" beyond equipment base in any direction; and 4" above finished floor elevation. Construct of reinforced concrete, roughen floor slab beneath base for bond, and provide steel rod anchors between floor and base. Locate anchor bolts using equipment manufacturer's templates. Chamfer top and edge corners.
- B. Provide structural steel stands to support equipment not floor mounted or hung from structure. Construct of structural steel members or steel pipe and

fittings. Provide factory-fabricated tank saddles for tanks mounted on steel stands.

3.6 ADJUSTING AND CLEANING

- A. Hanger adjustment: Adjust hangers so as to distribute loads equally on attachments.
- B. Support adjustment: Provide grout under supports so as to bring piping and equipment to proper level and elevations.
- C. Cleaning: Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.

AIR-CONDITIONING AND MECHANICAL SERVICES GENERAL REQUIREMENTS

21.1 Scope

This Section relates to the manufacture, works testing, supply, delivery, erection, commissioning and testing of Air-Conditioning and Mechanical Services systems for Buildings. This Specification defines the standards of equipment and work normally required. Occasionally (because of unusual site conditions or for other special reasons) alternative materials, equipment, techniques different from those specified in this document may be specified in the Particular Specification or on drawings:-

21.2 Related Regulations

The installation, materials, and components shall comply with all relevant statutory instruments and regulations current at the date of tender (unless stated otherwise in this specification or on any drawing) and in particular with the followings:

- a. The Institute of Electrical Engineers

Regulations or equivalent American Regulations for the Electrical Equipment of Building.

- b. Regulations under the Electrical Directorate.
- c. Any special regulations issued by the Ministry of Public Works.

21.3 Compliance with British / American Standards

The equipment and/or installation(s) shall comply with all relevant British/American Standards and Codes of Practice/Other Publication.

21.4 HVCA Publications

DW/141 Specification for Sheet Metal Ductwork. Low and High Velocity/Pressure Air Systems.

21.5 Electricity Supply

Unless otherwise indicated all apparatus and wiring shall be suitable for use with a 3-phase, 4-wire, 380/220-volt 50 isolated earth system.

21.6 Extent of Work

The work shall comprise the whole of the labour and all the materials necessary to form a complete installation and such tests, adjustments and commissioning as are described in subsequent clauses and may otherwise be required to give an effective working installation to the satisfaction of the Engineer.

The words "complete installation" shall mean not only the major items of plant and equipment conveyed by this specification but all the incidental sundry components necessary for the complete execution of the works and for the proper operation of the installation, with their labour charges, whether or not these sundry components are mentioned in detail in the tender documents issued in connection with the contract.

21.7 Space for Equipment

The Contractor shall ensure that all equipment to be supplied by him can be installed in the available space and there is adequate access to admit all plant to its position and allow for future maintenance.

21.8 Comments by the Tenders

Any comments by the Tenderer on the design, the availability of equipment, materials and labor and the time required for the completion of the work shall be made at the time the tender is submitted.

21.9 Drawings - General

Unless otherwise indicated, the Contractor shall submit for approval the following drawings:

Four sets of installation working drawings, within five weeks of acceptance of his tender.

Four sets of detailed plant room drawings within ten weeks of acceptance of his tender.

Four sets of purpose made diagrams detailing separately all the composite electrical circuit and wiring layouts within ten weeks of acceptance of this tender.

Four sets of builder's work drawings within four weeks of acceptance of his tender.

Four sets of drawings of any variations to the design suggested by or agreed with the Engineer.

One set of reproducible "as installed" drawings, process negatives upon completion of the work and as a condition precedent to the certification by the Engineer that the work is complete.

21.10 Builder's Work Drawings

Builder's work drawing shall show, fully dimensioned, all foundations, bases, plinths, sumps, holes required and the overall sizes and weight of the equipment concerned. With the agreement of the Engineer, holes fixing etc. other than in plant rooms, may be marked out on site instead of on drawings.

21.11 Electrical Diagrams

Composite circuit and layout diagrams for the electrical services shall detail not only all circuitry within main control panels but also that within all external equipment such as starters and thermostatic control devices and refrigeration equipment, together with all interconnecting wiring from the main point of supply onwards and all terminal markings. The required sizes and types of all cable shall be indicated on the layout diagrams together with the ratings of such items as fuses and switches.

Circuit diagrams shall, where possible, be arranged according to the main sequence of operation from left to right and/or from top to bottom of the diagrams. Symbols for diagrams shall comply generally with B.S. 3939. If the abbreviations are employed for the designation of components an integral schedule shall be provided on the drawings to explain the meaning of the abbreviations.

The composite diagrams shall subsequently form part of the set of "as built" drawings detailed in clause 21.9.

Individual circuit and layout drawings from the various component manufacturers will not be accepted in lieu of composite diagrams.

21.12 "As Built Drawings"

During the course of the works the Contractor shall maintain a fully detailed record of all changes from the working drawings, to facilitate easy and accurate preparation of the 'as built' drawings and to ensure that these drawings are in all respects a true record of the installations.

The drawings shall show the complete installation, including the sizes and runs of all ducts and pipeworks. The scales shall be such that details, particularly of equipment, can be clearly shown. The drawings shall show the names of the manufacturers, model and type numbers and all details of duty and rating of all items of plant including thermostatic control equipment.

The drawings shall include the physical location and identification number of each circuit control valve in accordance with the labelling and circuit control diagrams (clause 21.51).

A print of each of the composite "as built" circuit and layout diagrams shall be fixed securely to the inside of the hinged front of the main electrical control panels a appropriate, or in such other alternative positions as may be agreed with the Engineer, and shall be protected by non-flammable transparent material.

21.13 Painting

Any pipes, tanks brackets, hangers, steelwork etc. which are not protected by galvanizing, works applied primer, protective plant, or insulation shall be cleaned to remove all grease and rust and then painted with one coat of corrosion resistant paint. Those parts of the installation required to be left unpainted (e.g. brass work) shall be so left.

FANS

21.14 General

Fans shall be capable of giving the specified performance when tested in accordance with B.S. 848. Although estimated values of the resistance to airflow of items of equipment may be indicated this does not relieve the Contractor of the responsibility for providing fans capable of delivering the required air volumes through the system.

The make and design of fans shall be approved by the Engineer. Evidence supporting claimed noise levels and fan efficiencies may be called for.

Belt driven fans shall be fitted with pulleys suitable for V-Belts; pulleys of the taper lock type may be used for drives up to 10 KW capacity. Alternatively and in any case above 10 KW output, pulleys shall be secured to the fan and the motor shafts by keys fitted into machined keyways. Pulleys shall be keyed to the fan shaft in the overhung position. Keys shall be easily accessible so that they can be withdrawn or tightened and they shall be accurately fitted so that the big end does not protrude beyond the end of the shaft.

Machined bolts, nuts and washers only shall be used for the assembly of fans; all bearing surfaces for the heads of bolts or washers shall be counter faced. Holding down bolts for fans and motors shall be of square section under the head or be fitted with snug to prevent them turning in the fan base plate when the nuts are tightened. Any fan which is too large or too heavy for safe manhandling shall be provided with eyebolts or other lifting facilities to enable mechanical lifting equipment to be used.

21.15 Centrifugal Fans

Unless otherwise indicated centrifugal fans shall be of the forward curved multi-blade type having fan total efficiencies of not less than 78%.

Fan casings shall be constructed of mild steel plates with angle stiffeners and base angles to ensure freedom from drumming and shall be suitable for operation at the maximum static pressure of the system. Fan casings shall be constructed so the impellers can be easily withdrawn after installation. Outlet shall be flanged and inlets shall be flanged or spigoted as indicated, except that for suction pressures greater than 1000 N/m² (100 mm of water) inlets shall be flanged. A drain and plug shall be fitted to the fan casing at its lowest point. For all kitchen extract ventilation fans an access door, for inspection and cleaning, shall be fitted to the scroll casing in an accessible position. It shall be of the full width of the impeller.

Impellers shall be of mild steel of riveted or welded construction, with hubs of robust design, and shall be capable of running continuously at ten per cent in excess of normal mild steel shaft and the impeller with shaft shall be statically and dynamically balanced and tested for overspeed before leaving the maker's works. Shaft bearings of belt driven single inlet fans shall be truly aligned and rigidly

mounted on a pedestal common to both bearings. Double inlet, double width fans shall have a pedestal mounted bearing at each side of the fan. Fan bearings shall be sleeve or ball or roller type.

Unless otherwise indicated centrifugal fans shall be driven by electric motors through V-Belt drives complying with clause 21.78.

21.16 Axial Flow Fans

Axial flow fans shall be of either the single stage type or the multi stage contra-rotating type. Casings shall be rigidly constructed of mild steel stiffened and braced to obviate drumming and vibration. Cast iron or fabricated steel feet shall be provided where necessary for bolting to the base or supports. Inlet and outlet ducts shall terminate in flanged rings for easy removal. The length of the duct casing shall be greater than the length of the fan(s) and motor(s) in order that the complete section may be removed without disturbing adjacent ductwork. Electrical connections to the motor(s) shall be through an external terminal box secured to the casing.

Impellers shall be of steel or aluminium, the blades shall be secured to the hub or the blades and the hub shall be formed in one piece. The hub shall be keyed to a substantial mild steel shaft and the whole statically balanced. Blades shall be of aerofoil section. Shafts shall be supported on two bearings which may be ball, roller or sleeve type. Lubricators shall be extended to the outside of the casing. Where axial flow fans are driven by a motor external to the fan casing the requirements of clause 21.14c for pulleys and section 21.79c for V-Belt drives and guards shall be met. Unless otherwise indicated a guard is not required for any part of a drive which is inside the fan casing. An access door of adequate size shall be provided.

Where axial flow fans of the bifurcated type are indicated the motors shall be out of the airstream. Motors may be placed between the two halves of the casing in the external air or may be placed within the fan casing provided that effective ventilation is given to the motor. Where hot gases or vapours are being handled the motor and the bearings shall be suitable for operation at the temperature they may be subjected to.

21.17 Propeller Fans

Impellers shall be of steel or aluminium; the blades shall be fastened to the hub or the blades and hub shall be formed in one piece. The bearings may be ball, roller, or sleeve type. Propeller fans may be ring mounted, diaphragm mounted or diaphragm mounted in a casing, as indicated. Where they are mounted in a casing, the casing shall be longer than the length of the fan and motor. The casing shall be of steel, shall have flanged ends and shall incorporate an inspection door. A terminal box shall be mounted externally on the casing. The tip speed of fans shall not exceed 20 m/s.

21.18 Protectively Coated Fans and Special Enclosures

Protectively coated fans shall meet the appropriate requirements of the preceding clauses relating to fans generally and to particular types of fans, the form of

protection shall be as indicated. Where a protective coating is required for use with corrosive gases the coating shall cover all parts of the complete fan, motor and casing assembly which will be in contact with the corrosive gases. No fan shall be installed if the protective coating has been damaged in any way. Flame proof enclosures shall comply with the requirements of B.S. 229 for the appropriate gas group.

21.19 Mechanical Roof Extract Units and Dual Fan Extract Units

The fans used in roof extract units shall meet the appropriate requirements of the preceding clauses relating to fans generally and to particular types of fans. Cowls and bases shall be of weatherproof materials, e.g. steel galvanized after manufacture, aluminium magnesium alloy or glass fibre, or as indicated. Casings shall be formed so as to ensure a weatherproof fitting to the building structure.

Adequate access to motor terminals and lubricating points shall be provided by means of hinged cowls or otherwise as Back draught dampers and/or fire release dampers shall be provided where indicated.

The dual fan extract units shall be fitted with one duty fan and one standby fan each complete with electric motor. The fans shall be centrifugal type with either belt or direct drive. Fan impellers shall be dynamically and statically balanced and access for maintenance shall be from the top of the unit and/or as indicated. Duty and standby units shall be fitted with non-return shutters and be provided with automatic change over contractors fully interlocked. The control equipment shall comprise control panel mounted unit containing suitable starters, control switches, indicator lamps and shall provide automatic change-over from running to standby in the event of motor failure or overload. A three position selector switch shall be provided for motor 1/OFF/motor 2 operation with suitable indicator.

AIR FILTERS

21.20 General

Filters shall operate with the minimum efficiencies herein specified. They shall be complete with holding frames sufficiently robust to ensure that no distortion occurs in operating. All filters shall be installed with edge seals which shall prevent air by passing the filters. The seals shall remain effective even though the cells are periodically removed cleaned or replaced and refitted. Filters shall be arranged so that there is easy access for cleaning and or removal and refitting. Any tools necessary for removal and refitting shall be provided, including a servicing rack where applicable.

21.21 Dry Replaceable Media Type Filters

The air velocity at the face of the filter shall not exceed 2.5 m/s. Filters of this type shall have an efficiency of not less than 95% based on the tests specified in B.S. 2831 with test dust No.2.

Sufficient spare media shall be provided to replace all of the filter bank.

21.22 Throw-Away Type Filters

The filters medium shall be glass fibre or fabric. Metal wool filters will not be accepted. The air velocity at the face of the filter shall not exceed 2.50 m/s. Filters of this type shall have an efficiency of not less than 90% based on the tests specified in B.S. 2831 with dust No.2.

Sufficient spare cells shall be provided to replace all of the filter bank.

21.23 Open Cell Plastics Type Filters

The filter medium shall be processed open cell foamed plastics and shall be washable. The element shall be supported on plastics coated steel wire formers with a metal frame. The face velocity shall not exceed 2.5 not less than 90% based on the tests specified in B.S. 2831 with test dust No.2.

21.24 Viscous Unit Type Filters

The design and construction shall be such that it is impossible to see any light through the filter cell initially and after the filter has shaken down during use. The face velocity shall not exceed 2.5 m/s. Filters of this type shall have an efficiency of not less than 90% based on the test specified in B.S. 2831 with test dust No.2.

21.25 Grease Eliminators

Grease eliminators shall be of the corrugated plates or crimped wire mesh type and shall be entirely of metal, all ferrous metal shall be protected against corrosion. where grease eliminators are fitted in kitchen hoods the assembly shall include a drip tray and the element shall be secured in the frame by quick release clips.

21.26 High Efficiency Filters

High efficiency filters shall consist of asbestos cellulose or glass fibre pleated paper media in a rigidly constructed case with a completely positive seal.

The efficiency of the filters shall be equal to or better than that indicated and in any case these shall not be more than 5% penetration based on the tests specified in B.S. 2831 with methylene or the sodium flame test specified in B.S. 3928.

