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Technical Specifications of Solar and Civil Works

Planners Consultants Engineers (PCE), Peshawar

SECIFICATION
CIVIL WORKS

TECHNICAL SPECIFICATIONS

CONTENTS

SECTION – 0100

GENERAL REQUIREMENTS

1. GENERAL

1.1 The General Conditions of Contract shall form an integral part of these General Requirements.

1.2 The Contractor shall notify all sub-contractors of the provisions of the General Conditions of Contract and the General Requirements of this Specification.

1.3 The arrangement and divisions of these Specifications is not to be construed as establishing the limits of responsibility of sub-trades. The Contractor is responsible for delineating the scope of Sub-Contracts and for coordinating all theWorks.

2. APPLICABLE STANDARDS

In the absence of other Standards being required by the Contract Documents, all work shall meet the requirement of the Uniform Building Code of the United States, and/or applicable American Society for Testing Materials (ASTM) Specifications, except in cases where the Pakistan Building Code requires a higher standard. In such cases the Pakistani Code shall govern. Where the abbreviations listed below are used, it refers to the latest code, standards, or publication of the following organizations:

AASHO	American Association of State Highway and (AASHTO) Transportation Officials
ACI	American Concrete Institute
AI	Asphalt Institute
AIS	American Iron and Steel Institute
AISC	American Institute of Steel Construction
ANSI	American National Standards Institute
ASA	American Standard Association
ASCE	American Society of Civil Engineers
ASTM	American Society for Testing and Material
AWPA	American Wood Preservers Association
AWS	American Welding Society
AWWA	American Water Works Association
BSI	British Standards Institute
BS1CP	British Standard Institute Code of Practice
NPC	National Plumbing Code
PCA	Portland Cement Association
PCI	Prestressed Concrete Institute
PSI	Pakistan Standard Institute
UBC	Uniform Building Code
UL	Underwriters Laboratories, Inc.
UPC	Uniform Plumbing Code

Should the Contractor, at any time and for any specific reasons, wish to deviate from the above standards or desires to use materials or equipment other than those provided for by the above standards, then he shall state the exact nature of the change giving the reasons for making the change and shall submit complete specifications of the materials and descriptions of the equipment for the Engineer's approval, whose decisions shall be conclusive and binding upon the Contractor.

3. CODES, STANDARDS, CERTIFICATES

3.1 The Contractor shall supply and have at his site office:

3.1.1 Copies of all latest editions of codes and standards referred to in these Specifications by number, or equivalent codes and standards approved by the Engineer.

3.1.2 Catalogues and published recommendations from manufacturers supplying products and materials for the project.

3.2 The Contractor shall provide manufacturer's or supplier's certificates to the Engineer for all products and materials which must meet the requirements of a specific code or standard as stated in these Specifications.

4. MANUFACTURER'S RECOMMENDATIONS

Installation of manufactured items shall be in accordance with procedures recommended by the manufacturer or as approved by the Engineer.

5. STORAGE & HANDLING FACILITIES

The Contractor will arrange a space for the storage of plant, equipment and materials and for Contractor's temporary office, during the currency of the Contract adjacent or near the SITE. On no account shall such temporary installations conflict with any of the permanent installations and services. The handling and storage of all plants equipment and materials at site shall be the sole responsibility of the Contractor and at no risk and cost to the Employer.

The Contractor shall protect all material against corrosion mechanical damage or deterioration during storage and erection on site. The protection methods shall be to the approval of the Employer or his representatives. The ends of all nozzles, pipes, tubes and conduits during the period of storage at the site shall be covered with a tube cap to seal against entrance of rain water, blowing dirt, and other foreign matter. The out side surface of all pipes shall be protected and covered with suitable material. Protective material shall not obliterate ASTM (or equivalent) grade markings, etc. Imported materials shall be shipped, stored and protected as required.

The Tenderer shall provide with his Tender, details of his proposals in respect of stores, lay down areas, office accommodation and other such facilities and shall include all costs connected with these provisions in his Tender.

6. CONSTRUCTION & CHECKING AT SITE

The Contractor shall submit to the Engineer in due time for approval and discussion, his proposals and plans as to the method and procedure to be adopted for the temporary and permanent works involved.

The submitting of these suggestions and arrangements, and the approval thereof by the Engineer or his Representatives, shall not relieve the Contractor of his responsibilities and duties under the Contract.

The Contractor's representative on the site or his nominated agent is to be given full authority to enter into negotiations regarding points arising from the execution of the work.

The carrying out of all work included in the Contract is to be supervised by a sufficient number of qualified representatives of the Contractor and full facilities and assistance are to be afforded by the Contractor for the Engineer or his Representative to check & examine the execution of the work.

The Engineer reserves the right to inspect all parts of the works but may at his discretion waive inspection on certain items. This shall in no way absolve the Contractor from his responsibilities. This particularly applies to the checking of materials, the accurate setting out of foundations, the plumbing of all columns and to the leveling, setting and aligning of the various parts, and to the proper fitting and adjustment of manufactured andfinished materials and fixtures in position.

If the Engineer or his Representatives see that the work progress is slow in such a way that the works or parts thereof will not be completed in the time specified, then he shall order the Contractor to work overtime or in shifts and the Contractor shall obey. These arrangements will be free of all financial encumbrances and at no additional costs to the Employer.

In the event of night work, the Contractor shall provide sufficient and adequate lighting to the satisfaction of the Engineer or his Representative and shall supply the necessary manpower for satisfactory continuation of the work after normal hours.

6.1 Site

Within the Project area limits as defined on the Drawings, the Contractor shall carry out and perform the construction works, and subject to the approval of the Employer will be permitted to construct temporal')' road-way camps, buildings and temporary works which he may require for the execution of the work. If the Contractor wishes to use other land for camps he shall pay all rentals or other costs connected therewith.

7. BAR BENDING SCHEDULE

Bar bending (reinforcement bars) schedule of all drawings shall be prepared by the Contractor and submitted in triplicate to the Engineer for approval.

8. SHOP DRAWINGS

8.1 The Contractor shall submit with sufficient promptness as to cause no deli in the Works copies of all shop or setting drawings and schedules required for the Works or which have been specifically requested by the Engineer. The Engineer will check and approve with reasonable promptness such schedules and drawings for conformity with the provisions, with the design concept of the Works and compliance with the provisions of the Contract Documents. The Contractor shall make any corrections in the schedules and drawings as required by the Engineer and resubmit further sepias and prints thereof until approved by the Engineer. The Engineer will arrange to issue such copies of the approved shop drawings and schedules as may be| required by any nominated sub-contractor or other contractor, but the Contractor will be responsible for making all copies necessary for his own use and the use of his sub-contractor,

8.2 The shop drawings shall be properly identified with the name of the project, the name of the Contractor, Supplier etc., the date of preparation and the dates of all revisions. The Shop Drawings shall be complete and shall show the design dimensions, materials used finishes, type of shop paint and all other details and information and shall also show adjoining work and details of connections thereto.

8.3 Where adjoining work requires shop drawings the Contractor shall prepare and submit composite shop drawings which shall show and define the work under all affected trades. If the Contractor installs work before coordinating with other trades so as to cause interference with work of those trades, he shall make changes necessary to correct the conditions without extra cost to the Employer.

8.4 No changes shall be made by the Contractor in the resubmitted shop drawings in excess of the corrections spelled out by the Engineer and in a separate note on the shop drawings.