Where fire protection is required or the air temperature may exceed 200 degree C the filtering medium shall be glass fibre paper, and the casing spacers and seals shall be of fire-resistant material.

21.27 Activated Carbon Type Filters

The cell casing shall be of steel protected against corrosion. The internal arrangement shall include a corrosion proof framework or supports to ensure an equal disposition of individual panels and mechanical protection to the front and rear of the panels.

The carbon shall be of uniform bed thickness in the panels and shall be sufficiently densely packed to ensure that no settling down or gaps occur in use. For each rated 0.5 m/s, capacity, 20 kg of carbon shall be provided. The resistance to air flow shall not exceed 125 N/m (12.5mm of water).

22.28 Electrostatic Type Filters

The filter shall include a baffle or mesh to ensure even air flow, an ionize section, a collecting section, frames to hold the main sections and capable of being built into a filter bank, and automatic washing plant.

Where indicated the washing plant shall include the pump to provide the pressure at the washing nozzles, the hot water storage cylinder and the necessary pipework, fittings and valves. Where the filter will be built into sheet metal ducting the enclosing ducting shall be watertight and two watertight access doors with glazed portions for inspection purposes two bulkhead light fittings and a drain connection shall be provided; where the filter will be built into a builder's work casing, the doors and light fittings shall be provided. The electrical control panel shall include all necessary rectifier and transformer equipment circuit breakers, a millimeter a washing control panel, a light to indicate that power is on and a device to prevent the panel being opened when the power is on. An interlock shall be provided to prevent wash down while the filter is energized. Access to high voltage areas at the filters shall be protected by safety interlocks including the discharge to each of HT equipment; adjacent to all access doors there shall be clear indication of the danger of high voltage. On the larger models platforms and ladders shall be provided for access to the valve, spray nozzles and the travelling mechanism of the washing plant.

Two, or 10% whichever is the greater, spares shall be provided for the spray washer nozzles. Sufficient ionize wires shall be provided to replace 50% of the total.

The filters shall have an efficiency of not less than 90% based on the tests specified in B.S. 2831 with methylene blue.

All wiring between the filter control panel and the filter cells shall be carried out by the filter manufacturer.

CISTERNS AND WATER TANKS

21.53 Generally

For the purpose of this section the following definition apply:

- a. CISTERN:
An open topped vessel for feed and expansion and or the storage of water.
- b. TANK:
A closed vessel for storage only.

Cisterns and tanks shall be of one of the following types as indicated:

- a. Welded or riveted galvanized mild steel.
- b. Reinforced Polyester / Plastic / Glass Fibre.
- c. Pressed steel sectional.

Galvanized mild steel cisterns/tanks shall be of 2.5 mm thick sheet construction. Each cistern shall be provided with a 1.6 mm thick galvanized mild steel loose cover formed in flanged sections of not more than 2 m long and 1 m wide.

Unless otherwise indicated pressed steel sectional tanks shall be of the externally flanged type and shall be complete with purpose made covers and all necessary tie rods.

Galvanized mild steel cisterns and pressed steel tanks shall be cleaned and painted internally with two coats of bituminous solution.

Each cistern shall be fitted with a ball float valve (clause 21.50m). Ball float valves shall be of the size(s) indicated and suited to the mains pressure available.

Overflow pipes shall be twice the diameter of the nominal size of the ball valve fitted or be 32 mm diameter, whichever is the greater. Overflow pipes shall be run to discharge outside the building.

All connection to cisterns and tanks shall be made by means of bosses, screwed flanges or pads and studs. Connections of milds steel cisterns shall be welded before galvanizing. Flanges and or pads shall conform to B.S.10 Table A.

Glass fibre cold water storage tanks shall comply with the general requirements of B.S. 4994 and be of approved manufacturer. The tank shall be prepared with all holes, for connections and shall be supplied with a loose cover.

GRILLES AND DIFFUSERS

21.65 Grilles

Grilles shall be of steel, aluminium or P.V.C. as indicated. Steel grilles shall be protected against rusting and supplied in fully finished condition. Grilles shall be not less than the size indicated; where no size is given they shall be capable of dealing with the air flow and distribution as indicated without producing noise. All grilles except those on exposed ducting shall incorporate an edge seal.

Each supply air grille shall have two sets of separately adjustable blades, one set horizontal and one set vertical, and shall be complete with an opposed blade multi-leaf damper and rear parts finished matt black. The blades and damper or air controller shall be adjustable from the front of the grille. For up to ten grilles, two sets; above twenty five grilles, three sets.

Return air grilles may have either a single set of fixed horizontal blades or a lattice, egg crate or expanded metal front, or shall be as indicated. Each return air grille shall be complete with an opposed blade multi-leaf damper unless otherwise specified, operable from the front

Both supply and return grilles shall have quick-release subframes.

21.66 Diffusers

Diffusers shall be of steel or aluminium as indicated. Steel diffusers shall be protected against rusting and shall be stove enamelled. Diffusers, except on exposed ductwork, shall incorporate an edge seal, diffusers mounted on ceiling shall have antismudge rings, and duct mounting bracket complete with adjusting screw.

Diffusers shall be provided with volume control dampers of the opposed blade, or flab type which shall be adjustable from the front of the diffuser and rear parts finished matt black. Where the length of a vertical duct to a diffuser is less than twice the diameter shall be fitted.

Linear diffusers shall include a control damper at the rear of the vanes giving volume control down to complete shut off and operated from the face of the diffuser. Linear diffusers for supply air shall have adjustable blades to give directional control of flow . Where linear diffusers are mounted in a continuous line there shall be means of ensuring alignment between consecutive diffusers and of equalizing pressure behind the vanes.

FAN COIL UNITS

21.67 General

Fans, filters, cooling coils, heating element, motors and thermal and acoustic insulation shall comply with the appropriate sections of this specification, with the following exceptions or alternative:

- a. Fans may be of the forward curved centrifugal type and may be of galvanized steel sheet, aluminium, reinforced glass fibre or rigid plastic material.
- b. Air filters may be of nylon fibre, glass fibre or cellular plastic material and shall have a minimum efficiency as indicated when tested in accordance with B.S.2831 using Test No.3.
- c. Motors shall be quiet running and shall have sleeve bearings and factory lubricated for life. Motor windings and electrical components shall be impreganted or protected to avoid trouble from condensation.

21.68 Casings

Casing shall be of sheet steel not thinner than 1.2 mm and shall be protected against corrosion and finished inside and outside with stove primer. All corners shall be rounded. Casings shall include space for pipework connections and valves, and there shall be ready access to the fan and motor the filler, the damper, the drain pan and pipework connections and valves.

21.69 Components

Fans shall be of the centrifugal type. Cooling coils shall be at least three-row and shall include an air cock. All units shall include an easily removable and replaceable air filter capable of treating the total air volume. Drain pans shall be either of sheet steel protected against corrosion or of sheet steel protected against corrosion or of plastics or reinforced glass fibre material and shall arranged, and insulated where necessary, so as to ensure that no condensation is formed on the underside. Drain pans shall be large enough to collect all condensate from the coil, return bends and shall have a slight fall to the drain connection. For units whose loads will include a high proportion of latent cooling (e.g. in humid situations) the fall to the drain point and the size of the drain connection shall be adequate to deal with the condensed moisture.

21.70 Arrangement of Units

The arrangement of unit, i.e. whether they shall be wall, floor or ceiling mounted, the position of inlet and outlet grilles if any, the need for sheet metal and casing, etc. shall be as indicated on the drawing.

21.71 Controls, Dampers and Grilles

Fan coil units shall have a control giving at least three running speeds and an 'OFF' position. They shall have connections for both fresh and recirculated air and shall include a damper which shall be adjustable to 25% fresh air. Outlet grilles shall be adjustable to enable the direction of airflow to be reset. On floor mounted units, supply grilles shall be on the top of the unit. Automatic temperature control system shall be as indicated on the drawings.

21.72 Noise Level

Casing shall be lined with material to act as both thermal and acoustic insulation. Fan and motor assemblies shall be complete with anti-vibration mountings. Noise data shall be provided and shall be based on tests in accordance with the HVCA Test Code, or similar tests; full details of the testing technique and procedure shall be given. The data given shall include an octave band analysis of the sound power level of the unit.

21.87 Split Air-Conditioning Units

The air-cooled condensing units and the evaporator blower units shall be suitable for remote installation on site.

The material specification for these units shall be same as described under the packaged Air-Conditioning Units.

21.88 Refrigeration Plant Accessories

Each systems with an air-cooled condenser shall have a liquid receiver complete with two step valves, a sight glass, a charging connection and a purge valve. Relief valves shall be fitted on liquid receivers. Liquid receivers serving plane of 17.5 KW capacity or less shall have either a relief valve or a fusible plug. The liquid receiver shall have a purge valve. A capped valved connection shall be provided for refrigerant charging.

All major items of plant shall be dried at the factory and filled with a holding charge of refrigerant or inert gas; all openings shall be sealed. During erection care shall be taken to prevent the entry of moisture. A dehydrator shall be fitted in the refrigerant pipework and so arranged that the drier cartridge can be replaced when the refrigerant circuit is charged. In addition to the suction gas and lubricating oil strainers fitted in the compressor, a liquid line strainer shall be fitted to protect the expansion valve or float valve; where any pressure regulating device is fitted in the suction line it shall be protected by a strainer. Where an evaporator pressure regulating device is fitted an additional gauge to indicate evaporator pressure shall be provided and shall be complete with means of isolation.

21.89 Refrigeration Plant Pipework

Pipework for refrigeration systems shall be refrigeration quality copper. Joints shall be flanged, brazed, welded or made with soldered capillary fittings. Pipelines shall be taken to prevent vibration weakening joints and connections. Pipework shall be designed and run so that any oil in the compressor discharge refrigerant which passes through the oil separator (where fitted) is carried through the system and returned. At any point where a large quantity of oil may accumulate an oil separator and a means of returning the compressor shall be provided.

Valves required for compressor, liquid receivers etc. shall be of either diaphragm or bellows type or be packed valves complete with a back seating and a seal cap.

Compressors shall not be connected to run in parallel (i.e. with common discharge and/or suction lines). Where, to increase availability, it is required that any compressor shall be capable of working with any condenser or evaporator, cross connections shall be provided and all major plant items shall be valved for isolation.

After erection the whole of the refrigeration pipework shall be pressurized and tested for leaks all in accordance with the manufacture's printed instructions.

21.90 Thermal Insulation

Normally discharge and liquid lines need not be insulated, but where they are likely to receive solar radiation they shall be shielded or insulated with 12 mm thickness of a material having a thermal conductivity of less than 0.04 w/m degC and weatherproofed with a material having a reflective or a light coloured finish. The suction line from the evaporator to the compressor shall be insulated with a material having a thermal conductivity of less than 0.04 w/m degC and at least 12 mm thick for pipes of up to 75 mm diameter and 19 mm thick for pipes over 25 mm

diameter. This insulation shall be protected by a vapour barrier which shall not be broken between joints of sectional material or at discontinuities at valves or brackets.

Shell and tube evaporators shall be insulated with at least to a thickness of material having a thermal conductivity of less than 0.04 w/m degC. to prevent condensation. This material shall be protected by a vapour barrier and further protected by a painted sheet metal casing. The insulation and protection shall be so arranged that the end covers of evaporators can be removed without damage to the installation.

21.91 Refrigeration Plant Control

In addition to the controls specified elsewhere in this section the following controls shall be provided:

A solenoid valve shall be fitted in the liquid line to each evaporator, except high pressure float controlled flooded evaporators, to prevent the flow of liquid refrigerant to the evaporator when the compressor is not running.

Each compressor of 35 KW capacity and above shall be provided with an oil pressure failure control.

Where the compressor of more than 35 KW capacity (or, where indicated, of lesser capacity) is not controlled by suction pressure (e.g. it is controlled by air or water temperature) and the evaporator is at a higher level than the compressor, a pump-down cycle shall be incorporated. The control signal shall initially close the liquid line solenoid valve and the compressor shall then pump down to a predetermined suction pressure.

For each shell and tube evaporator a flow switch shall be fitted in the chilled water pipeline. The flow switch shall prevent the compressor (s) starting unless the chilled water is flowing and shall stop the compressor (s) if the water flow falls below a safe minimum. Additionally a chilled water low temperature limit thermostat shall be provided and shall stop the compressor (s) if the leaving water temperature drops below a set value.

The flow switch and the thermostat shall each be connected in a separate circuit independent of all other control circuits; they shall not be wired in series.

THERMAL INSULATION

21.92 General

Thermal insulation work shall comply with CP 3005.

Thermal insulation and finishes shall be proof against rotting, mould and fungus growth and attack by vermin. Thermal insulation exposed to the weather shall comply with clause 21.95.

21.94 Thermal Insulation on Pipework etc..

Thermal insulation shall be applied to hot water pipework which is not used as a heating surface, to chilled water pipework and hot and chilled water storage tanks and cylinders. Cold water pipework and tanks shall be insulated where indicated to prevent condensation and freezing.

Thermal insulation shall be securely fixed to the pipework, tanks etc. Pipework which is concealed from view and is not readily accessible shall be insulated with rigid preformed sectional material with a facing insulation. Material shall have a density of at least 110 kg/m³. Pipework which is exposed to view and is not readily accessible shall be insulated with rigid material with a facing of aluminium foil, non flammable plastics, hard setting cement or a fabric covering suitable for painting as indicated. Pipework which is exposed to view and is readily accessible, pipework in plant rooms and cylinders shall be insulated with rigid material and protected against mechanical damage either by aluminium sheet jacketing thickness as indicated in the particular specification,

or reinforced hard setting plaster at least 12 mm thick (1 line, 1 cement and 3 parts sand) as indicated.

The insulation shall be 50 mm thick unless otherwise indicated.

21.96 Painting and Identifications

Insulation on ductwork and pipework exposed to view or in plant rooms, and where not protected by aluminium foil sheet, plastics film or a weatherproof finish, shall be painted with one coat of undercoat and one coat of gloss finish. Absorbent surfaces shall be suitably primed. Insulation on ductwork and pipework concealed from view and not readily accessible need not be painted.

The colour of paint on thermal insulation on pipework, except where weatherproofed, shall in accordance with Table 1 of B.S.1710: chilled water pipework shall be coloured blue B.S.4800. Thermal insulation on ductwork shall be painted Light Grey, B.S.4800; exceptionally the Engineer may indicate an alternative colour to be used in occupied areas where the colour treatment is aesthetically important.

Uninsulated pipework or ductwork and thermal insulation which is unpainted or painted grey on ductwork shall be identified by colour bands at least 25 mm wide on triangles of at least 150 mm side. The bands of triangles shall be suitably spaced to permit the ductwork pipe to be readily identified. For pipework and its insulation the colours of the bands or triangles shall be as specified in clause 21.96 b; for ductwork and its insulation the colours shall be as follows:

Services:	Colour (B.S. 4800)
Fresh air	Green
Recirculated air	yellow
Chilled air	Blue

Conditioned air which may
either warm or chilled

Red and Blue be

Exhaust air

purple

Foul air

Brown

In addition to the colour bands or triangles specified in clause 21.96c all pipework and ductwork in plant rooms and service areas, whether insulated or not, shall be legibly marked with black or white letters and triangles to indicated the type of services and the direction of flow. Services shall be identified as follows:

- | | | | |
|----|---------------------------|---|------|
| a. | Low temperature hot water | - | LTHW |
| b. | Chilled water | - | CHW |
| c. | Condensate | - | CN |
| d. | Supply air | - | S A |
| e. | Return air | - | R A |
| f. | Fresh air | - | F A |
| g. | Exhaust air | - | E A |

Where pipes are run in pairs the letters F and R shall be added to indicate flow and return respectively.

21.107 Equipment and Wiring

As far as practicable all indicating lamps, instruments and controls shall be of the same manufacture and style, to provide uniformity of appearance and to facilitate maintenance. Externally visible equipment shall be flush mounted with minimum projection and be fixed securely to the front panels or other members. Internal equipment shall be secured to purpose-made rails or mounting bars. All fixing shall incorporate shake proof washers or other vibration resistant fastenings. Fuses, terminal blocks and each item of equipment shall be readily identified by clearly visible labels. The arrangement of switches, lights, instruments etc. shall be neat and as near symmetrical as possible.

Indicator lamps shall be under-run and shall be supplied from a low voltage output transformer complying with B.S.3535 or shall incorporate individual step-down transformers having a low voltage circuitry. Glasses of not less than 25 mm diameter shall be fitted. Where indicator lamps are not immediately adjacent to their associated switches they shall be clearly labelled.

Ammeters shall be not less than 75 mm diameter.

Internal wiring shall be colour-coded and in general shall be bunched and run on trays or in purpose-made slotted plastic cable trunking. Positive fixing of cable ends shall be ensured by purpose-made clamps or pinch type terminals, or by the use of crimped cable tags or other approved termination devices. Each cable end shall be permanently identified.

Main Control panels, local control panels and equipment having its own individual panels must have a micro-sized complete wiring diagram secured on the inside of the panel door or a suitable location inside the panel.

Grouped terminal blocks of adequate capacity and fully numbered, with permanent labels, shall be provided for all wires leading to equipment outside a panel. Terminal numbers or markings shall correspond with those used on related apparatus and wiring diagrams. Removable plates or other facility shall be provided for the entry of incoming cables, conduits, trunking etc., with means for effective earthing to the cubicle chassis. Provision shall be made for the earthing of all non current-carrying metalwork. For main power terminals incorporated within a panel, soldered socket type terminals shall be provided. Starters and control circuits shall be protected by fuses of the HRC cartridge type fuse complying with B.S.88. Fuses shall be grouped and mounted so as to be readily accessible without danger. One spare set of fuses for each rating of fuse installed shall be supplied and fitted on the inside of the panel door or in some other conveniently accessible position.

2.2 FIRE: EXTINGUISHERS

- A. At each fire extinguisher cabinet, provide one multipurpose chemical fire extinguisher with UL rating of 2A-10B:C, Larsen model "MP5", or equal approved in advance by the Engineer.

- B. Service, charge, and tag each fire extinguisher not more than five calendar days prior to the Date of Substantial Completion of the Work as that Date is established by the Engineer.

PART 3 - EXECUTION

3.1 SURFACE CONDITIONS

- A. Examine the areas and conditions under which work of this Section will be performed. Correct conditions detrimental to timely and proper completion of the Work. Do not proceed until unsatisfactory conditions are corrected.

3.2 INSTALLATION

- A. Coordinate as required with other trades to assure proper and adequate provision in the work of those trades for interface with the work of this Section.
- B. Install the work of this Section in strict accordance with the original design, the approved Shop Drawings, pertinent requirements of governmental agencies having Jurisdiction, and the manufacturer's recommended installation procedures as approved by the Engineer, anchoring all components firmly into position for long life under hard use.

COPPER PIPES FOR GAS SYSTEMG

Pipe work Supports

Shall:-

Be provided at intervals as specified below:-

Metric Sizes outside diameter mm	Maximum intervals for vertical runs Meter	Maximum intervals for horizontal runs Meters
12	1.2	1.0
15	1.8	1.2
22	2.4	1.8
28	2.4	1.8
35	3.0	2.4
42	3.0	2.4
54	3.0	2.7
76	3.6	3.0

Comprise, except for vertical drops to terminal units, secondary fixing brackets or supports of a suitable metallic, non ferrous material or a ferrous material suitable treated to prevent corrosion and electrolytic action.

Comprise for vertical drops to terminal units secondary fixing brackets or supports of a suitable metallic non ferrous material or a non metallic material.

Ensure that the pipe work does not come into contact with any treated timber contained in the building structure.

Pipe work within Bed Head Services

Shall:-

Be run in a separate compartment form the electrical services.

Pipe work Concealed in Walls / Floors

Shall:-

Have their route marked on “ as fitted” drawings, where specified in part D.

Where the route differs from the contract drawings have re routing brought to the attention of the Contract Supervision Officer immediately following Installation.

Shall not:-

Be carried solidly in floors.

Have a joint in a wall until that of pipeline has been satisfactorily tested. Joints in walls to be kept to a minimum.

Pipes Passing Through Walls

Shall:-

Be provided with copper sleeves where passing through a fire compartment wall. Fire stopping to be provided within the sleeves, as specified in part D.

Be provided with cover plates fitted over the sleeves where exposed to view.

Shall not:-

Have joints occurring within sleeves.

Cleanliness

Shall:-

Be maintained by capping incomplete sections of erected pipe work with plastic end caps or trap to prevent the ingress of extraneous material.

Separations

Shall:-

Except for bed head services and pendant devices, ensure pipelines are physically separate from the metal sheath and armour of electric cables and from metal conduits, ducts, trunking and bare earth continuity conductors associated with any cables.

Extension to Existing Installation

Shall:-

Be subject to the requirements of the "permit to work" system.

Be physically separated from the existing pipe work and the final connection made only when all tests required on the new extension have been completed.

Brazed pipeline Jointing

Shall:-

For copper to copper joints made on site, utilize a copper phosphorus brazing alloy type CP1 or CP4 to BS 1845 and an inert gas shield and no flux.

For copper to brass or gunmetal joints made off –site, utilize a silver brazing material type AG 13 to AG18 BS 1845, a flux as recommended by the manufacturer and the joint to be subsequently cleaned to meet the requirements in element 01, clause 04.

Pipe Preparation

Shall:-

Include for pipe ends to be cut clean and square with the pipe axis, using wheel cutter where possible and debarred, re rounded and cleaned of cuttings.

Provide for pipe ends and inside of fittings to be thoroughly cleaned.

Include for the use of the correct pipe expanding tools when utilizing expanded tube joints. The expanded tube joint is only permitted for straight tube joints and on sizes up to and including 28mm.

Inert Gas Shielding

Shall:-

Be provided internally for all on site fluxless jointing and hot forming of bends. The inert gas to be oxygen free grade nitrogen.

Include for each cylinder or group of cylinders to be fitted with a pressure regulator and a means of providing and controlling a high flow flush purge and a low flow purge. The equipment to include all necessary hoses and pipe connectors purpose made for N2 purging only and specially identified.

Safety Measures

Shall:-

Be taken during brazing with a shield gas to avoid contaminating confined areas, ducts etc and if necessary, ventilation to these areas is to be included or other means taken to remove the shield gas from the area.

Be the responsibility of the contractor who will provide and use detection equipment where necessary and inform the engineer of any potentially hazardous situation.

Include the recording of the use and removal from site of shield gas cylinders after installation of work is completed.

Demonstration Joints

Shall:-

Be provided to demonstrate the competence of craftsmen in fluxless brazing techniques, by making demonstration joints in advance of the installation.

Comprise a maximum of 5 additional joints cut out of a complete installation at the contractor's expenses before testing has started and for their reinstatement.

If any one of these joins is proved to be unsatisfactory, include for further joints to be cut out and remade until the extent of the defective joints has been established.

Be considered satisfactory when:

- (a) the penetration of brazing alloy is a minimum of 3mm at any point.
- (b) the internal surface is clean and free of oxide when wiped with a tissue or cloth.

Mechanical Pipeline Jointing

Shall:-

Be used only when connecting pipe work to plant and equipment items.

List of Approved Manufacturers

<u>Item</u>	<u>Manufacturer</u>
<u>Air Conditining Equipment</u>	CARRIER PETRA TRANE SKM
<u>Fans</u>	WOODS GREEN HECK POLAK BROSS
<u>Sound Absorbers</u>	WOODS Sound Attenuators LTD TROX
<u>Grills & Diffusers</u>	Cooling Industry TITUS TROX RUSKIN
<u>Automatic Controls</u>	Honey well Danfoss SAUTER
<u>Cooling & Heating Water Pumps</u>	Armstrong ITT KSB
<u>Sanitary fixtures</u>	Ideal Standard Vollery & Boch

<u>Hot Water Boilers</u>	Fredrick Grohe Chocran Boilers Chappee Boilers
<u>Heat Exchangers</u>	ITT ORAN
<u>Panels & MCC's</u>	Klockner Moeller ARDAN EMCO ELEMCO
<u>Flush Valves</u>	ZURN
<u>Pressure & Expansion Tanks</u>	Armstrong ELBI ZILMET REFLEX

SECTION 14

SPECIFICATION FOR ELECTRICAL WORKS

General Terms

1. Scope of Work

The following specifications and bills of quantities refer to the electrical, lighting and communication installation works in Munib Rashid Masri – School of Engineering – Nablus.

Works to be executed as part of this contract/tender include: -

- ☐ Supply and installation of underground piping for the connection of telephones to the building, in co-ordination with the Palestinian Telecommunication Company.
- ☐ Earthing System, including foundation-welding system.
- ☐ Supply and install of an additional diesel generator system, including fuel system, exhaust piping and control panels.
- ☐ Supply and install of an Uninterrupted Power Supply (UPS) System.
- ☐ Supply and installation of the main electrical switchboard and secondary switchboards.
- ☐ Installation of supply cables for main and secondary switchboards, in the building, and for the electrical switchboards of such systems as air-conditioning, central heating, etc.
- ☐ Electrical installations for lighting, power supply sockets and other installations.
- ☐ Supply and installation of luminaries (Lighting Fixtures) for general lighting and for external lighting.
- ☐ Supply and installation of supply trunks for electrical, communications and medical gases.
- ☐ A complete grounding system in the floors.
- ☐ Supply and installation of communications cabinets.
- ☐ Supply and installation of trellis trays and/ or sheet-metal ducts for electricity and communications.
- ☐ Supply and installation of a Fire-Detection and Fire Alarm system.
- ☐ Supply and installation of Computer System.

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- Supply and installation of Lightning System

2. The Electrical & Communication Systems - General Description

- * The main electrical switchboard for the whole building will be installed in the second basement floor. This switchboard will receive its power supply from transformer room which is fed by electrical authority.
- * Secondary electrical switchboards will be installed into the building. These secondary switchboards are to supply power for the condition, lighting, machines and socket outlets on the floors and/ or areas associated with it.
- * These secondary switchboards will receive their power supply from the main electrical switchboard or from other secondary switchboards, all according to the electrical power supply descriptions in the drawings.
- * The electrical cables supplying power to the secondary switchboards will be installed into conduits with appropriate size laid into ground slab or floor slab or in electrical shafts.
- * A communication cabinet will be installed into the building. This cabinet is to serve as a central distribution cabinet for all signaling and communications systems into that floor.
- * The main communication and signaling cables will be installed into conduits with appropriate size laid into ground slab or floor slab.

3. Compliance with Regulations and Standards

The electrical installation must meet all the requirements of the Electrical Company. The electrical installation must meet all the requirements of international standards which apply to any part, component or accessory thereof, and in the absence of applicable Local Standards, all parts, components and accessories must comply with British or German standards (In that order).

4. Compliance with Agreements

All works associated with this contract/tender will be executed in accordance with these specifications. These specifications constitute a complementary supplement to the General specifications. In any event of a point or issue for which contradicting instructions had been given in different publications, the documents listed below shall take precedence, in the following order: Bill Of Quantities, the plans/ drawings, these specifications, the general specifications. The "Preliminaries" sections included in the construction works specifications equally apply to these specifications.

For further emphasis, we include the following Topics, for the contractor's attention:-

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- a. Preliminaries.
 - b. Earth moving Works.
 - c. Site Concrete Works.
 - d. Electrical Installations.
 - e. Paint Works.

5. Compliance with Plans and Specifications

The electrical installation must be executed with complete adherence to the plans and other contractual documents. Any change of plan must be authorized, in writing, by the supervisor. This requirement applies to changes suggested by the contractor as well as to changes demanded by the supervisor.

6. Quality Assurance and Licensing Requirements

All works must be executed to the highest standards and in accordance with the applicable requirements of the Electrical Authority. The contractor must have a government-issued license for electrical works of the "Chief Electrician" type, and he must have in his permanent employment, on the site, electrical engineer with at least five years experience.

The contractor must also employ as sufficient number of employees to ensure the proper progress of his work and its completion's on time. The engineer, the supervisor or his representative may reject the work or any part thereof if the work or any part thereof had not been carried out in accordance with the correction and/ or the specification and/ or the required professional standards. The contractor should employ the assistance of sub-contractors and the appropriate specialists for all special jobs which, in the supervisor opinion, are not within the normal scope of the contractor's expertise. The supervision may reject any employee, manufacturer, etc. who, in his opinion, is not suitable for the execution of the work in question.

7. Quality of Materials

All materials and equipment used for the execution of the work must be new and of the best quality, and must be approved by the supervisor before execution. The equipment and/ or materials must comply with the following European standards: VDE, IEC, or BS. The equipment and/or materials must be accompanied by a certificate of testing by an authorized institute, to confirm their compliance with the applicable standard. All expenses incurred in connection with these tests and in connection with other tests, if required by the supervisor, will be covered by the contractor.