8.5 No work in the shop shall be started and no material or equipment ordered until the Engineer has approved the shop drawings. It shall be the responsibility of the Contractor to submit the shop drawings on a schedule that allows reasonable time for checking and approval and subsequent fabrication. Failure to submit shop drawings in ample time for checking, correcting, and rechecking will not justify a delay in time for completion of work.

8.6 The Contractor shall also check and verify all site measurements wherever requested by other Specialist Contractors or by Nominated or other Sub-contractors to enable them to prepare their own shop drawings and pass on the information with sufficient promptness as will not in any way delay the works. A copy of all such information passed on shall be given to the Engineer.

9. AS-BUILT DRAWINGS

The Contractor shall, at all times, keep on the site one copy of all drawings and approved samples together with copies of all building, mechanical, electrical and public safety codes and relevant standards applicable to the works. All such material shall be made available to the Engineer.

In addition, the Contractor shall, at all times, keep on site a separate set of prints on which shall be noted neatly, accurately and promptly as the work progresses all significant changes between the work shown on the drawings and that which is actually constructed. The mechanical and electrical Sub-Contractors shall each keep on site, at all times, a separate set of prints of the drawings showing their parts of the work on which shall be noted, neatly accurately and promptly as work progresses the exact physical location and configuration of the works as actually installed, including any revisions or deviation from the Contract Documents.

At the completion of the works, the Contractor shall at his expense, supply the Engineer with reproducible copies of these drawings. The Contractor and the Subcontractors shall revise these reproducible copies neatly and legibly, so as to show clearly the way in which the work was actually constructed. The Contractor shall provide in the same format as the original drawings, any additional sheets required to record the work.

10. PROTECTION OF THE WORKS

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

The Contractor shall take all proper steps for protection at all places on or about theworks which may be dangerous to his workmen or any other person or to traffic. The Contractor shall provide and maintain warning - signs, warning lamps and barricades as necessary. The Contractor shall wherever practical, leave on fittings their protectivetapes, coverings, wrappings and comer protectors and the like after they have beeninstalled until all work in the region of the fittings has been completed.

11. RESTORATION AND CLEANING

Upon completion of the works the Contractor shall restore all items covered by the Contract to the satisfaction of the Engineer.

The Contractor shall do regular cleaning and cleaning away all rubbish and excessmaterials that may accumulate from time to time on completion and before handing over. Upon completion of the works he shall obliterate all signs of temporary construction facilities such as work areas, structures, foundations of temporary structures, stock pilesof excess or waste materials, or any other vestiges of construction, as directed by the Engineer. All buildings shall be cleaned, floors and paving scrubbed and the works and site shall be left in a clean and satisfactory state for immediate use and occupation. Care shall be taken not to use any cleaning materials which may cause damage to the surfaceto be cleaned.

The Contractor shall also take all necessary precautions to keep the works and site free from vermin during construction and he shall leave the works vermin free on completion. Application of pest control agents shall not commence until the specific product, name, method and extent of application have been submitted to and approved of by the Engineer.

12. PRODUCT DATA

Manufacturer's standard schematic drawings shall be modified or deleted to indicate only information which is applicable to the project. Such standard information shall be supplemented to provide all additional applicable information.

Manufacturer's catalogue sheets, brochures, diagrams, schedules, performance charts, illustrations and other standard descriptive literature shall be clearly marked to identify pertinent materials products or models. Dimensions and required clearances shall be indicated. Shop performance characteristics and capacities shall be noted. Wiring diagrams and controls shall be illustrated.

13. SAMPLES

13.1 The Contractor shall furnish for approval of the Engineer with reasonable promptness all samples as directed by the Engineer or specifically called for in these Specifications. The Engineer shall check and approve such samples with reasonable promptness only for conformance with the design concept of theWorks and for compliance with the information given in the Contract Documents.All work shall be in accordance with approved samples.

13.2 Duplicate final approved samples, in addition to any required for the Contractor's use, and shall be furnished to the Engineer one for office use and the other for the Site.

13.3 Samples shall be furnished so as not to delay fabrication, allowing the Engineer reasonable time for consideration of the sample submitted.

13.4 Each sample shall be properly labeled with the name and quality of the material, manufacturer's name, name of the project, the Contractor's name and the date of submission, and the Specifications Article number to which the sample refers.

The manufacturer's installation directions shall be provided with each sample. The Contractor shall pay all transportation costs and deliver samples to the Engineer's office, Site or testing laboratory as directed by the Engineer.

13.5 Samples will not be returned unless return is requested at the time of submission; all packing and transportation costs for the return of samples shall be paid by the Contractor.

13.6 Samples shall be of adequate size to permit proper evaluation of the material by the Engineer. Where variations in colour, texture, dimensions or other characteristics are to be expected, the Contractor shall submit samples

showing the maximum range of variation. Materials exceeding the range of variation of the approved samples shall not be used on the work.

13.7 In order to permit coordinated selection of colours and finishes, the Contractor shall deliver samples of all items of interior finish to the Engineer at one time. Samples of such materials will not be approved until all related samples havebeen submitted.

13.8 If both Shop Drawings and samples are required for the same item, the Engineer may require both to be submitted before approving either.

13.9 No acceptance or approval of any Shop Drawings or sample, or any indication or request by the Engineer on any Shop Drawings shall constitute an authorization for any increase in the Contract Sum.

14. PRODUCT QUALITY AND HANDLING

14.1 Sub-Contractors and suppliers of local and foreign products and installations specified shall be regularly engaged in the business of manufacturing, fabricating, installing and/or servicing work required for a period not less than 5 years. In addition, the supervising Engineer may request as appropriate a:

- List of similar installations that describes project, scope, and date of completion.
- Complete literature, performance data, and technical data. List of service accounts within Pakistan.
- Location of service office from which this installation could be maintained.
- Location of the closest parts inventory for the installation.

14.2 For the actual fabrication, installation, and testing of the specified work. use only thoroughly trained and experienced workmen completely familiar with the items required and with the manufacturers recommended methods of installation. In acceptance or rejection, no allowance will be made for the lack of skill on the part of workmen.

14.3 Use all means necessary to protect materials before, during, and after installation and to protect the installed work and materials of all other trades. In the event of damage, immediately make all repairs and replacement necessary for approval and at no additional cost to the Employer,

15. PAKISTANI GOODS AND SERVICES

The Contractor shall give preference to materials, supplies, goods, equipment, crafts and services of Pakistan origin which may be incorporated in the design, drawings and specifications.

The specifications for the goods produced by these manufacturers may be obtaineddirectly from the firms and shall be incorporated in design work where meeting basic standards of quality as established herein.

16. INSPECTION & TESTS REPORTS

16.1 All equipment and materials furnished under these specifications and all work performed in connection therewith will be subject to rigid inspection by the Engineer or the Engineer's Representative. Acceptance of equipment and material or the waiving off inspection thereof shall in no way relieve the Contractor of his responsibility for meeting the requirements of the Contract.

16.2 The Contractor shall furnish to the Engineer's Representative four certified true copies of reports of the tests of all materials used in the manufacture and fabrication of all equipment and material including but not limited to structural steel, metal work, steel pipes, fire bricks etc. The result of these tests shall be in such form as to show compliance with the applicable specifications, standards andcodes for the material used.

17 ACCIDENT PREVENTION, PROTECTIVE EQUIPMENT

The Contractor shall comply and enforce compliance by all his sub- contractors with the highest standards of safety and accident prevention in accordance with international standards and in compliance with all applicable laws, ordinances and statutory provisions.

All requisite barriers, fences, warning signs, lights and other safety precautions as required for the protection of persons and property on or adjacent to the site shall be provided at the Contractor's cost.