The contractor must submit to the supervisor samples of all materials, accessories and all other parts of the installation, in order to obtain the later 's approval for these elements prior to execution. All samples will be kept on the site, at such a location as determined by the supervisor.

In addition to complying with the applicable standards, the equipment and materials must agree with the samples approved by the supervisor. Any equipment and/or materials which fail to agree with the aforementioned samples will be removed from the site by the contractor

at his expense, and the contractor would have to supply other equipment and/or materials which agree with the plans, specifications and samples approved by the supervisor in place of those removed.

8. Approval of Samples

The approval of samples of materials and/or equipment by the supervisor, does not in any way detract from the contractor's full and exclusive responsibility for the quality of equipment and materials supplied in the model of those samples, in accordance with the quality definitions prescribed in the specifications and/ or applicable standards.

9. Additional Tests

The supervisor may demand from the contractor that samples of materials/ equipment, in whole or in part, be submitted to testing. These tests, if required, will be conducted by the Local Standards Institute, at the contractor's expense, without meriting any additional payment.

10. Equipment & Materials

In the submittal of his proposal, the contractor must undertake and specifically state that all the materials and equipment required in order to complete the installation are readily available to him, and that they will be delivered to the site at the appropriate time with the purpose of completing his work on time.

This undertaking and statement must also cover all tools, instruments and labor required in order to execute the work contained in these specification. All work must be carried out by skilled, professional workers, under the supervision of a professional foreman approved by the supervisor.

11. Management of Work

In order to supervise the execution of his work, the contractor will appoint an electrical engineer with experience not less than five years, who must be approved by the supervisor. The foreman must be present on the site whenever the works constituting the subject of this contract are being carried out, and he will be the only person authorized to address the supervisor with any problem arising during work execution. The foreman will carry out his work subject to the supervisor's instructions, and any instruction issued by the supervisor to the foreman will bind the contractor.

In any event when a certain matter has to be clarified between the supervisor and foreman, and in the contractor's absence, the foreman must be fully authorized to represent the contractor, and his signature will bind the contractor's.

The contractor, through his foreman, will conduct a regular work log, in which all work progress processes will be entered, as well as the supervisors' remarks and any claims for irregular works. This work-log must be kept on the site and be available to the supervisor at all times.

12. Co-Ordination of Execution with Other Entities

The contractor will be responsible for the execution and completion of his work in such time as proves appropriate for the progress of the over-all project, while co-ordinating his work with the primary contractor and the other subcontractors, without causing any damages or delays in the works carried out inside the building and in the surrounding area. The contractor must ensure, particularly, that none of the junction boxes or passages/ductworks already installed be locked by other installations such as: water pipes, sewage pipes, air conditioning ducts, etc. The contractor must submit to the supervisor's approval a timetable for the execution of his work, which had been co-ordinated with the timetable of the primary contractor.

13. Familiarization with the Site Surroundings and Working Conditions

The contractor must specifically state that he had visited the site and had thoroughly familiarized himself with the topography of the area and the locations of the buildings property, the access roads leading to these buildings, the locations of adjacent buildings, the working conditions on the site and buildings and any consequences which may pertain to the execution of his work. The contractor must specifically state that he had studied, familiarized himself with and thoroughly understood the specifications, drawings and bill of quantities, and that he undertakes to execute his work according to the requirements, either expressed or implied, contained within these documents.

The contractor must specifically state in his proposal that he had taken into account all conditions and details pertaining to his work. No claims based on such arguments as not having been familiar with the working conditions on the site or with the requirement of having to execute the work stage-by-stage instead of continuously, or the requirement of having to co-ordinate one's work with other sub-contractors and specialists may be accepted.

14. Contractor's Responsibility Warranty

The contractor will be responsible to the client for the quality of the workmanship and materials he had supplied for a period of one year after the installation has been completed, tested and accepted. Any malfunctions, failures, faults and defects detected in the installation during this warranty period, or any work found to have been executed not according to the plans, blueprints, specifications and instructions, will be repaired by the contractor, at his expense, within an appropriate time-interval, as determined by the engineer and supervisor.

Supervision of the contractor's work and approval of it by the engineer and supervisor will not exempt the contractor from his responsibility for the execution.

15. As-Built Drawings

Before the final, comprehensive test is commissioned, the contractor will prepare the electrical plans/drawings of the installations as built, with clear markings of all deviations and changes carried out - with the supervisor's consent - in relation to the original plans. The contractor will submit to the supervisor two sets of updated plans, in addition to those required for submittal to the Electrical Company for the purpose of testing the installation in addition to a CD copy with all as built drawings and details.

16. Installation Testing & Acceptance

When the installation has been completed, a trial run will be carried out to ensure that the installation functions properly. Any malfunctions detected must be repaired to the supervisor's fullest satisfaction. Following the trial run, the contractor will commission a test by the official authority, which is to be co-ordinated in advance with the supervisor. The contractor will invite the official authority to test the entire installation or any part thereof, as required by the supervisor.

The work shall be considered complete after it has been accepted, without reserve, by the official authority, by the supervisor, and after a trial run has been carried out. Any changes or repairs required will be carried out without delay, until the aforementioned installation has been finally accepted. The contractor will supply all the labor, means and instruments required in order to carry out the aforementioned tests and trial run. The supervisor will serve as the exclusive arbiter regarding any term or definition contained within these specifications, as well as the evaluation of the works and their compliance with these specifications.

17. Cutting and Patching

Any cutting in walls for the installation of electrical work shall be done by the contractor with extreme care, so that the structure will not be endangered. Adequate protection shall be provided to prevent damage to adjacent areas. Patching and finishing of openings shall be the responsibility of the electrical contractor.

18. Additional Work & Variation Orders

Any additional work or variation order should be approved during the work. The client or the supervisor engineer should approve any additional work or variation order. Without such an approval the contractor will do any of these works at his expense, without meriting any additional payment.

Electrical Switchboards

1. General

1. The manufacturer of the electrical switchboards must be a reputable, well-established manufacturer with at least 10 years' experience in the manufacture of electrical switchboards of similar size and power as the switchboards required for this project. The contractor must obtain the client's approval for the order of the electrical switchboards.
2. The manufacturer of the electrical switchboards should be capable of providing engineering and technical support services such as consulting and maintenance for the switchboards he had manufactured.
3. The electrical switchboard manufacturing plant must have a quality assurance department which relies on written procedures and regulations, in accordance with the directives of the Local Standards Institute. A quality assurance engineer must head this department. The manufacturer would have to present a document confirming this upon the client's demand.
4. The manufacturer of the electrical switchboards must submit with his bid a document listing the knowledge and technology according to which the switchboards are manufactured, as well as documents which confirm that the electrical switchboard chassis in accordance with the recommendations of its manufacturers.
5. The bid will apply to the contents of these specifications, and must take into account the manufacturing, operation and testing of the switchboard at the manufacturer's plant, as well as its packing and transportation to the site, preparations for switchboard storage for a period of time in excess of one year, including wrapping with polyethylene sheets if so required by the client, and its installation at the site at such a time as determined by the supervisor, including connection of all circuits supplied by the switchboard in question.
6. The manufacturer of the electrical switchboards will supply, at his own expense, all the testing equipment required in order to test the switchboards in accordance with the client's requirements.
7. The contractor will bear full and exclusive responsibility for the quality of planning and manufacturing of the electrical switchboards, and the client's approval would not exempt him from this responsibility.

2. Main & Secondary Electrical Switchboards–Structural Requirements:

1. The electrical switchboard will consist of a cabinet made up of galvanized, 2mm thick metal sheets, with all equipment items installed behind removable panels. Any changes in the switchboard structure or layout must be authorized in advance by the supervisor, or in accordance with the bill of quantities. Structural requirements are also specified in the plans/ drawings for each switchboard.

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2. The electrical switchboards must be constructed/ manufactured according to a modular method, including modular assembly hardware to enable the feature addition of cabinets and equipment without difficulty. This modular manufacturing method must agree with the recommendations of the manufacturers of the electrical equipment regarding the necessary clearance between adjacent accessories and between the accessories and the switchboard chassis.
 3. The electrical switchboards must have an impermeability grading of IP34 according to the requirements of the German Standards VDE 0100/0660. Din 40050, and Local Standards.
 4. When determining the switchboard dimensions, the manufacturer must take into consideration some extra space for additional equipment (25% spare space minimum), or as specified in the drawings.
 5. Switchboard construction must permit convenient access to all switchboard equipment items as well as to instruments, etc., for such purposes as maintenance & service, repairs, etc. All switchboards must have internal panels unless otherwise specified in the bill of quantities or plans. All switchboard accessories must carry sign/ indications in accordance with the switchboard manufacturing plans.
 6. Painting of electrical switchboards will be carried out in accordance with the General Specifications for Paint Works. The topcoat must be applied electrostatically and oven-baked. Color shade should be Oven RAL-7032, and the minimum thickness of all paint layers must be 90 microns.
 7. All secondary electrical switchboards will be installed inside niches enclosed by metal doors, which are to be installed as part of the construction work.
 8. Electrical switchboard structure must include panels to cover input and output pipes/ conduit.
 9. The structure of the main electrical switchboard will be suitable for installation over a channel in the floor. All switchboards must include proper floor-attachment facilities, and terminal panels in the top section and bottom section, in accordance with the location of the cable output.

3. Electrical Switchboard Manufacturing Plans

The drawings of the switchboard plans submitted to the contractor are principle drawings only. The contractor (manufacturer) of the electrical switchboards must prepare detailed manufacturing plans for all switchboards, in accordance with the aforementioned drawings, the type of switchboard in question and its construction method, as listed in these specifications. These manufacturing plans must include the following: -

- a. A single-wire electrical schematic of the electrical switchboards, including identifying data from the various equipment items.
- b. A diagram of the switchboard with its doors/ panels closed, and in a separate diagram, an outline of the switchboard without its doors/ panels.

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- c. Structural cross-sections of the switchboard from all sides, including detailed description of its structural elements (e.g. metal profile type and thickness, method of connection between the sheet-metal covers and the profiles, welding method, etc.).
 - d. A diagram of the routing of the main and secondary bus bars, main bus-bar junctions, and the reinforcing hardware for the main and secondary bus-bars.
 - e. An accurate, detailed diagram, including dimensions, of the installation and locations of all equipment items on the switchboard.
 - f. A full list of accessories, including: the name of the manufacturer and his representative in Palestine or Israel, part numbers of all equipment items plus their technical characteristics (e.g. breaking capacity, rated current, physical dimensions, rated voltage/ frequency, disruption and insulation voltages).
Whenever possible, the manufacturer should accompany the plans with original catalogues and technical information as issued by the original manufacturer of the equipment, for all equipment types and items he intends to use.
 - g. Detailed cross-sections of the bus bars, the type of insulators on which they are installed, and the clearances between them (the manufacturer should accompany the plans with catalogues of the insulators). The technical data for the cross-sections of the bus-bars and insulators will be determined by the manufacturer in accordance with the following criteria:
 - 1. Tables of bus-bar cross-sections and spatial arrangement as a function of operating current and environment temperature. The tables must be obtained from the manufacturer of the accessories installed in the switchboard, or according to DIN 43671.
 - 2. Tables or calculations of the clearances between the insulators holding the bus bars as a function of the short-circuit current.
 - h. Switchboard impermeability data according to the IP classification, in accordance with the requirements contained in the specifications, plans or bill of quantities.
 - i. The plans must include the manufacturer's specifications for the painting process of the switchboard chassis, including step-by-step instructions for preparing the switchboards prior to the actual painting.

4. Approval of the Manufacturing Plans

The plans specified in paragraph 3 above must be submitted by the contractor for reviewing and approval by the planner. Only after the plans have been approved and all modifications and updates (if such had been required) have been introduced may the contractor begin the actual manufacturing of the switchboards. Any plans submitted for authorization with any of the details listed in paragraph 3 above missing will be

returned to the contractor without having been reviewed or authorized, and the contractor will be held responsible for any delays in the work process.

5. Electrical Switchboard Testing

a. The manufacturer of the electrical switchboards will invite the planner, through the supervisor, to oversee the manufacturing of the switchboards at the following stages:

- 1) Following completion of the switchboard frames and prior to painting of same.
- 2) Following completion of the final painting.
- 3) Following assembly of the bus bars and accessories.
- 4) Following completion of the wiring for the switchboards and all accessories.

In the event that the switchboard manufacturer had used standards, pre-fabricated cabinets manufactured by an approved manufacturer, and this has been confirmed and approved by the planner, stages 1) and 2) above may be waived.

Only after each of the execution stages listed above has been approved may the manufacturer proceed with the switchboard manufacturing process.

b. When the manufacturing of the switchboards at the plant has been completed, the manufacturer will invite the planner, through the supervisor, to test the switchboards at the plant. Only after the planner has carried out a test and issued a written authorization may the contractor remove the switchboards from the manufacturer's plant and transfer them to the site.

In any case, the aforementioned authorization may not be regarded as a final acceptance of the switchboards. The final acceptance will take place on the site, in the presence of the client, the supervisor and the contractor, after the switchboards have been installed at the site, connected to the users and activated.

6. Bus Bars

a. The switchboards will contain bus bars for phases R, S, T, neutral and ground, without paint. These bus bars shall be made of copper, and their cross-section must be compatible, thermally and mechanically, with the short-circuit currents specified in the plans, and in any case not less than 15KA.

b. The electrical switchboards must be constructed without any cables, and all connections between the main bus bars and equipment items must be done through flexible, insulated secondary bus bars, attached to the

switchboard chassis. The cross-section of the neutral bus bar must be the same as the cross - section of the phase bus bar.

- c. Connection between main bus bars and secondary bus bars must be done by means of suitable terminals, without drilling any holes through the bus bars.
- d. Miniature automatic circuit breakers for up to 63 A will be connected to the bus bars in groups by means of terminal strips (blocks).
- e. In cases of cable outputs from the top and bottom sections of the switchboard, neutral and ground bus bars will be installed at the top section as well as at the bottom section of the switchboard.
- f. Multi-layer plastic signs carrying the appropriate written identification will be installed over the bus bars.

7. Ground & Neutral Bus Bars and Terminal Panels

Each electrical switchboard will include a grounding bus-bar which would provide grounding connections for the various circuits, as well as terminals for the grounding lead which supplies the switchboards or grounds it to a metal fixture.