All flasework, scaffolding and hand rails shall be well constructed and secured at all times. Where overhead work is being carried out, warning signs shall be installed at ground level clearly warning of the overhead work.

All warning signs shall be in two languages, English and Urdu, and shall at all times be maintained in a clean and legible condition, to the satisfaction of the Engineer.

Trash shall be removed at frequent intervals to the satisfaction of the Engineer.

18 CONSTRUCTION SCHEDULE

18.1 A Construction schedule shall be maintained in accordance with the provisions of the General Conditions of Contract.

18.2 The schedule shall be accompanied with sufficient data and information including all necessary particulars of constructional plant, equipment, machinery, temporary Works, arrival of plant, equipment at site and their installation, method of operation, work forces employed, etc., for all activities of the Works.

18.3 Should the Engineer consider any alteration or addition in the Programme and time schedule, the Contractor shall conform thereto without any cost to the Employer.

18.4 Whenever necessary and wherever the progress of the actual works shows departure, the programme and time schedule shall be updated and submitted to the Engineer for his approval.

19. CONSTRUCTION PROCEDURES

The Contractor shall advise the Engineer of proposed construction procedures in accordance with the General Conditions of Contract.

20. NOTIFICATION TO ENGINEER

The Engineer's Representative shall be notified daily in writing of the nature and location of the Works the Contractor intends to perform the next day so as to enable necessary inspection and measurement to be carried out. The Engineer may. If necessary, direct that longer notice be given of certain operations.

21. NIGHT WORK

When work is done at night the Contractor shall maintain from sunset to sunrise such lights on or about his work and plant as the Engineer may deem necessary for the proper observations of the work and the efficient prosecution hereof.

22. WEATHER

No work is to be undertaken when, in the opinion of the Engineer, the weather is so unsuitable that proper protection of the work cannot be ensured.

23. CO-ORDINATION WITH OTHER CONTRACTORS

It shall be the responsibility of the Contractor to co-ordinate and keep-up good relations with other Contractors employed on site by the Employer.

24. CONTRACTOR'S RESPONSIBILITIES

24.1 Review Shop Drawings. Product Data and Samples prior to submission.

24.2 Verify:

Field measurements
Field construction criteria.

24.3 Coordinate each submittal with requirements of work and of Contract Documents.

24.4 The Contractor's responsibility for errors and omissions in submittals is not waived by the Engineer's review of submittals.

24.5 The Contractor's responsibility for deviation in submittals from requirements of Contract Documents is not waived by the Engineer review of submittals unless the Engineer gives written acceptance of specific deviations.

24.6 Notify Engineer in writing at time of submission, of deviations in submittals from the requirements of the Contract Documents.

24.7 Begin no work which required submittals until return of submittals with Engineer's stamp and initials or signature indicating review.

24.8 After Engineer's review, distribute copies.

25. SUBMISSION REQUIREMENTS

25.1 Schedule submission at least thirty days before the dates when reviewed submittals will be needed.

25.2 Submit one reproducible transparency and one print of Shop Drawings, andnumber of copies of Product Data which Contractor requires for distribution plus four copies which will be retained by the Engineer.

25.3 submit three samples unless otherwise specified.
25.4 company submittals with transmittal letter, in duplicate, containing:

- Date
- Project title and number
- Contractor's name and address
- The number of each Shop Drawing, Product Data and the Sample submitted.
- Notification of deviations from Contract Documents.
- Other pertinent data.

26. RE-SUBMISSION REQUIREMENTS

Shop Drawings:

- Revise initial drawings as required and resubmit as specified for initial submittal.
- Indicate on drawings any changes which have been made other than those requested by the Engineer and the s.
- Product Data and Samples: Submit new data and samples as required for initial submittal.

27. DISTRIBUTION OF SUBMITTALS AFTER REVIEW

27.1 Distribute copies of Shop Drawings and Product Data which carry the Engineers stamp to:

- Contractor's file
- Job-site file
- Record Documents file
- Other prime Contractors
- Sub-Contractor
- Supplier
- Fabricator

27.2 Distribute samples as directed by the Engineer.

28. ENVIRONMENTAL CONSIDERATIONS

The Contractor shall be concerned with the impact of his work upon the environment. This applies to the effect upon the residential zones, adjacent dignitary facilities and uponthe area outside the site boundary. Areas of concern will include but are not limited to:

Use of clean fuels to minimize air polluting emissions.
Control of other air pollutants.
Recovery and recycling of usable materials.
Control of vehicle noise.
Control of noise from power facilities.
Limitation of vibrations.
Preservations of natural land to the extent possible.
Preservation of archaeological sites.

29. EMPLOYER'S REQUIREMENTS

29.1 Meeting and Reports

Approved representatives of the Contractor shall attend formal meetings at the office of the Employer's Representative on Site. When called upon for the purposes of Contact administration. Such meeting, unless otherwise agreed, shall no be more frequent that once per month.

The Contractor shall submit to the Employer each month a report on his progress in the performance of the contract including an updated CMP/PER.T type analysis.

29.2 Photographs

The Contractor shall supply negatives and un-mounted colour positive prints of photographs, 5" x 7" size, of such portions of the Works which are in progress or that which is completed, as directed by the Employer. The negatives and prints shall not be returned. No prints from these negatives shall be suppliedto anyone without the written permission of the Project Manager.

The photographs shall be of two categories:

a) Progress photographs;
b) Record photographs

30. PAYMENT OF WORK

No payment shall be made for the works involved within the scope of this section of specification unless otherwise specifically stated in the Bills of Quantities or herein.

The cost thereof shall be deemed to have been included in the quoted unit rate of other items of the Bills of Quantities.

Payment will be released to the Contractor within Fifteen (15) days after receipt of the verified by the Project Engineer and Employer.

SECTION - 1000

EARTHWORKS

1. SCOPE

The work under this section of the specifications consists of furnishing all plant, labour, equipment, appliances and materials and in performing all operations in connection with earthworks of all foundation for structure & services line trenches including stock piling of suitable excavated material, disposal of unsuitable and surplus excavated material in accordance with this section of specifications, the applicable drawings and subject to terms and conditions of the Contract.

2. GENERAL

2.1 The Contractor shall acquaint himself with the nature of the ground, existing structures, foundations and subsoil which might be encountered during excavation or earthworks. The Employer does not guarantee or warranty in any way that the materials to be found in the excavation will be similar in nature to that of any samples which may have been exhibited or indicated in the Report, Drawings or in any other Contract Documents or to material obtained from boring or trial holes. The Contractor shall be deemed to have made local and independent inquires as to, and shall take the whole risk of, the nature of the ground subsoil or material to be excavated or penetrated and the Contractor shall not be entitled to receive an extra or additional payment nor to be relieved from any of his obligations by reasons of the nature of such ground subsoil or material.

2.2 All excavations cut and fills shall be constructed to the lines, levels and gradients specified with necessary allowance for consolidation, settlement and drainage so that at the end of the Period of Maintenance the ground shall be at the required lines, levels and gradients. During the course of the Contract and during the Period of Maintenance any damage or defects in cuts and fills, in structures and other works, caused by slips, falls of wash-ins or any other ground movement due to the Contractor's negligence shall be made good by the contractor at his own cost.

3. SITE PREPARATION

3.1 The Contractor shall set out the works and shall be responsible for true and perfect setting out of the same and for correctness of the positions, levels, dimensions and alignments of all parts thereof. If at any time any error in this respect shall appear during the progress of the works, the Contractor shall at his own expense rectify such error.

3.2 The Contractor shall construct and maintain accurate bench marks so that the lines and levels can be easily checked by the Engineer.