Ditto for the neutral bus bar and terminals.

The switchboard is to include also a "terminal and connection box/panel", which should enable convenient access to the terminals, and a profile for cable attachment. With each cable, conductor or wire connected to the terminals, some excess must be provided by forming a length of the cable or wire into a loop.

8. Grounding

- a. Grounding of the switchboard chassis will be effected by welding a galvanized stud inside the switchboard, to which a grounding lead from the grounding bus-bar of the switchboard will be connected by means of a cable shoes.
- b. Galvanic continuity must be ensured for all parts of the switchboards. In switchboards with doors a grounding bridge must be established between the switchboard chassis and the doors by means of a flexible grounding lead and cable shoes.
- c. In switchboards consisting of integrated modules, a grounding stud will be connected as described in sub-paragraph (a) above to each module separately, in order to obtain a galvanic continuity between all modules.

9. Accessories

All switchboard accessories must withstand a short-circuit current of 15,000 Amperes minimum, per VDE 0641/0660, unless otherwise specified. Each accessory must carry a marking of the standard to which it conforms (approved standards: IEC, VDE and UL). All connection

terminals for the various accessories must be protected against contact with live parts in accordance with VDE 106, Part 100.

The switchboard accessories must be of the following types and models, and must conform to the instructions listed below:-

- a. "KLOCKNER-MOELLER", "MERLIN-GERIN", "SIEMENS", "TELEMECANIQUE", or "GE".
- b. Functionally equivalent accessories in all switchboards must be of the same make. Installation of functionally- equivalent accessories of different makes will not be allowed.
- c. Rotary switches will be as made by "KLOCKNER-MOELLER", "GE" or equivalent, of the on-load disconnected type, with a zero position. Rotary switches must conform to VDE 0660, 0113 regarding their breaking capacity, as well as to the insulating characteristics specified in VDE 0110, class "C".
- d. All indication lamps will be of the incandescent type, 220 Volts, with an E-14 type base and an arrangement for voltage reduction to 75% of the lamp's rated voltage by means of an integral resistor.
- e. Miniature automatic circuit breakers for currents up to 63 A will be as made by "MERLIN-GERIN", "SIEMENS", "KLOCKNER-MOELLER", with tripping characteristic "G", unless otherwise specified in the plans. All automatic circuit breakers must conform to VDE 0110, 0641, 0660, and must withstand a short circuit current of 10000 Amperes minimum.
- f. Three-phase automatic circuit breakers for currents in excess of 63 A must have an adjustable magnetic and thermal current, and a facility for the connection of auxiliary contacts, trip coil, etc.
- g. Earth-leakage relays will be as made by "MERLIN-GERIN", "SIEMENS", "KLOCKNER MOELLER", and must conform to VDE 0664.
- h. Contactors will be as made by "TELEMECANIQUE" or "KLOCKNER-MOELLER" or "GE", and must conform to VDE 0660/1 and to AC2-class operating conditions.
- i. Built-in measuring instruments (gauges) must be 96x96 mm or 72x72 mm, as required by the plans and/or the bills of quantities.
All built-in measuring instruments (gauges) must be screened against electromagnetic induction, with an accuracy rate of 1.5%, and protected against short-circuit in the measured line.
- j. Terminals will be made of a thermoplastic material, with a screw and pressure clamp, such as made by "PHOENIX", of the type suitable for installation on "DIN"-type rails, for operating voltage of 500 Volts and with "C"-class insulation characteristics.
- k. When selecting the equipment and the method for installing it on the switchboard, the contractor must take into consideration an operating

temperature of 40 degrees centigrade. All equipment items must conform to DIN 40040 regarding environmental and climatic conditions.

10. Terminals

All connections between the various accessories of the switchboard and the installation must be arranged by means of terminal strips, with indication tags and numerated bus-bars for the neutral and ground. All terminals must be of the rail-mounted (terminal strip) type.

11. Signing

- a. The contractor must arrange for the proper signing of all circuits, and match all signs with the installation in its complete state. Multi-layer plastic signs will be attached to the front of the switchboard and inside it by means of screws and in such a manner as to ensure the unequivocal identification of all components even when the protective covers have been removed. The signs will be installed after the switchboard has been painted for the second time. Signs will also be installed on the doors enclosing the niches in which electrical switchboards had been installed.
- b. Color shades for switchboard signing will be as follows:
 1. Main cable inputs - white over a red background.
 2. Outputs & accessories - white over a black background.

In addition to the aforementioned color shades, signs in different color combinations will also be prepared in order to distinguish specific areas of the switchboard. These color combinations will be co-ordinated with the manufacturer of the electrical switchboards before any of the circuits and accessories have been sign-posted.

- c. At the top part of the switchboard, a sign will be installed which would indicate the switchboard name (designation), number and supply source. Another sign will be installed on the side of the switchboard, which would contain the name, address and telephone number of the switchboard manufacturer.

12. Switchboard Schematics

Each switchboard will contain a pouch with a drawing, which is to include an electrical schematic and the switchboard structural plan.

13. Proper Location

The contractor must check the locations where the switchboards are to be installed. He must also ensure that the switchboards are compatible with the building and with the locations where they are to be installed.

Installations in the Building

1. Piping / Cable Conduits

1. Conduits shall be installed for all wires and cables except where otherwise stated or directed. The conduits shall be PVC pipe of the thinner type (Merikaf) or similar under plaster.
2. Conduits of a fireproof plastic type should be used whenever exposed installations are used or inside acoustic ceiling. And it shall be securely fastened in place by means of galvanized metal profile sections.
3. No conduits used should have an internal diameter less than 13mm. The conductor's area within the conduit should not exceed 50% of the area of the conduit.
4. The contractor shall be responsible for ensuring that the conduits are so laid that the water cannot infiltrate or accumulate at any point.
5. The contractor shall be responsible to ensure that placing of the conduit is done prior to pouring of concrete without delaying the concrete work.
6. In conduit installation the contractor should make all his effort to run all the pipes in horizontal or vertical lines and not inclined and to be at the same level from the floor in all rooms.
7. The conduits should have at least cover of 2cm of plaster or concrete.
8. Separate conduits have to be used for different electrical systems of different voltage.
9. Conduits between any two-connection boxes have to be of one piece with no connection in the pipes.
10. Where finish wall surfaces are to be plastered, the Electrical Contractor shall cooperate with the general contractor during construction of these walls and use care in the installation of all conduits and boxes so that wall surfaces will have a finished appearance.
11. Conduits shall be installed to requirements of structure and to requirements of all other work on the project. Conduits shall be installed to clear all openings, depressions, pipes, ducts, reinforcing steel, etc. and conduit set in forms for concrete structure shall be installed in a manner that installation will not affect the strength of the structure.
12. All conduits have to be approved by local standards.
13. All piping/ cable conduit installations must be co-ordinated with the installation of the air-conditioning piping and ductwork, water pipes, sewage pipe, etc.
14. For exposed installations on walls, heavy, rigid PVC, self-extinguishing type piping/ cable conduit shall be used

2. Pull Boxes and Connection Boxes

1. The contractor has to make his best to use the minimum number of these boxes.
2. Connection boxes should be of the same material as that of the conduits.
3. Pull boxes should be of steel or plastic according to the engineer instructions.
4. All boxes should be covered.
5. Installed connectors should be used in all the connections inside the boxes.

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6. Cable of different voltages should not be drawn or connected in the same connection boxes.

3. Switches

1. Outlet boxes for switches are to be fixed 140cm above finished floor level and 12cm horizontally from the outside edge of the nearest door.
2. Switches should be of 10Amp. with different signs for emergency switches if used.
3. Switches should be of waterproof type GEWISS or equivalent for the bathrooms and where other else shown.
4. All switches should be all insulated flush of GEWISS or equivalent.
5. Switches shall be wired with the phase lines only.
6. Switch panels shall have a similar assembly to switches and it should be group mounted in a common box if possible. Otherwise it has to be group mounted in aluminum or stainless steel cover to the approval of the engineer.

4. Wires & Cables

1. All wires and cables, except where otherwise stated should have a soft copper core, refined and tinned, with an electric conductivity of not less than 98%. The core shall be insulated with rubber with braid for 750 volts service.
2. The contractor prior to commencement of the work should submit samples of cabling and wiring proposed by the designer. These must comply with the requirements of the IEE and the local standards to ensure a constant voltage in every part of the building.
3. All wires are to be standard. (For power and lighting, the neutral wire shall be different in color from and the phase wires).
4. All wires shall be run on conduit and shall be continuous between outlets and boxes. At least 20cm of wire shall be left at outlets for fixture connections.
5. Where size is shown on drawings, or specified it shall be the same size throughout the circuit.
6. Wiring inside panel boards shall neat and well arranged, using appropriate lugs for terminals and connection of conductors.
7. Joints in the cables or wires are not allowed inside the conduits.
8. Wires are to be fixed to boards with an appliance ensuring perfect electrical contact, to the approval of Electrical Engineer.
9. Cable shoes have to be used for wires or cables 6mm² or above.
10. All boxes and distribution boards have to be carefully cleaned from plaster and other foreign material before drawing any electric wires or cables.
11. All the cables should be of the NYY type 5 or 4 cores, 11000 volt, plain annealed high conductivity copper wire conductors PVC sheathed.
12. Cable terminations should be through brass glands. Glands should be complete with brass earth tags and steel lock nuts.
13. Cable connections at both ends should be through cable shoes.
14. Cables should be covered with soft sand, concrete slabs and special warning tape.

5. Painting

All metal elements, including pipes, supports, reinforcement hardware, brackets, etc., shall be painted with one layer of anti-corrosive Zinc-Chromate primer, followed by two layers of oven-backed topcoat, in the color shade specified. Before painting, all metal elements must be cleaned of any dirt, rust, etc.

6. Cable & Piping/ Conduit Reinforcing Hardware

All reinforcing hardware profiles shall be type Z20N2 as manufactured by "ASHDOD ELECTRO-MECHANICS" or equivalent, with 30mm sides. All profiles must be galvanized, and shall be attached to ceiling and/or walls by means of Philips-head screws. The above profiles should be included in the regular prices for the installation of the cables or piping.

7. Preparatory Work for Electrical (Mains) & Telephone Supplies

The contractor shall be charged with the responsibility for finding out the manner and details concerning the supply of mains electrical power by the Electrical Co. as well as the supply of telephone lines by the Pal Tel Co. The contractor shall make all necessary preparations for this purpose in due time, in co-ordination with the Electrical Co. and the Pal Tel Co. The contractor would also have to co-ordinate the works having to do with crossing of the road or any other public passageways with the supervisor and the client representative and/or the local Municipality (excavation permits, etc.).

8. Location of Electrical Installation Elements

Before the actual execution of his work, the contractor must obtain from the supervisor a final approval for the accurate locations (measurements and heights) of such accessories as socket housings, lighting switches, telephone sockets and lighting fixture outlets. In addition, the contractor must obtain an approval for the manner in which adjacent or multiple items are to be installed. The measurements indicated in the drawings (according to the relevant scale) must not be relied upon without the supervisor's approval.

The contractor must be assisted by the architectural room-layout drawings which indicate the locations of the various electrical and communications accessories, as well as by the air-conditioning and sanitary installation drawings, in order to establish and verify the accurate locations for the installation of all electrical accessories as well as ductwork and piping passages.

9. Accessories

- a. Bakelite accessories - switches, socket housings, push buttons, telephone sockets, etc. shall be as manufactured by GEWISS 20 Euro system range-modular components, and GEWISS 22-24 Euro system range plates, supports.

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- b. In places where multiple electrical accessories (e.g. socket housings, lighting switches, etc.) are to be installed side-by-side, they shall be mounted on common frames and covers in a "composite" structure, with the contractor observing the proper separation between circuits, as prescribed by the Electricity Act.
 - c. Metal accessories - in installations where armored accessories are used, all socket housings must feature a spring-loaded or screw-on (threaded) type cover.
 - d. All electrical and communications accessories shall be attached to their related junction boxes by means of screws, in order to prevent these accessories from being pulled loose when plugs, etc. are being pulled out.
 - e. All terminal boxes shall have covers attached to the box by means of screws.

10. Sleeves and Piping/ Conduit Passing Through Concrete Floors on Structural Walls:

- a. Sleeves through which electrical and telephone cables are inserted shall be fabricated from pipes, as described in the drawings.
- b. The sleeves shall be laid in the ground before the concrete floor is cast, in accordance with the location and routing described in the drawings.
- c. Installation of sleeves prior to concrete casting shall necessitate the preparation of frames, brackets and reinforcement hardware for fixing the sleeve in place.
- d. Sleeves extending outside of the building shall be installed with a downward, outward gradient, to prevent water penetration.
- e. After the cables have been inserted through the sleeve, the sleeve ends shall be sealed against moisture using the appropriate sealant.

11. Cable Ducts

- a. Plastic cable ducts shall be of the self-extinguishing materials.
- b. All ducts shall be installed horizontally using suitable reinforcing hardware, made up of 1 mm thick galvanized sheet-metal, or attached to the ceiling by means of hangers at 40 cm intervals.
- c. Inside the ducts, serrated profiles shall be installed for cable routing, by means of plastic clamps only.
- d. Metal cable ducts shall be made up of 1.5mm thick sheet metal, and attached to the ceiling, wall or on the roof by means of hangers, at 60cm intervals. All hangers and reinforcing hardware should be included in the price of the duct. The reinforcement specifications for each duct type must be approved prior to execution.

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- e. Fireproof partitions shall be installed in all enclosed cable conduits, to prevent the possibility of fire spreading through the passages/ conduit from one wing of the building to another.
Partition installation shall be executed as specified in paragraph 3.12 below.
 - f. Trellis trays (mesh-type ducts) shall be made of round section, 5 mm diameter steel rods. All trays must be galvanized with hot Zinc after welding. All changes in duct direction and all bends shall be facilitated by means of standard bending. Separate ductwork sections shall be attached together by means of standard joints, as manufactured by the manufacturer of the ductwork elements.
The ducts shall be installed on ceiling or walls by means of special hangers, at 60 cm intervals maximum. The cost of all hangers and reinforcing hardware should be included in the price of ductwork, and would not merit any separate payment. The final approval of the planner and supervisor must be obtained for all ductwork installation and reinforcement specifications prior to execution.
 - g. All metallic cable conduits must be grounded in accordance with the electricity Act.