3.3 The Contractor shall construct and maintain such ditches, in addition to thoseshown on the plans, as will adequately drain areas under construction.

3.4 The Contractor shall perform a joint survey with the Engineer's Representative, of the area where earth work is required, plot the ground levels on the drawings and obtain approval from the Engineer before starting the earth-work.

4. FOUNDATION FOR STRUCTURE

4.1 Excavations

4.1.1 Excavation shall include the removal of all material of every name and nature.

Excavations shall be carried out in accordance with excavation plans and sections shown on the Drawings.

4.1.2 The major portion of excavations shall be carried out by mechanical excavators and excavated materials disposed off to stock on spoil as per Drawings or as directed by the Engineer. The excavation which cannot be done by mechanical means shall be done by manual tools. Unless otherwise specified by the Engineer, leveling, trimming and finishing to the required levels and dimensions shall be done manually. The material suitable for fill and backfill if approved by the Engineer shall be stockpiled within the free haulage limit of the project boundary of the works.

4.1.3 The Contractor shall give reasonable notice that he intends to commence any excavation and he shall submit to the Engineer full details of his proposals. The Engineer may require modifications to be made if he considers the Contractor's proposals to be unsatisfactory and the Contractor shall give effect to such modifications but shall not be relieved of his responsibility with respect to such work.

4.1.4 For major excavations, the Contractor shall submit for the prior approval of the Engineer full details and drawings showing the proposed method or procedure, supporting and strutting, etc. The design, provision, construction, maintenance and removal of such temporary works shall be theresponsibility of the Contractor and all cost in these respects shall be included in the quoted unit rate for the permanent work.

4.1.5 The Contractor's attention is drawn particularly to his obligations under the General Conditions of Contract in respect of those works which are in close proximity to existing buildings.

4.1.6 The Contractor shall preserve the completed excavation from damage due to slips and earth movements, ingress of water from any source whatsoever and deterioration by exposure to the sun and the effects of the weather.

4.1.7 All excavation of every description, in whatever material encountered shall be performed to the elevations and dimensions shown on the Drawings in such a manner as to avoid interruption to work in other parts of the site. The Contractor shall be responsible for injury to the other works caused during excavation period.

4.1.8 Excavation shall extend to adequate distance from walls and footings to allow for placing and removal of forms, installations of services and for inspection, except where the concrete for walls and footings is authorized to be deposited directly against excavated surfaces. Undercutting will not be permitted.

4.1.9 All excavations in foundations shall be taken to 6 inch above the final excavation elevations shown on the drawings and the last 6 inch shall be trimmed carefully to a smooth and level surface. Immediately after trimming to the final elevation, a layer of blinding concrete shall be placed to the thickness shown on the drawings. All excavations for foundations which have been trimmed and disturbed shall be compacted and covered by lean concrete by the end of the day. It is specifically brought to the notice of theContractor that any excavation taken down to the trimmed elevation whichis left over-night or for any length of time thereafter, uncovered by the blinding concrete, shall be required to be trimmed to such lower elevation asdirected by the Engineer and any extra work or any consequent increase in the quantities caused thereby shall not be paid to the Contractor.

4.1.10 No excavation shall be covered nor any permanent work commenced until the foundation has been inspected by the Engineer and his permission to proceed is given.

4.1.11 If excavation for sub-structures are carried below the required level, as shown on the Drawings or as directed by the Engineer, the surplus depth shall be filled in with concrete of same grade as of blinding concrete at the sole cost of the Contractor.

4.1.12 All excavation shall be performed in the dry. The placing of blinding concrete, placing of reinforcement and casting of the permanent works in the excavation shall be carried out in the dry and the Contractor shall have sufficient dewatering equipment for this purpose. Adequate precautions shall be taken to prevent any erosion due to undercutting from underneath the previously constructed adjoining foundations.

4.1.13 Shoring, where required during excavation, shall be installed to protect workmen and the bank, adjacent paving, structures and utilities. The term shoring shall also be deemed to cover whatever methods the Contractor elects to adopt, with prior approval of the

Engineer, for upholding the sides of excavation and also for planking and strutting to excavation against the side of roadways and adjoining properties in existing hardcore of any other material. The Contractor will be held responsible for upholding the sides of all excavations and no claim for additional excavation, concrete or other material will be considered in this respect.

4.1.14 Existing utility lines that are shown on the drawings or the locations of which are made known to the Contractor prior to excavation and that are to be retained, as well as utility lines constructed during excavation and backfilling, and if damaged, shall be repaired by the Contractor at his own expense. Any existing utility lines which are not known to the Contractor insufficient time to avoid damage, if inadvertently damaged during excavation, shall be repaired by the Contractor and adjustment in payment will be made as approved by the Engineer. When utility lines which are to be removed, are encountered within the area of operations the Contractor shall notify the Engineer in ample time for the necessary measures to be taken to prevent interruption of the service.

4.1.15 Excavated material suitable for use as fill and backfill shall be stockpiled within free haulage limit of the project boundary as directed by the Engineer. This stockpiled material shall be transported back to places requiring fill or backfill.

4.1.16 Excavated material unsuitable for use as fill and backfill shall be disposed off, by the Contractor at locations approved by the Engineer within specifiedfree haulage limit.

4.1.17 The excavation work shall include the excavation in above water table and excavation below water table. The Contractor shall submit the proposal for dewatering from the areas of excavation for the approval of the Engineer and shall provide all plant, equipment, pumps, sheeting, well points asrequired to keep the water table 3 feet below the deepest foundation as shown on the drawings till the completion of foundation works, all in accordance with the specification section 1200.

4.1.18 The Contractor shall make independent enquiries and perform and make independent observations to ascertain the water table in the areas of excavations during the period when the construction works are in progress. The Contractor shall take whole risk of any nature for fluctuation of the water table from his own findings. The Employer does not bind himself in any way and shall not be responsible for any information given by him or any information, observations or values obtained from his reports, Drawings, and Documents or anywhere in this Document.

4.1.19 Excavation shall be performed within the tolerances for excavation limits indicated on the drawings. Where no tolerance limits are indicated excavation shall be performed to tolerances established by the Engineer as acceptable for the design and type of work involved.

4.2 Fill and Backfill

4.2.1 After completion of foundation footing, foundations, walls, and other construction below the elevation of the final grades and prior to start filling forms shall be removed and the excavation shall be cleaned of trash and debris.

4.2.2 The fill/backfill shall include filling under the floors and around the foundations.

4.2.3 The fill/backfill shall include loading, unloading, transporting, placing, stacking, spreading of earth, watering, rolling, ramming and compacting, etc., complete as specified herein.

4.2.4 Filling under floor shall done with approved selected material obtained from required excavation or outside sources. It shall be predominantly granular material and free from slurry mud, organic or other unsuitable matter and capable of compaction by ordinary means.

4.2.5 The Contractor shall provide the approved quality backfill and fill material required to complete the specified fill and backfill from the places designated by the Engineer.

4.2.6 Filling in foundations shall be placed in 200mm layers and compacted at optimum moisture content by mechanical means or other means as approved by the Engineer.

4.2.7 Material for fill/backfill shall be as approved by the Engineer and shall be placed in layers not exceeding 150mm measured as compacted material and saturated with sufficient water and compacted to produce in-situ density not less than 95% of the maximum dry density at optimum moisture content, achieved in Test No.15 of BS 1377 : 1975.

4.2.8 All fill areas shall be left neat, smooth and well compacted, the top surface consisting of the normal site surface soil, unless otherwise directed.