12. Sealing of Passages for Electrical & Communication Cables

- a. After all electrical and communication cables have been installed, all openings through which cables had been inserted must be sealed. This requirement applies to horizontal passages through walls as well as to vertical passages between floors.
- b. Sealing materials and method shall be such as KBS by GRUNAU, and must meet the requirements of at least one of the following standards: DIN 41 02, UL 263, UL 1479, NFPA 251, BS 476.
- c. Sealant must be water-resistant and water weatherproof.
Sealant must be flexible enough to enable the insertion of additional cables through the passage, after it had been sealed.
- d. In any event, the sealant must not affect the thermal and electrical conductivity characteristics of the cable insulation.
- e. Sealing to prevent the passage of fire and smoke shall be executed so that it may retain its resistance characteristics for 180 minutes minimum.
- f. Upon contact with fire, the sealant must not emit toxic fumes. Toxicity level shall conform to Israeli Standard 755, and must meet toxicity rating which is not considered fatal for personnel.
- g. Sealing is to be executed as follows: -
 - 1) All openings shall be sealed by 60mm thick boards of compressed rock wool, with a density of 160kg/ sq.m, coated on both sides with a uniform, 1.5 mm thick layer of "FLAMMASTIK". Board dimensions shall match the

dimensions of the openings, plus 3 mm at both directions to allow for pressure during installation.

- 2) Before placing the rock-wool boards, a layer of KBS sealant shall be applied to the entire contact area between the boards and the wall and between the boards and cables.
- 3) After the boards have been installed, all points which had not been sealed shall be sealed using bulk rock-wool, and an additional coating of KBS sealant.
- 4) In addition, a 30-mm wide strip around the opening should be coated with FLAMMASTIK.
- 5) After the passage has been perfectly sealed, FLAMMASTIK shall be applied or sprayed over the cables on both sides of the passage, to a distance of 50 cm from it. Thickness of the coating layer after drying must be about 2.5-mm minimum.

13. Marking & Signing

- a. In addition to the prescriptions in this chapter of the general specifications, special markings and signs shall be required for this project, due to the fact that it involves a public installation.
- b. Electrical switchboards and socket housings: a sign shall be attached to the front of each electrical switchboard, with a breakdown of the switchboard code, number and supply source. All switchboard accessories and wiring shall be clearly marked, and all markings must be identical to the descriptions in the drawings, including operating instructions and warning signs.
- c. Lighting fixtures: two signs shall be attached to each lighting fixture, one indicating its serial number, and the other indicating the number of the electrical circuit supplying it. All incandescent lighting fixtures shall carry signs indicating the maximum allowable bulb wattage, as required.
- d. Lighting switches: each switch shall be identified by the serial number of the circuit to which it belongs. Also, a sign indicating the lighting fixtures it controls shall be installed next to it.
- e. Cables: the serial numbers of all cables shall be marked on identification discs or "sandwich" type signs attached to the cables at their tapping (branch-off) points, with all junction boxes marked as well, or with signs placed at 10 m intervals along the entire length of the cable in question (whichever is shorter). Wherever cables are installed inside conduit/ ductwork, an identification sign shall be attached to the conduit/ duct with the serial numbers of all cables installed inside that conduit/ duct, their cross-sections and functions. Markings shall be placed at 10m intervals along cable at electrical switchboard inlets and in passage pits must be identified by signs.

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- f. All signs shall be of the "sandwich" type, in the colors specified by the supervisor prior to manufacturing of the signs.
 - g. Electrical cabinets: signs conforming to the fire department's standards, with information such as "Main electrical circuit breaker", etc., or any other message, as required, shall be installed on the doors of the electrical cabinets. Sign finishing shall be co-ordinated with the architect. All communication cabinets shall be identified by the appropriate signs as required.
 - h. All sign costs should be included in the regular unit price of the electrical works, and would merit no separate payment whatsoever.

Grounding and Other Protective Devices

1. Foundation Earthing Welding System

- a. The work is to include the execution of foundation earthing welding for the building in question, in accordance with the principle described in the drawings.
- b. Foundation earthing welding is to consist of two closed rings of 30 x 3.5mm galvanized steel strips to be welded to the building's structural foundations as shown in the drawings.
- c. From the steel rings described above there has to be outlets extending outside the building and they shall terminate 40cm above ground level. Outlets shall be protected by means of armored plastic or metal boxes, with a sign " Foundation Earthing Outlet ". These boxes shall be integrated into the external covering of the building, in accordance with architect's instructions.
- d. Grounding work shall be executed in accordance with, and subject to the foundation ground order, official Government Records 3854, and any updated publications on the subject.
- e. All electrical connections constituting a part of the foundation earthing shall be done by welding.

2. Directives for the execution of Foundation Grounding

2.1 Grounding Objectives

- 1) To augment and complement the earthing to metal water pipes.
- 2) To equalize the potentials of different building and service elements, thus reducing the danger of dangerous voltages occurring between building elements.
- 3) To facilitate connection of the neutral lead of the supply line provided by the Electrical Co. to the potential-equalizing bus-bar ("ZERO-setting").
- 4) The foundation-grounding electrode shall consist of a bus bar laid inside the concrete layers of the structural foundation, and connected to the reinforcing steel rods of the piles.

2.2 Installation Method for Foundation Grounding Electrode – Bridge Ring

- 1) The electrode shall be laid in an enclosed ring, at the bottom of the building foundations, under the external walls.
- 2) The electrodes shall be laid in such a manner as to maintain a concrete layer at least 5 cm thick under it. If the electrode is made up of a steel bar, it must be installed vertically inside the concrete.
- 3) In order to maintain the electrode's stability during the concrete casting process, special holders or brackets shall be installed at 2-m intervals.

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- These brackets may be of different types. One of the options may be a 6mm diameter steel wire bent into the appropriate shape.
- 4) The electrode's passage through the expansion seam shall be above ground level, outside the concrete. Connection between both sides of the seam shall be by means plates cast onto the concrete, to which tabs shall be welded. An electrical bridge/ jumper shall be installed between these tabs, by an insulated, 50mm² copper conductor/ lead with 2 cable shoes.

2.3 Foundation Grounding Electrode Connections

- 1) All connections between separate electrode sections and between the electrode and reinforcing steel rods of the structural elements must be executed in such a manner as guarantee electrical continuity. To facilitate these connections, electrical welding shall be used.
- 2) To facilitate these connections, electrical welding shall be used.
- 3) Connections between the electrode and reinforcing steel rods shall be made along the entire length of the electrode. The interval between each two adjacent connections shall be 5 meters, plus connections made at the corners of the building.

2.4 Outlets from the Foundation Grounding Electrodes

- 1) Outlets shall be fabricated at site.
- 2) All outlets shall consist of a 30x3.5mm galvanized steel strip.
- 3) All outlets extending outside the building shall terminate 40cm above ground level. Outlets shall be protected by means of armored plastic or armored boxes, with a sign "Foundation Grounding Outlet". These boxes shall be integrated into the external covering of the building, in accordance with the architect's instructions.

2.5 Potential Equalizing Bus-Bars & Installation Grounding

All potential equalizing bus-bars shall consist of copper strips. The potential equalizing bus-bars shall accept the grounding connections of all metal services in the structural frame construction stage, passage piping shall be prepared for the grounding of the main water piping (including jumpers to the water flow meters), metal sewage piping, air-conditioning ducts and conduit, etc. the local equalizing bus-bar shall accept the grounding connections of all metal service at the area where it is installed. Grounding of all installations shall be measured complete.

3. Ground Supply to Secondary Bus-Bars

From the main potential equalizing bus-bar at the electricity room, a main grounding conductor or vertical bar shall be installed along the entire height of the building. This conductor or bar shall be connected to the secondary potential equalizing bus-bar at each floor. In the event that a conductor is installed, connection shall be done by means of a special grounding terminal, which is to ensure the continuity of the vertical conductor.

The secondary potential equalizing bus-bar shall be connected to the various grounding users on the floor by means of grounding conductors

paralleling the power supply lines, or by means of a grounding bus-bar installed in the corridor, from which grounding conductors shall be connected to each of the grounding users.
In addition, each secondary switchboard shall be earthed to the water piping.

Lightning Protection System

1. General

1.1 Summary

This section specifies the furnishing of all labor, materials, and appurtenances and inspections required for a comprehensive lightning protection system.

1.2 Reference Standards

Comply with the latest edition of the following reference standards:
IEC 1024, BS7430, BS6651.

1.3 Submittals

- Shop Drawings: Detailed plan drawings shall be prepared to 1:100 scale which indicate all work to be performed. Details of all component mounting and connections shall be included on separate detail drawings. Manufacturer's catalogue numbers and generic shall be indicated for all components shown on the drawings.
- Product Data: Submit complete descriptive information on all materials and installation methods.
- Approvals: Secure formal approval of shop drawings and product data prior to ordering material. Secure approvals in sufficient time to allow installation of concealed system components without delaying the project.

1.4 Subcontractor

The subcontractor for the work covered by the specification shall be one that is recognized as being regularly engaged in the installation of lightning protection systems. The subcontractor must employ competent personnel fully qualified of lightning protection system.

2. Products

2.1 General

The system furnished under this specification shall be the standard product of a manufacturer regularly engaged in the production of lightning protection systems. No combination of materials shall be used that forms an electrolytic couple of such nature that corrosion is accelerated in the presence of moisture. Where unusual conditions exist which would cause deterioration or corrosion of conductors, conductors

with suitable protective coating or oversize conductors shall be used. If a mechanical hazard is involved, the conductor size shall be increased to compensate therefore, or suitable protection shall be provided. The conductors may be protected by covering them with molding or tubing preferably made of nonmagnetic material.

2.2 Air Termination Network

A mesh of 10mx20m for most structures is considered sufficient. The zone of protection offered by an air terminal network is considered to be 45 degrees for heights up to 20m.

2.3 Conductors

All conductors shall be copper and of the grade ordinarily required for commercial electrical work generally designated as being 98 percent conductive when annealed. Conductor minimum size is 30x3mm copper. Main conductor and secondary conductor cable size shall be the same.

2.4 Down Conductors

Down conductors siting and distancing is often dictated by architectural circumstances. There should be one down conductor for every 20m or part thereof of the building perimeter at roof or ground level. They should be routed as directly as possible from the air termination network to the earth termination network to avoid risks of side flashing.

2.5 Air Terminals or Pulsar

Air terminals shall be nickel-plated solid copper with tapered bullet point tips. Minimum air terminal size 18mm diameter by 1000mm or 2000mm long.

2.6 Earth Termination Network

Each down conductor must have a separate earth termination. Moreover provision should be made in each down conductor, for disconnection from the earth for testing purposes. This is achieved by testing clamp. BS6651 stipulated that the resistance to earth of the complete Lightning Protection System measured at any point, should not exceed 10 Ohms. With the test clamp disconnected, the resistance of each individual earth should be no more than ten times the number of down conductors in the complete system.

2.7 Bonding

All metal work, including water pipes, gas pipes, handrails, air conditioning units, window frames, cladding, antenna, metal roofs etc., in the vicinity of the Lightning Protection System must be bonded to it, to avoid the danger of side flashing.

For the same reason, the lightning protection system should be bonded to the main electrical earth, as well as any other earthing system present in the structure.

Preparation for Communication & Signaling Systems

The building in question is to include a fire-detection & alarm system, TV system, a public address system, Intercom system, as well as telephone systems, The electrical works are to include only the preparations required for the installation of these systems.

In order to facilitate the installation of the aforementioned systems, communication cabinets are to be installed in accordance with the principle instructions included in the drawings.

All preparatory outlets for the aforementioned systems must be marked with signs and other identifying measures.

1. Preparatory Works for the Installation of Telephone Systems

- a. These preparatory works include underground piping for the main telephone input connection for the building, with an 8mm diameter Nylon drawstring.
- b. All communications cabinets on the floors shall incorporate primary or secondary telephone tapping boxes (CORONAS).
- c. Each telephone point must consist of a 16mm diameter, heavy, bendable, self-extinguishing type pipe with a 2x2x0.5 telephone cable as made by "Cable Zion", "Teldor", or "Cvalim" drawn inside the conduit. The outlet accessory is to consist of a fixed telephone socket, such as manufactured by "Gewiss" 20 Eurosystem range type.
- d. All telephone piping works must be carried out in accordance with applicable standards and the requirements of the PALTEL Co. after the work has been completed . The contractor must co-ordinate the necessary supervision and obtain the approval from the regional office of the PALTEL Co.

2. Preparatory Works for the Installation of a Sound System

- a. Each Sound system point must consist of a 16mm diameter, heavy, bendable, self-extinguishing type pipe with a 2mm diameter Nylon drawstring, installed under the plastering and/or a duct leading from the sound system section of the communications cabinet to point, All points must terminate with an under-plaster or over-plaster type junction box, as required.

3. Preparatory Works for the Installation of a Fire-Detection & Alarm System

- a. All communications cabinets shall incorporate tapping boxes for a fire detection & alarm system.

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- b. Each preparatory point for the fire detection & alarm system must consist of a 16 mm diameter, heavy, bendable, self-extinguishing type pipe with a 2 mm diameter Nylon drawstring, installed under the plastering and /or a duct leading from the fire detection system section of the communications cabinet to the terminal point. All fire detection & alarm points must terminate with an under-plaster or over plaster type junction box, as required.

4. Preparatory Works for The Installation of A TV Antenna System (M.A.T.V)

- a. All communications cabinets shall incorporate tapping boxes for a TV antenna system.
- b. Each TV antenna connection point must consist of a 23 mm diameter, heavy, bendable, self-extinguishing type with RG6 TV cable, installed under the plastering and/or a duct leading from the TV antenna section of the communications cabinet to the terminal point. All TV antenna points must terminate with an under-plaster type junction box, for the installation of a TV antenna socket.
- c. In addition, an outlet to the roof shall be facilitated, and all preparations for routing communication cables to the TV antenna installed on the roof shall be carried out in accordance with the drawings.

5. Preparatory Works for the Installation of a Computer Communication Network System

- a. All communications cabinets shall incorporate tapping boxes for a computer communication (Network) system.
- b. Each computer communication point must consist of a 23 mm diameter, heavy, bendable, self-extinguishing type with suitable computer STP level 5 twisted pair cable, installed under the plastering and/or a duct leading from the computer communication section of the communications cabinet to the terminal point. All computer communication points must terminate with an under-plaster type junction box.

Lighting Fixtures

1. General

- a. Lighting fixtures in the building shall include fixtures for general-purpose lighting, emergency lighting, and external (outdoor) lighting.
- b. All lighting fixtures must conform to Israeli standard No. 20 or to equivalent European standards.
- c. Installation of equipment items inside lighting fixtures shall be carried out so as to prevent any vibrations (by means of vibration dampers) or

humming. Also, all contacts and connections must be secured against loosening due to vibrations.

- d. All lighting fixtures must be easily accessible and removable for equipment replacement purposes, by a single person, without the use of screwdrivers or any other tools.
- e. All sockets for incandescent lamps/bulbs must be made of porcelain.
- f. A junction and/or connections box must be installed for each lighting fixture. This also applies to lighting fixtures recessed into walls or ceilings.
- g. Lighting fixtures installed where there are trusses must be fitted on special cross beams fastened along each room in the proper direction so as to fix the light fixtures on them, these cross beams shall be included in the regular price for the light fixtures, and shall not merit any separate payment.
- h. Co-ordination of installation of recessed lighting fixtures in concrete ceilings or steel structural elements:
The contractor shall be charged with the responsibility for the proper installation of all lighting fixtures recessed into ceilings. The contractor shall be charged with the responsibility for the integrity of the ceiling, as well as for the full co-ordination between the various sub-contractors. Also, separate reinforcing elements must be installed for tall lighting fixtures attached to metal structural elements, in accordance with the detail as approved by the supervisor. These reinforcing elements must be included in the lighting fixture installation price.
- i. Lighting fixtures to be supplied by the client:
Should this be required, the contractor shall install lighting fixtures supplied by the client. In this case, the contractor shall be paid only for the installation of the lighting fixtures, which is to include all operations and materials required for the installation and proper operation of the lighting fixtures in question. The contractor shall be charged with the responsibility for the integrity and serviceability of these lighting fixtures from the moment he has taken delivery of them. The contractor must sign a receipt for taking delivery of these lighting fixtures, and shall arrange for proper storage, security and maintenance for the lighting fixtures until the moment of installation. Any defaults/malfunctions detected in these lighting fixtures after and /or prior to installation shall be regarded as the contractor's responsibility.

2. General Purpose Fluorescent Lighting Fixtures

- a. All lighting fixtures be constructed so as to enable connection of leads after installation, with convenient access to terminals and other equipment items by removal of front cover, without having to remove the lighting fixtures itself.
- b. All lighting fixtures must be supplied with all auxiliary equipment and tubes.

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- c. All lamp sockets must be of the spring-loaded type.
 - d. Ballast's for fluorescent lighting fixtures shall be with a five-year warranty and a capacitor to improve the power factor. Also, for specialized lighting fixtures, ballasts may be installed in accordance with the manufacturer's recommendations or specific requirements.
 - e. All starters for fluorescent lamps shall be of the electronic type.
 - f. Lighting fixtures with PL type miniature fluorescent lamps shall be round, rectangular or square, made of plastic, with a polycarbonate base and prismatic or opal polycarbonate cover, as specified in the Bills of Quantities.
Also, these lighting fixtures must include a built-in reflector and a suitable ballast, such as manufactured by "OSRAM" as well as terminals for lead connection.
 - g. Fluorescent Lamps /Tubes
 - 1) All fluorescent tubes shall have a diameter of 26mm, such as "LUMILUX Daylight No.11", as manufactured by "OSRAM", with a wattage of 18, 36 or 58 Watts, and a luminous flux of 1300, 3250, and 5200 Lumens, respectively, after 100 hours of operation, or such as "Polylux" , as manufactured by 'THORN'.
 - 2) Miniature PL-type fluorescent lamps shall be such as model "DULUX-S" as manufactured by 'OSRAM", light shade No. 21, with a wattage of 9 or 11 Watts, and a luminous flux of 600 or 900 Lumens, respectively, or such as "PL" as manufactured by "PHILIPS", light shade No. 84.
 - h. Louvers for Fluorescent Lamps/Tubes (When Required)
All louvers must be non-yellowing, made with a special anti-yellowing agent. The contractor must guarantee all louvers for a period of two years.

3. Emergency Lighting Fixtures

- a. 220 Volts Emergency Lighting Fixtures
220 volts emergency lighting fixtures shall include a battery designed for 1.5 hours of operation, fluorescent, 20 or 8 Watts, as required. Emergency lamps should turn on automatically in any event of a power breakdown, and turn off automatically as soon as power supply has been resumed. All lamps must feature an 'EXIT' sign, as required by fire department regulations.
- b. Dual Purpose 220 Volts Emergency Lighting Fixtures
These lighting fixtures shall be fluorescent, of the type specified in the Bill of Quantities, and shall feature an automatic turn-on system for power breakdowns, as described above, also with a battery designed for 1.5 hours of operation.

5. Special Conditions for Supply of Light Fixtures

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- a. A catalogue of fixtures to be supplied, should be submitted by the contractor for approval before ordering any fixture pointing in the catalogue to the specific fixture offered.
 - b. The fixtures supplied should comply with the relevant catalogues and specifications mentioned in the Bill of Quantities. The contractor will be totally responsible in case of discrepancy with these catalogues and specifications.
 - c. In the selection of manufacturers and / or products preference shall be given to products specified in the bill of quantities by manufacturer and code number.
 - d. Fixtures of similar construction, appearance, dimensions and maintenance features and equal in efficiency, distribution, brightness and degree of protection (IP) shall be accepted as approved equivalents. Fixtures failing in any of these respects will not be approved.
 - e. The contractor is totally responsible for the supply of the lighting fixtures with all its needed fixing accessories whether to be fixed on ceiling on truss structural elements or on walls and these accessories are considered to be included in his offer.
 - f. Each fixtures must be equipped with the proper number of new lamps of the correct size, all in good operating conditions and as manufactured by " OSRAM ". The price of these lamps is included in the unit rate of the lighting fixture.
 - g. Ballast's for fluorescent lighting fixtures must be with a five year warranty and a capacitor to improve the power factor.
 - h. All starters for fluorescent lamps shall be of the electronic type.

Generator Set

1. General

The emergency generator set shall be automatic mains failure type, complete with diesel engine, generator, control panel, batteries, starting motors, radiator, exhaust piping, silencer, fuel tanks, fuel pumps and piping and all other accessories as specified. It should be made by an approved reputable manufacturer with service facilities and spare parts stock in West Bank.

All materials and equipment shall comply with relevant IEC and B.S specifications as regards quality of materials, performance and proving tests.

The set shall have the output capacity 550KVA as indicated on drawings. It shall be capable of carrying a load of 10% above the full derated output for a period of one hour /12 hours.

The engine and generator shall be properly aligned and mounted on a common steel base through resilient mounting to prevent vibrations. The whole set shall be fixed on roof on a number of adjustable spring type vibration isolators.

2. Operation

Operation of the main failure emergency (stand by) generating set shall be as follows:

I- When the main voltage falls by 20% from normal, the engine shall be started automatically within 0-5 sec. and the full load of alternator within (15) sec. at which the automatic transfer which shall transfer the emergency load to the generating set.

II- The set shall be disconnected from the load when the mains voltage is restored to within 90% of its normal value, but shall remain running for 10 minutes after which it shall automatically stop.

3. Engine

The engine shall be direct injection, four stroke, 1500rpm. The engine shall be water cooled with radiator and shall include air filter, fuel and lubricating oil filters, water pump, fuel and lubricating oil pumps, oil cooler, governor, fly wheel, starter motor, tachometer, service hour counter, oil and water gauges, safety devices and all other accessories.

The engine shall run steadily at any local at its rated speed. Changes in speed shall comply with BS 5514 for class (A2) governor.

The cooling system of the engine (mounted water radiator and fan) should be thermostatically controlled.

Diesel engine manufacturer – Daewoo, SDMO, Perkins or equivalent type.

6" exhaust pipes shall be galvanized steel, airtight flexible coupling to the engine. A silencer of heavy duty residential type (Multi stage) shall be provided in the exhaust system and it shall be lagged.

Exhaust pipes and silencers shall be support from ceiling by special unit vibration hangers, rain caps shall be installed at the end of exhaust pipes.

4. Starting and Batteries

The engine shall be starter by a 24 VDC starting motor, supplied by batteries of the nickel cadmium type 24 V heavy duty diesel starting type filled with electrolyte.

The battery charge, shall be static-type complete with all necessary relays, cutouts, controls, switches and instruments for automatic charging of batteries.

An ammeter and voltmeter in the control panel shall indicated the state of batteries and its charging rate.

5. Fuel Supply

The engine shall be suitable for running on diesel oil.

Fuel supply to the engine shall be maintained by a daily service 500 liter fuels tank.

The contractor should provide and install one 2.2 kW fuel transfer pump in fuel room. The pump shall be automatically controlled by the high and low level switches in the daily tank.

Fuel piping between storage and daily tank shall be 1/2 in. hot galvanized pipes with flare end connections.

6. Alternator

The alternator shall be 3 phase, 4 wire, 380/220 volt, 50hz of output
200kw - 250 KVA continuos rating
220kw - 275 KVA stand-by rating, rotating field, Brussels self exciting with silicon rectifiers, self regulating within +2.5% under all conditions.

The generator shall include radio and TV suppressers to B.S. 800.

7. Voltage Regulation

The automatic voltage regulation shall be within + 2.5% and provision shall be made for adjusting the alternator voltage within +5%.

8. Control Panel

The control panel shall be metal enclosed cubicle free standing, made of sheet steel plates, dust and vermin protected will all equipment necessary for automatic mains failure operation as specified here above.

The control panels shall include;

400 amperes main C.B with over current, short CCt and earth fault protection, voltmeter 0-500V with selector. Switch off/test/manual/auto, voltage and frequency sensing relays, starting and cycling and switch (TPN) comprising mechanically and electrically interlocked MCCBS, battery charger, voltage trimmer, (Visual and audible alarms for overspeed: high water temp, low oil pressure, failure to start, engine shutdown, low fuel level in tank, remote operation in ground floor with relays for supply available, battery charge and cooling water heater, switch for cooling water

heater, start - stop and lamp test push buttons and all other accessories as fuses, terminals, wiring etc.....

Sound System

1. General Description

This work includes the system installed in the main lecture hall.

2. Products

All Products shall be Philips or Equivalent.

- a. Mixing Amplifier 120W type LBB1912/00.
- b. Column loud speaker 12W Type LBC3042/02.
- c. Cabinet Loud speaker 6W with volume control type LBC 3041/12.
- d. Desk Top Microphone.

3. General Directive for Execution

a. Installation of Accessories :

1. All equipment items shall be installed in their proper locations in accordance with the drawings.
2. The contractor must obtain the supervisor and planner's approval for the precise location of each accessory prior to execution.

b. Wiring :

1. All wiring shall be carried out using multiple-wire cables in accordance with the instructions issued by the equipment suppliers.
2. Most of the cables shall be routed through existing piping and communication ducts, as well as through additional pipes / ducts installed as required, in accordance with the drawings.
3. All system cables passing through communication cabinets must be protected by means of protective pipes, including identification signs.

c. Marking and Identification

1. Identification and instruction signs shall be installed next to all system accessories and where the cables pass through communication cabinets, in accordance with the requirements of the specifications and drawings.
2. All signs shall be " Sandwich " type, in red over a white background.
3. The costs of all signs shall be included in the regular unit prices, and will merit no separate payment.

d. System Testing and Commissioning

The system shall be tested and operated for a trial run, and will only be delivered to the client after it has been operated, tested and completed to the client's fullest satisfaction.

Upon delivery, the contractor must supply a manual which is to cover the equipment items installed and supplied (catalogues, etc.) , as well as a wiring diagram for the system. 3 sets of these manuals shall be delivered.

e. Equipment and Accessories

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1. Each accessory must agree with the requirement of the special Technical Specification and the Bill of Quantities.
 2. The equipment suppliers must be capable of supplying spare parts and repair services or minimum period of 10 years from the date of installation.
 3. The types and specifications of all equipment items, including brochures and samples, must be submitted to the client and planner's approval prior to installation.

4. System Technical Characteristics

a. General

1. The sound system shall be designed to transmit voice to all lecture hall.
2. The amplification unit of the system shall be located in the stage.
3. The amplification unit shall operate on standard mains power, with a backup emergency batteries, capable of keeping the system in operation for 300 minutes during a power breakdown.

b. Loudspeakers

The sound system shall feature standard loudspeakers (PHILIPS)LBC 3041/12, 12W with high sound pressure level and extended frequency response in the higher frequency range for music reproduction.

All speakers shall be connected through a line transformer for 100 Volts. An option for varying the output power for each speaker shall be provided.

c. Pre-Mixing Amplifier:

- Five input channels.
- Dual Tone Control.
- Built in priority functions.
- Built in speech filters on microphone channels.

The Pre Mixing Amplifier has five input channels that can be pre-selected as microphone or line inputs. The microphone inputs have phantom power available. Speech filters on all microphone channels reduce the bass content to improve the clarity of spoken speeches, and there are separate tone controls for music.

An LED VU meter provides a visual indication of the output level. The unit can be mains powered, or powered by a 24 V d.c. supply (protected against reversed polarity). All amplifiers are supplied with a 2m long mains lead, terminated with a 2-pole mains plug with earth contacts, and a CEE mains connector.

Measurement & Payment Methods For Electrical & Communications Installations

1. General

- a. The contractor must rely, as a primary source of reference, on Chapter 16 of the General Specifications for Construction Works, unless otherwise specified below.

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- b. All items shall be regarded as inclusive of "Supply" and "Installation", with the exception of those items where "Supply Only" or "Installation Only" are specified expressly. "Installation Only" should be read as inclusive of the costs of transporting the accessory/system in question from the location where it had been supplied to the contractor, storage for same, and full responsibility for its serviceability until the installation in question has been delivered to the client.
- c. All signing required for identifying the various accessories or for providing operating instructions, etc., shall be included in the supply and installation costs of the part to which the signing in question refers.
- d. Prices should also include the value of all accessories and auxiliary materials which had not been measured separately, such as fittings, hangers, brackets, supports, terminals, cable shoes, clamps, all kinds of reinforcing/attaching hardware, nails, screws, bolts, also prices should include covering of all electrical pipes installed below tiles with concrete layer to protect them.
- e. Prices for all works should also include the value of painting operations as specified, testing and repairs, trial runs, etc.
- f. Service and Spare Parts
- 1) The contractor must submit a warranty certificate for the quality of the products supplied, for a minimum period of one year from the date in which the installation has been approved and accepted, as well as written undertaking for supplying repair and maintenance services if so required, for a minimum period of 5 years from the date in which the installation has been accepted.
- 2) The contractor must supply spare parts as required by the drawings or as instructed by the supervisor.
- g. Electrical Connections
Connections of all cables and electrical accessories including switchboards, lighting fixtures, etc., shall be included in the installation prices for these elements, and will merit no separate payment. Connection to motors or electrical installations supplied by other contractors shall be measured separately, complete.
- h. Painting & Coating
The prices for painting and coating of the various equipment items and installations, as required by the General Specifications, the special specifications or the drawings, including paint touch-ups and repairs, shall be included in the supply and/or installation prices of these equipment items and installations.
- i. Reference to Product Brand-Names
Any references made to specific product brand-names are merely intended to indicate the quality standards of the required product, and must not be regarded as compulsory or binding. The contractor will be allowed to suggest products which he considers to be on a par with those
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specified, however in any event, the planner and supervisor's approval must be obtained.