4.2.9 Depending on the capacity of the compacting equipment the Engineer may instruct increased thickness of successive layers to be placed.

4.2.10 Fill shall not be placed against foundation walls prior to approval by the Engineer. Fill shall be brought up evenly on each side of the

walls as far as practicable. Heavy equipment for spreading and compacting the fill shall not be operated closer to the wall than a distance equal to the height of the fill above the top of footing.

4.2.11 In case the Contractor has to arrange the fill material from outside sources the quality of the fill material will be subject to the approval of the Engineer.The Engineer shall require the Contractor to carry out various tests of the fill material. All such tests shall be made at an approved laboratory at the cost of the Contractor.

4.2.12 Fill/Backfill of foundations shall be carried out only after the structural works within the excavations have been inspected, tested and approved by the Engineer.

4.2.13 Before the start of fill & backfill the Contractor shall satisfy himself as to the levels and slopes of the fills and backfills shown on the Drawings, the requirements of compaction, the possibility of settlement and all other particulars what-soever in connection of the filling works.

4.2.14 If it is found necessary to alter the moisture content of the fill material in any way, then, very strict control shall be exercised over the wetting and/or the drying process and frequent moisture content tests shall be carried out.

4.2.15 The upper 300mm thick layer of natural soil shall be scarified and compacted to 95% of modified AASHTO T-180 before filling the area upto plinth level of the building/structures.

4.2.16 Tolerances: The surface of compacted backfill/fill shall be smooth and even and gradual irregularity shall not vary more than 50mm in 10 feet length and abrupt irregularity shall not be more than one inch.

5. SERVICE LINE TRENCHES

5.1 Excavation

5.1.1 All excavation shall be made to the lines, levels and grades shown on the drawings or established by the Engineer.

The sides of trench shall be as nearly vertical as practical. If found necessary by the Engineer a side slope on either side of the trench may be permitted for a trench equal to or greater than 6.5 feet depth so that the average width of the trench does not exceed 5 feet. Bell holes and depressions for joints shall be dug after the bottom of trench has been graded. Bell holes and depressions shall only be of such length, depth and width as required for properly making the particular type of joints as shown on the drawings or as directed by the Engineer. The bottom of trench shall be properly graded and compacted with approved compacting equipment. Stones, protruding edges etc. shall be removed. When unsuitable material is encountered in the bottom of the trench, such material shall be removed to the required depth and the trench backfilled to proper grade and required level with coarse sand or other approved material.

If the Contractor excavates beyond the required depth it shall be backfilled with approved material and thoroughly compacted at the expense of the Contractor.

5.1.2 Before starting the excavation, the Contractor shall ensure the correct alignment of the pipe line on the ground the depth and width of excavation of the trench, all in accordance with the drawings and instructions of the Engineer. The Contractor shall make profile with cement concrete pillars.

5.1.3 Excavation shall be carried out true to lines, levels, grades and widths as shown on the drawings or as directed by the Engineer ensuring properlaying of the pipe line, the bedding fill, construction of chambers for appurtenances and any other structures. The trench bottom shall be gradedto provide even and substantial bearing over the specified bedding and of the structure.

5.1.4 The Contractor, at his cost shall provide to the satisfaction of the Engineer all timbering, approved supports, shores and bracings to the sides of the excavated trench and foundations in such a manner so as to secure the sides of the trench and excavations from falling or adverse movement. All responsibility connected with such shoring shall rest with the Contractor.

5.1.5 Without the written permission of the Engineer, not more than 650 feet of the trench shall be opened in advance of the completed pipe line.

5.1.6 The bottoms of all excavations shall be carefully leveled. Any pockets of soft or loose material in the bottoms of the trenches shall be removed andthe cavities so formed filled with lean concrete at the Contractor's expense.

5.1.7 During excavation, material suitable for backfilling shall be stockpiled in an orderly manner at sufficient distance from the excavated trenches for reuse in backfill.

5.1.8 All necessary precautions shall be taken to properly maintain the excavation while it is open and exposed. If necessary, grading shall be done to prevent surface water from flowing into trenches and any water accumulated therein shall be removed by pumping or other approved methods. If ordinary open cut excavation is not possible or advisable, sheeting and bracing shall be furnished and installed in such excavations to prevent damage and delay of work and to provide safe working conditions. Sheeting and bracing shall be removed as the work progresses.

5.1.9 If for any reason, the levels, grades or profiles of the excavations are changed adversely, the Contractor shall, at his own cost, be liable to bring the excavations to the required levels and profiles as shown on the drawings or as directed by the Engineer.

5.2 Backfill and Compaction

5.2.1 Backfilling and compaction of trench bottoms shall be done in the following three stages.

I. Prior to lowering the pipe into the trench, 6” thick layer of approved sand will be placed over properly graded and compacted bottom of the trench wherever required.

II. Coarse sand shall be placed around and over the pipe after it has been properly laid and tested as directed by the Engineer.

III. Backfilling of the remaining trench will be done with the approved material as specified herein.

5.2.2 The material for backfilling required herein above will be sand as specified in the section "Concrete". The material for backfilling in stage III will be the same as that for stage I and II, if it is under paved areas. In all other cases, stage III material shall be in accordance with the following specifications.

All the material shall be clean excavated earth or quarry spoil from trenches or from other approved borrow areas and shall not contain stones, organic matters, cinders and refuse that would prevent proper compaction or cause subsequent settlement.

5.2.3 The backfill material shall be placed evenly and carefully around and over the pipes in layers not exceeding 6". When the material has been conditioned and placed as specified, each layer shall be thoroughly and carefully rammed with tamper of adequate size and weight and watered if necessary for proper compaction. Backfill shall be done by hand until a thickness of 1 ft. has been compacted over the pipe. The remaining backfill may be done with machine. The degree of compaction desired will be atleast 95 percent of maximum dry density.

The Contractor shall be responsible for any damage to installations caused by his operations in compacting of backfills and any damage to the pipe and fitting shall be repaired by the Contractor at his own expense.

5.2.4 Backfill designated to be compacted shall be compacted to 90% in situ density with respect to maximum density to the lines, levels and grades as shown on the drawings or established by the Engineer. The Contractor's operations in the placing of backfill

designated to be compacted shall be such as will result in an acceptable gradation of material when placed for use in backfill.

5.2.5 Prior to and during placement operations, the material shall have the optimum moisture content required for the purpose of compaction, as determined by the Engineer, and the moisture content shall be uniform throughout each layer. If the moisture content is less than optimum for compaction the moisture content shall be supplemented by sprinkling and reworking the material at the site of compaction. If the moisture content is greater than optimum for compaction the 0material shall be dried by reworking, mixing of the dry material or other approved means.

5.2.6 The material obtained from excavation shall be reused for backfilling brought from the stock pile with approval of the Engineer.

6. DISPOSAL OF SURPLUS EXCAVATED MATERIAL

6.1 The rejected unsuitable material and surplus excavated material shall be disposed off out of boundary limits from any lead as directed by the Engineer.

6.2 The disposal of surplus/unsuitable excavated material shall include loading, unloading, transporting, stacking, spreading and leveling as directed by the Engineer.

7. MEASUREMENT AND PAYMENT

7.1 General

Except otherwise specified herein or elsewhere in the contract documents, no measurement and payment will be made for the under mentioned items related to this section. The cost thereof shall be deemed to have been included in the quoted unit rate of the items of the Bills of Quantities.

7.1.1 Timber shoring, planking, strutting and providing slope for upholding the sides of excavations.

7.1.2 Any fill with approved material necessitated by over excavation due to fault or convenience of the Contractor.

7.1.3 Stockpiling the excavated material at approved location within free haulage limit of the project boundary and transporting back suitable material toplaces requiring fill or backfill.

7.1.4 Foundation preparation.

7.1.5 Extra excavation involved in providing adequate working space aroundsides of foundation and service line trenches.

7.1.6 Not used

7.1.7 Rolling, leveling, watering & compacting the fill and backfill to required density.

7.1.8 Excavation and backfill involved for maintaining stability of sides of foundation and pipe line trenches.

7.1.9 All laboratory and field tests stipulated in these specifications.

7.1.10 Disposal of rejected surplus and unsuitable excavated material within 5 miles free lead measured along the most direct route from the site of works.

7.1.11 Scarifying top 1 foot of natural soil and compaction to required density.

7.1.12 De-watering if required to keep the excavated pit dry till completion of work.

7.2 Excavation for Foundation and Service Line Trenches

7.2.1 Measurement:

The quantities set out for excavation and its subsequent disposal shall be deemed to be the bulk quantity before excavating and no allowance shall be made for any subsequent variations in bulk or for any extra excavation.

Unless otherwise shown on the Drawings quantities of excavation shall be measured of acceptably completed works on the basis of vertical excavation lines required for the nominal concrete dimensions of foundations.

Quantities of excavation for laying service line trenches shall be measured for payment on the basis of vertical excavation faces for the specified width of the trench as shown on the drawings.

Measurement of acceptably completed works of excavation will be made on the basis of number of cubic foot of material excavated as shown on the drawing. It shall be calculated/ measured from pre- work levels of ground surfaces taken jointly by the Engineer and the Contractor before commencement of the work and the levels shown on the drawing.

7.2.2 Payment:

Payment will be made for acceptable measured quantity of excavation on the basis of unit rate per cubic foot quoted in the Bills of Quantities and shall constitute full compensation for all the works related to the item.

7.3 Backfill / Fills for Foundation, Floor and Service Line Trench

7.3.1 Measurement:

Measurement of acceptably completed backfill/fill works will be made on the basis of number of cubic foot of compacted backfill/fill provided in position in accordance with the lines, levels and grade as shown on the Drawings.

7.3.2 Payment:

Payment will be made for acceptable measured quantity of backfill/fill on the basis of unit rate per cubic foot quoted in the Bills of Quantities and shall constitute full compensation for all the work related to the item.

SECTION - 1500

TERMITE CONTROL TREATMENT

1. SCOPE

The scope of work for anti termite treatment includes injection of insecticide in sides and bottom of foundation trenches, spraying on stockpiled backfill material and injections of the insecticide in floor sub-grade of the building. The scope also covers treatment of all wood works with insecticides before installation in position.

2. QUALITY ASSURANCE

2.1 In addition to the requirements of these specifications, comply with manufacturer's instructions and recommendations for the work, includingpreparation of substrata and application.

2.2 A professional operator shall be engaged who shall have licence in accordance with regulations of governing authorities for application of soil treatment solution.

3. EXTENT OF APPLICATION

3.1 Insecticide solution shall be applied with approved pressure spraying equipment maintaining required pressure recommended by the manufacturer to all applications to, on or in earth.

3.2 Soil treatment shall begin after all work of preparation of earth prior to installation of concrete has been done. After application, no additional earth moving or work upon sub grade should be done. No covering of earth orconcrete should be applied over soil treatment until at least 24 hours after treatment has been made.

3.3 Insecticide solution should not be applied during wet weather, or when the earth surface is excessively wet. Application should be made to all areas beneath concrete slabs-on-grade, including side walks and paving abutting buildings for distance of at least 7 feet beyond building line. Solution shall be applied in amounts of not less than 0.122 gallon/sq.ft of area. If applied over gravel or sand fill, application shall be not be less than 0.150 gallon/sq.ft of area. Insecticide shall penetrate to a depth of 1 inch minimum in porous earth at bottom and 2 inches to 3 inches at sides of excavations.

3.4 Sides of foundation excavations, grade beam, and similar areas shall be treated with solution at a rate of 0.37 gallon per square feet upon inner sides of such excavations, and at all locations where concrete slabs for platforms and similar work abut the building. Similar treatment shall be made at all locations where expansion joints, control joints, column bases and similar work occur at or below grade slabs.

3.5 In the areas of application signs shall be fixed to show that soil treatment has been applied. Such signs shall be removed when areas are covered by other construction.

3.6 Care shall be exercised to insure that no marks or damage occurs to the finished structure as a result of the work under this section.

3.7 All wood work for the entire project is to be insecticide treated (before application of solignum). Insecticide shall be sprayed on all surfaces of all the wooden work viz, door frames, blocking, furring, planks, boards etc. beforeinstallation. Spraying is to be done at the site, after delivery and before installation. No spraying shall be necessary after field sawing, jointing or installation of such material.

4. STANDARDS

All methods of termite protection used herein shall be in accordance with the standard practices of National Pest Control Association, U.S.A and the British Wood Preserving Association.

5. SAMPLES AND TESTS

The Contractor shall supply samples of all the materials to be used for insecticide control for approval of the Engineer and testing in accordance with the specified standards. Rejected materials shall be removed from the site immediately.

6. GUARANTEE

The Contractor is to guarantee that the building shall be free from termites (white ants), wood bores and other pests which cause damage to wood or other organic material for 10 years from the date of acceptance of the building.

In the event of any damage caused within the guaranteed period, the Contractor shall replace at his own cost such damaged material, finishes affected and suitably preserve and treat the entire premises with the best method known to the trade to prevent the spreading of termites.

7. MEASUREMENT & PAYMENT

8.1 General

Except otherwise specified herein or elsewhere in the Contract Documents, no measurement and payment will be made for the under mentioned specified works related to the relevant items of the Bills of Quantities. The cost there of shall be deemed to have been included in the quoted unit rate of the respective items of the Bills of Quantities.

7.1.1 Termite control treatment on wood works.

7.1.2 Any material required for mixing insecticide solution.

7.1.3 Transportation of material and storage at site.

7.1.4 Anti-termite treatment on stock piled backfill material.

7.2 Termite Control Treatment

7.2.1 Measurement:

Measurement of acceptably completed works of termite control treatment will be made on the basis of number of square foot of area treated by measuring the two dimensions (length & breadth) of treated surface.

7.2.2 Payment:

Payment will be made for acceptable measured quantity of termite control treatment on the basis of unit rate per square foot quoted in the Bills of Quantities & shall constitute full compensation for all the works related to the item.

SPECIFICATIONS

SECTION - 2000

FORMWORK

1. SCOPE

The work under this section of the Specifications consists of furnishing all plant, labour, equipment, appliances and materials and in performing all operations in connection with the supply and installation of formwork for the purpose of shuttering in concreting work, complete in strict accordance with this section of the specifications and the applicable drawings and subject to the terms and conditions of the Contract.

2. GENERAL

It shall be the responsibility of the Contractor to perform the work by engaging well trained and experienced staff or by the sub contractor who shall have enough number of well trained and experienced staff to coordinate his activities with the other operations. However the Contractor shall be responsible for the quality of work performed by the sub-contractor as per the requirements of these specifications.

3. MATERIALS

The Contractor shall use the following formwork materials for different purposes as stated below:

3.1 Timber

Form framing, sheathing and shoring.

3.2 Plywood

Form sheathing and panels.

3.3 Steel

Heavy forms and false work Column and joint forms Permanent forms Welding of permanent forms

3.4 Form Ties Anchors and Hangers

For securing formwork against placing loads and pressures.

3.5 Coatings

Facilitate form removal.