The various items of the Bill of Quantities and/or specifications do not include the definition "or approved equivalent" following the specific manufacturer or brand-name specified. The paragraphs where manufacturer or brand-names have been specified should be read as inclusive of the suffix "or approved equivalent" following the brand-name or manufacturer's name specified.

When suggesting an equivalent product, the contractor must submit, in addition to an actual sample, relevant catalogues and brochures, and any other certificates as required by the supervisor and planner.

- j. Prices of all required junction boxes and pull boxes used to facilitate electrical connections are to be included in the unit rates of the points with no additional cost, the contractor should note that he must arrange all electrical installation in a proper way so as to use the minimum number of such junction boxes and pull boxes.

2. Electrical Switchboards

- a. Switchboard prices must include switches circuit breakers and all switchboard structural elements, bus-bars, terminal strips, "press-on" type aluminum - copper conductor terminals, tapping insulators, bus - bar system insulators, complete signing for the switchboard, installation, connection of all cables and leads to the switchboard, as well as piping covers at switchboard entrance. All prices of switchboard accessories must include installation and connection of said accessories in the switchboard.
- b. Socket Panels
Prices of socket panels must include all details as specified in the specifications and drawings, with all accessories thereof. Socket panels may be measured as units or complete.

3. Installations

a. Profiles

Profile prices must include all details as specified in the specifications. The Bill of Quantities specifies the profile length. Profiles shall be measured in units. Profiles and various reinforcing/attaching hardware items which are included in the specifications and unit prices for other items or completes shall not be measured separately.

b. Connection of Electrical and/or Telephone Piping to the Building

- 1) Piping prices must include all details as specified in the specifications, as well as installation.
Pipes shall be measured in meters (length) long their axis - No. separate or additional payment may be allowed for bends of any type.
- 2) Prices include excavations for piping and consists of:
 - a. Excavation to the depth and width as specified in the drawings.
 - b. 10 cm thick sand bedding around the pipes.

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- c. Refilling and placement of marker tape (danger).
 - 3) Connections of pipes to underground manholes must be included in the piping prices.
 - 4) Connections of pipes to buildings must be included in the piping prices.

c. Pipes

All pipes for the electrical and communication installation and all parts thereof must be of the heavy, bendable, self - extinguishing type. Pipes of the same type shall be measured as part of the same item, without differentiating between pipes attached to structural elements and those installed inside cast concrete elements. Pipe prices must include the supply, installation and Nylon drawstrings in "reserved" or pre-assigned pipes. The above shall only apply if the pipes are not expressly included in the prices of specific points or completes.

d. Cables and Leads

Prices of cables and leads must include all details as specified in the specifications, as well as all connectors, reinforcing attaching hardware, terminals, cable shoes, clamps, etc., required for their installation. All cables shall be measured in meters (length). The above shall only apply if the cables are not expressly included in the prices of specific points or completes.

e. Passage Sleeves in Concrete Walls

Sleeve prices must include all details as specified in the specifications. Measurement shall be complete for each sleeve/pipe, or in meters (length).

f. Underground Manholes

Prices for underground manholes must include all operations and materials required in order to install each manhole, including B-300 type reinforced concrete (in accordance with the General Specifications for On-Site Cast concrete Works), frames and covers, excavation, bottom bedding, drainage pits and sealing of piping connections.

g. Digging and/or Excavation Operations

Digging and/or excavation operations for underground cables or piping shall be included in the prices of the pipes and cables which are to be installed in these excavations, the depth and width specified, including sand bedding, covering with bricks, refilling, marker tapes, compacting, removal of excess earth and restoration of area to its previous condition.

i. Testing of Installation

Work prices must include all details as specified in the "Installation Testing, Trial Run and Acceptance" section of the General Specifications. Testing and approval by the Electrical Co. and all other tests must be included in the relevant unit prices, with no additional cost.

j. Ducts

Ducts shall be measured in meters (length). Duct prices must include the covers and all profiles, supports and reinforcements required in order to install these ducts in any way required.

k. Points

1) Wall, Ceiling or False Ceiling Mounted Lighting Point Normal or Water Proof or Halogen Spot Light

Each outlet for the installation of a lighting fixture on the ceiling or wall or truss shall be measured as one point. Price is to include a 16 mm or 23 mm diameter pipe and leads with a cross-section of 1.5 sq.mm, or 3x1.5 NYY type cable, installed under the plastering, leading from the applicable electrical board to the point, regardless of the distance between the board and the point, an outlet for the lighting fixture in the form of an under-plaster junction box, as well as a plastic light switch of any type, either single, double, two-way, changeover, water-tight, a push - button to activate a step relay, or switch panels. Accessories shall be as manufactured by "Gewiss" 20 Eurosystem range type. All auxiliary accessories, including common passage boxes, must be included in the point price. For halogen spot lights same as above is said except that prices shall include wires of different sizes up to a cross section of 10sq.mm so as to be enough for the 12V supplied to such points depending on the number of these halogen lamps fed from the same line.

2) Lighting Point in Boiler, Laundry Rooms and Kitchen

Each outlet for the installation of a lighting fixture in the boiler room, laundry room and the kitchen shall be measured as one point. Price is to include a 16 mm or 23 mm diameter pipe and leads with a cross-section of 1.5 sq.mm, or 3x1.5 NYY type cable, installed inside a designated profile for the installation of fluorescent lighting fixture (Measured separately), leading from the applicable electrical board to the point, regardless of the distance between the board and the point, mounted over the plastering, down to armored, water-tight light switches, including co-ordination of the final location of the lighting fixture outlets in accordance with the actual placement of the equipment and machinery in the room (i.e. air-conditioning system, sanitary installations, generator, etc...).

3) Outdoor Lighting Point

Each outlet for the installation of an outdoor light point or on one of the external walls of the building as indicated in the drawings shall be

measured as one point. Price is to include a 23mm diameter pipe or sections of PVC (MERIRON) or galvanized pipes where the cables cannot be routed through the normal piping, plus armored, water tight passage boxes and 3x2.5 NYY, or 5x2.5 NYY cables. Prices must include connection to switch panel and to the switchboard regardless of the distance between the switch panel, switchboard and the point. Switches are also included in the unit price as manufactured by "Gewiss" 20 Eurosystem range.

4) External Lighting Point For Lighting Poles:

Each outlet for the installation of a light pole into the external pavement or into the external basket court as indicated in the drawings shall be measured as one point. Price is to include a 23mm or 29mm, 2 inch or 3 inch flexible spiral pipe and 3x4 NYY, 5x4NYY, 5x6 NYY or 5x10 NYY cables to be buried in the ground. Prices include excavation, laying, and backfilling in the way described into the specifications. Connection to switchboard and connections between switchboard and switch panel concerning external lighting regardless of the distance, switches as manufactured by "Gewiss" 20 Eurosystem range are all included in the point price.

5) 220 Volts Emergency Lighting Point & Orientation Sign

Price is to include the same as listed above for the standard wall or ceiling-mounted lighting points, plus an additional 1.5sq. mm

6) Standard Wall-Mounted Socket Outlet Point, Normal or Water Proof, or UPS Connected

Each outlet for a 16A 3-contact wall-mounted socket accessory shall be measured as one point. Price is to include 16 mm diameter pipe and 3 x 2.5 sq. mm leads installed under the plastering, or a 3 x 2.5 NYY cable routed, in part, through cable duct (measured separately) and in part through 16mm or 23 mm diameter protective piping installed under the plastering, leading from the point to the applicable electrical board, regardless of the distance between the point and switchboard, and including a 16A 3-contact plastic socket outlet accessory such as manufactured by "Gewiss" 20 Eurosystem range type, standard or water-tight or special for UPS sockets, installed under the plastering at any height as required, and attached to the wall by means of screws, all connected, ready for use.

7) Three Phase Socket Outlet Point

Each outlet for connection of a three phase 16A wall mounted socket shall be measured as one point. Price is to include a 5x2.5 NYY cable inside 23mm diameter conduit leading from the point to the applicable electrical switchboard, regardless of the distance between the point and switchboard. Price also includes a socket panel such as NISKO NI516 including a miniature automatic circuit breaker and on-off switch, or such as "Gewiss" Eurodin 66/67 IB range with three phase 16A industrial socket and on-off rotary switch.

8) Supply Point for External Fan, 1 Phase

Each outlet for connecting a single phase exhaust fan shall be measured as one point. Price includes a 3x2.5 NYY cable leading from the switchboard up to the roof inside a 23mm diameter pipe then through the cable duct on the roof then using a metal flexible pipe leading from the cable duct on the roof till the applicable point of exhaust fan regardless of the distance. Point also includes a double pole switch with an indication lamp including main line and switch connection to associated switchboard. Point is to terminate with armored, watertight 16A 2-pole circuit breaker, installed near the fan. All the above mentioned parts are included into the unit price except the cable duct on roof which is to be measured separately.

9) Supply Point for Exhaust Fan, 3 Phase

Ditto as item 11 above but, but 5x2.5 NYY cable instead of 3x2.5 and a single pole switch to activate contractor with indication lamp instead of the double pole switch with indication lamp.

10) Single Phase Floor Power Supply Point for Machines

Each main line coming from the switchboard until a floor outlet in the building shall be measured as one point including the outlet. Price includes a 3x2.5 NYY cable passing through 23mm diameter conduit from the switchboard till the machine which is to be connected or till the working table which is to be supplied with power from the floor.

11) Three Phase Floor Power Supply Point for Machines

Ditto, as single phase above but 5 x 2.5 NYY cable instead of 3 x 2.5.

12) Socket Outlet Point in Communication Cabinet

Point price is to include 16 mm diameter heavy, bendable type piping installed under the plastering, with 3 x 2.5 sq.mm leads, or 3 x 2.5 NYY cable, leading from the switchboard to the point. Point is to terminate with water -tight socket installed in the communications cabinet.

13) Emergency Shut-off Push -Button Point (In Boiler Rooms)

Point price is to include 16 mm diameter heavy, bendable type piping installed under the plastering, with 3 x 2.5 sq.mm leads, or 3 x 2.5 NYY cable, leading from the switchboard to the push-button such as model XAS - E25 by "Telemechanique", red colored.

14) Telephone Connection Point

Each outlet for telephone connection shall be measured as one point. Price is to include a 16 mm diameter pipe with a 2 x 2 x 0.5 telephone cable installed under the plastering, leading to the telephone distribution frame in the communication cabinet or to the main communications duct, as well as an outlet with a plastic socket Gewiss 20 Eurosystem range type.

15) Preparatory Point for Computer Terminal Connection

Each outlet for computer terminal connection shall be measured as one point. Price is to include a 23 mm diameter pipe with a 2 mm diameter Nylon drawstring, installed under the plastering, leading to the computer section in the communications cabinet, or to the main computer hub. Point is to terminate with a junction box installed under the plastering with "Gewiss" Eurosystem 22-24 range plates and supports.

16) Preparatory Point for Sound System Connection

Each loudspeaker outlet of the public - address system shall be measured as one point. Price is to include a 16 mm diameter pipe with Nylon drawstring, leading to the Public-Address section in the communications cabinet, as well as the preparation of an under-plaster junction box at the outlet, including terminal boxes as required.

17) Preparatory Point for Fire Detection & Fire Alarm System Connection

Each outlet for fire/smoke detector, detector indicator lamp, outlet for emergency push-button or alarm horn, shall be measured as one point. Price is to include 16 mm diameter heavy, bendable type piping under the plastering with drawstrings, leading from the fire detection section in the communications cabinet to the point, as well as the preparation of an under-plaster junction box at the outlet, including terminal boxes as required.

18) T.V Antenna Connection Point

Each outlet for TV antenna connection shall be measured as one point. Point price is to include a 23 mm diameter pipe with a 75 ohm coaxial cable drawn in the pipe under the plastering leading from the TV section of the communications cabinet to the point. Point is to terminate with an under-plaster junction box, which is to accept a TV antenna socket. T.V antenna socket shall be Gewiss 20 Eurosystem range type.

4. Grounding and Protective Devices

- a. The price of the foundation earthing welding for the building is to include all the details as specified in the specifications and drawings, and shall be measured complete, for the entire building.
- b. Connection of a potential-equalizing bus -bar to the outlets from the foundation grounding is to be included in the price for the bus-bar.

c. Installation Grounding System

The price of the grounding system is to include all the materials and operations necessary to ensure proper grounding, such as: leads with the cross-section specified, protective piping, terminals, clamps, excavation (in the event that connection to underground water piping is carried out outside the building), etc. Grounding conductor length- as required. The grounding system shall be measured complete, regardless of the actual length of the piping and leads.

d. Grounding of Electrical Switchboards or Grounding Bus-bars to Water Piping or Other Metal Elements

The price of the grounding system is to include all the materials and operations, necessary to ensure proper grounding such as: leads with the cross -section specified, protective piping, terminals, clamps, etc. Grounding length- as required, including connection & signing, all to be measured complete, regardless of actual length of the piping and leads.

5. Lighting Fixtures

Prices for lighting fixtures shall include all details as specified in the specifications, with all parts and accessories thereof, including lamps, tubes and all auxiliary operations and materials required for the operation and perfect installation of the lighting fixtures to ceilings, walls or metal structural elements, including any required cross beams or hangers used to fix or support light fixtures into areas where there are trusses as the workshops areas, or for their incorporation in acoustic ceilings, as well as hangers to attach the lighting fixtures to the ceilings. Lighting fixtures shall be measured separately in units. If otherwise specified, the supply and installation of the lighting fixtures shall be measured and priced separately.