3.6 Steel Joints

For formwork support.

3.7 Steel frame shoring

For formwork support.

4. DELIVERY AND STORAGE

4.1 Delivery

The delivery of formwork materials shall be done in such a manner that damage can be prevented.

4.2 Storage

Form work should be stored, after cleaning and preparing for re-use if used before in such a manner that access to all different materials is available.

Material which can be affected by weathering shall be stored in appropriate building or under covers and shade.

5. WORKMANSHIP

5.1 Forms shall be used, wherever necessary, to confine the concrete and shape it to the required dimensions. Forms shall have sufficient strength to withstand the pressure resulting from placement and vibration of the concrete and shall have sufficient rigidity to maintain specified tolerances.

The main architectural theme is to retain the concrete as the finished facade material. The Contractor therefore shall realize a special and perfect formwork. The drawings set out details and locations of this special formwork. The Engineer shall refuse any formwork and any part of the building, which has been constructed with a non-approved formwork. The Engineer shall refuse any concreting which will not be perfect or may not conform to the approved model.

5.2 Earth cuts shall not be used as forms for vertical surfaces of reinforced concrete work unless required as such or permitted by the Engineer.

5.3 Mud centering shall not be permitted without the prior approval of the Engineer.

5.4 Formwork shall be of wrought timber, steel, plywood, proprietary building boards and such special materials, as may be shown on the drawings or approved by the Engineer, which give the required finish to the surface of concrete. Wooden formwork shall be free from loose knots and shall be well seasoned.

5.5 The formwork shall conform to the shape, lines and dimensions as shown on the plans, and be so constructed as to remain sufficiently rigid during the placing and compacting of the concrete, and shall be sufficiently tight to prevent loss of liquid from the concrete.

The design and Engineering of the formwork, as well as its construction, shall be the responsibility of the Contractor. Where necessary, to maintain the specified tolerances, the formwork shall be cambered to compensate for anticipated deflections in the formwork due to the weight and pressure of the fresh concrete and due to construction loads.

The Contractor shall establish and maintain in an undisturbed condition and until final completion and acceptance of the project, sufficient control points and bench marks to be used as references for checking upon tolerances.

5.6 Requirements for 'facing materials' are given in the Section relevant to 'Finishing of Formed Surfaces'. The maximum deflection of facing material reflected in concrete surfaces exposed to view shall be 1/240 of the span between structural members.

5.7 Where natural plywood-form-finish, grout-cleaned-finish, smooth-rubbed-finish, scrubbed-finish, or sand-floated-finish is required, forms shall be smooth (faced with plywood, liner sheets, or pre-fabricated panels) and true to line, in order that the surfaces produced will require little dressing to arrive at true surfaces. Where any as-cast finish is required, no dressing shall be permitted in the finishing operation.

5.8 Where as-cast surfaces, including natural plywood-form-finish are specified, the panels of material against which concrete is cast shall be orderly in arrangement, with joints between panels planned in approved relation lo openings, building corners, and other architectural features.

5.9 Where panels for as-cast surfaces are separated by recessed or otherwise emphasized joints, the structural design of the forms shall provide for locating form ties, where possible, within the joints so that patches of tie holes will not fallwithin the panel areas.

5.10 Forms shall not be re-used if there is any evidence of surface wear and tear or defect which would impair the quality of the surface finish. Forms shall bethoroughly cleaned and properly coated before re-use.

5.11 The formwork shall be designed so that the soffits of slabs and sides of beams, columns, and walls may be removed first, leaving the forms to the soffits of beams and their supports in position.

5.12 Forms shall be sufficiently tight to prevent loss of mortar from the concrete. Unless otherwise specified in the Contract Documents chamferstrips shall beplaced in the corners of forms to produce leveled edges on permanently exposed surfaces. Interior corners on such surfaces and the edges of formed joints will not require leveling unless required by the Contract Documents.

5.13 Positive means such as wedges or jacks for accurate adjustment and for proper removal of shores and struts shall be provided and all settlement shall be monitored during concrete placing operation. Forms shall be securely bracedagainst lateral deflections.

5.14 Where concreting of thin members is required to be carried out within formwork of considerable depth, temporary openings in the sides of the formwork shall be provided where necessary to facilitate the placing and consolidation of concrete. Small temporary openings shall also be provided at the bottom of the formwork for columns, walls and deep beams to permit the cleaning out of debris and observation immediately before concrete is deposited.

5.15 Form ties shall be constructed so that the ends or end fasteners can be removed without causing appreciable spalling at the faces of the concrete. After the ends or end fasteners of form ties have been removed, the embedded portion of-the-ties shall terminate not less than 2 diameters or twice the minimum dimension of the tie from the formed faces of concrete to be permanently exposed to view and inno case shall this distance be less than 20 mm. When the formed face of the concrete is not to be permanently exposed to view, form ties may be cut off flush with the formed surfaces.

Through bolts may be permitted provided that they are greased to allow for easy withdrawal and the holes subsequently made good. Through bolts are not to be used on water-retaining structures.

5.16 At construction joints contact surface of the form sheathing for flush surfaces exposed to view shall overlap the hardened concrete in the previous placement by no less than 25 mm. The forms shall be held against the hardened concrete to prevent offsets or loss of mortar at the construction joint so as to maintain a true surface.

5.17 Wood forms for wall opening shall be constructed to facilitate loosening, if necessary to counteract swelling of the forms.

5.18 Wedges used for final adjustment of the forms prior to concrete placement shall be fastened in position after the final check.

5.19 Formwork shall be so anchored to shores or to other supporting surfaces or members that upward or lateral movement of any part of the formwork system during concrete placement will not occur.

5.20 Runways or planks for moving labour and equipment shall be provided with struts or legs and shall be supported directly on the formwork or upon the structural member without resting on the reinforcing steel.

5.21 All surfaces of forms and embedded materials shall be cleaned of any accumulated mortar or grout from previous concreting and of all other foreign material before placing fresh concrete.

5.22 Forms shall be sufficiently tight to prevent leakage of grout or cement paste. Board forms having joints opened by shrinkage of the wood shall be removed andreplaced. Plywood and other wood surfaces not subject lo shrinkage shall be sealed against absorption of moisture from the concrete by either (I) a field applied, approved form oil or sealer, or (2) a factor)' applied non-absorptive liner. When forms are coated to prevent bond with concrete, it shall be done prior to placing of the reinforcing steel. Excess coating material shall not be allowed to stand in puddles in the forms nor allowed to come in contact with the concrete against which fresh concrete will be placed. Care shall be taken that such approved composition is kept out of contact with the reinforcement. Where as- cast finishes are required. materials, which will impart a stain to the concrete shallnot be applied to the form surfaces. Where the finished surface is required to be painted, the material applied to form surfaces shall be compatible with the type of paint to be used.

5.23 For reinforced concrete, in no circumstances shall forms be struck until the concrete attains strength of at least twice the stress to which the concrete may be exposed at the time of striking.

The strength referred to shall be that of concrete using the same cement and aggregates, with the same proportions, and cured under conditions of temperature and moisture similar to those obtaining in the work. Where possible, the formwork should be left for longer time as it would assist the curing.

In normal circumstances (generally where temperatures are above 20 degree C/(168°F) and where ordinary cement is used, forms may be struck after expiry of the following periods.

-	Walls, columns and vertical sides of beams.	48 hours or as may be Decided by the Engineer.
-	Side of slab (shores of props left under).	6 days.

- Beams soffits (shores or props left under). 12 days.

- Removal of shores or props to slabs.

1. Spanning up to 13 ft. 10 days.
2. Spanning over 13 ft. 16 days.

Removal of shores or props to beams.

1. Spanning up to 20 ft. 18 days.
2. Spanning over 20 ft. 25 days.

For rapid hardening cement 3/7 of the above period will be sufficient in all cases except vertical sides of slabs, beams and columns which should be retained for a minimum of 24 hours.

The number of shores or props, their sizes and disposition shall be such as to be able to safely carry the full dead load of the slab and beams, as the case may be.

Proper allowance shall be made for the decrease in rate of hardening of concrete in cold weather and the above minimum duration must be increased when the mean daily temperature is below 20 degree C.

5.24 When repair of surface defects or finishing is required at an early age, forms shall be removed as soon as the concrete has hardened sufficiently to resist damage from removal operations.

5.25 Top forms on sloping surfaces of concrete shall be removed as soon as the concrete has attained sufficient stiffness to prevent sagging. Any needed repairs or treatment required on such sloping surfaces shall be performed at once and be followed by the specified curing.

5.26 Wood forms for wall openings shall be loosened as soon as this can be accomplished without damage to the concrete.

5.27 All formwork shall be removed without such shock or vibration as would damage the reinforced concrete. Before the top plank and struts are removed the concrete surface shall be exposed where necessary in order to ascertain that the concrete has sufficiently hardened. Proper precautions shall be taken to allow for the decrease in the rate of hardening that occurs with all cement in the cold weather.

5.28 When reshoring or repropping is permitted or required, the operations shall be planned in advance and shall be subject to approval. While reshoring is underway no live load shall be permitted on the new construction.

In no case during reshoring shall concrete ill beam, slab, columns or any other structural member be subjected to combined dead and construction loads in excess of the load permitted by the Engineer for the developed concrete strengthat the time of reshoring.

Reshores shall be placed as soon as practicable after stripping operations are complete but in no case later than the end of working day on which stripping occurs.

Reshores shall be tightened to carry their required loads without overstressing the construction. Reshores shall remain in place at least until tests representative of the concrete being supported have reached the strength specified in sub- clause 5.23 hereof.

5.29 Floors supporting props or shores under newly placed concrete shall have their original supporting props or shores left in place or shall be reshored. The reshoring system shall have a capacity sufficient to resist the anticipated loads andin all cases shall have a capacity equal to at least one half the capacity of the shoring system above. The reshores shall be located directly under a shore position above unless other locations are permitted.

The reshoring or re-propping shall extend over a sufficient number of storeys to distribute the weight of newly placed concrete, forms, and construction live loads in such a manner that the design superimposed loads of the floors supporting shores or props are not exceeded.

5.30 It is generally desirable to give forms for reinforced concrete an upward camber to ensure that the beams or slabs (specially cantilever slabs) do not have a sag when they have taken up their deflection, but this should not be done unless permitted by the Engineer.

5.31 No loads, other than man and light plant required in connection with the actual work in hand, shall be allowed on suspended floors until 28 days after concreting where ordinary Portland Cement is used and 14 days when rapid hardening Portland Cement is used.

5.32 The formwork and shuttering for prestressed concrete beams shall be well and stoutly constructed from steel clad timber or steel. It shall be fully capable of supporting all the loads due to the fresh concrete and due to construction equipment and operations, including vibration, without deformation or deflection that will affect the dimensions of the concrete member beyond the tolerance stipulated hereinafter.

It is expressly stipulated that in view of precision and powerful vibration required in casting the prestressed concrete girders and precast members particularly in the zones of end blocks or around anchorages, specially designed formwork and supporting systems shall be required.

All details of formwork of girders and the supporting systems shall be submitted to the Engineer who shall check their safety and approve and/or amend the same, provided however that the approval of the formwork shuttering and supporting system by the Engineer, shall not in any way affect or diminish the Contractor's sole responsibility for fully satisfactory performance of the work.

All joints between formwork boards and/or panels shall be flush and tight. Internal ties shall be used as few as possible and shall, when unavoidable, be in steel, located at such positions which will not disturb the reinforcement or prestressing steel. The use of spacer blocks for the reinforcement shall be prohibited whenever the same effect can be achieved by properly dimensioned spacer rings mounted directly on the reinforcement. All spacer blocks and rings shall be of the same strength as the concrete in which they are embedded and shallbe adequately cured before use.

Prior to placing concrete, all forms shall be inspected and all debris and extraneous matter removed. The form oil or release agent shall not react with concrete to affect the strength nor shall it give any colour. It shall be applied in such a manner as not to contaminate the reinforcement and other fixtures to be embedded in concrete.

6. MEASUREMENT AND PAYMENT

No payment will be made for the works involved within the scope of this section of the specifications unless otherwise specifically stated in the Bill of Quantities or herein.

The cost thereof shall be deemed to have been included in the quoted unit rate of relevant items of the Bills of Quantities.

SECTION - 2100

REINFORCEMENT

1. SCOPE

The work under this section of specifications consists of furnishing, cutting, fabricating, bending and placing steel reinforcement and Welded wire fabric in concrete structures or elsewhere as shown on the drawings or as directed by the Engineer. The scope of this section of specification is covered with detailed specifications as laid down herein.

2. APPLICABLE STANDARDS

Latest editions of the following Pakistan, British and ASTM Standards are relevant to these specifications wherever applicable.

Pakistan Standard

P.S 241	Tensile Testing of Steel.
P.S 244	Bend test for Steel
P.S 580	Rolled deformed Steel bars (intermediate grade) for concrete reinforcement.
P.S 605	Rolled deformed steel bars (hard grade) for concrete reinforcement.
P.S 606	Rolled deformed Steel bars (structural grade) for concrete reinforcement.
P.S 607	General technical delivery requirement for steel.

British Standard

B.S 693	General requirements for Oxy-acetylene welding of mild steel.
B.S 785	Hot rolled bars and hard drawn wire for the reinforcement of concrete.
B.S 1856	General requirement for the metal are welding of mild steel.
B.S 4449	Hot rolled steel bars for reinforcement of concrete
B.S 4461	Cold worked steel bars for reinforcement of concrete.
B.S 4466	Bending dimensions and scheduling of bars for the reinforcement of concrete.

ASTM Standard

A 305	Minimum requirement for the deformations of deformed steel bars for concrete reinforcement.
A 615	Deformed billet steel bars for concrete reinforcement.

In addition to the above, the latest editions of other Pakistan Standards, British standards, American Concrete Institute Standards, American Society for Testing and Materials Standards and other standard as may be specified by the Engineer for Special Materialand construction are also relevant.

3. MATERIAL AND SIZE OF BARS

3.1 Reinforcement for concrete shall conform to the respective Pakistan, British, ASTM, or other Standards as specified in the Drawings and in the Contract Documents or as may be specified by the Engineer.

3.2 All reinforcement shall be hot rolled deformed billet steel bars conforming to ASTM A-615 grade 60 or grade 40 with specified characteristic strength of not less than 60,000 psi and 40,000 psi respectively.

3.3 Not used

3.4 Not used

3.5 If the reinforcement is supplied by the Employer, the Contractor should inform the Employer of his requirements much before its use in construction.

3.6 Reinforcement of all types is to be stored on Site in an approved manner so as to avoid damage.

3.7 If the reinforcement is supplied by the Employer, the Contractor should report immediately on receipt of any consignment, any deviation from the standard for the reinforcement bars beyond those allowed in respective standards. If the Engineer directs, the Contractor shall test the samples of reinforcement at his cost and submit to him the test report.

3.8 Steel wire mesh reinforcement shall conform to requirements of ASTM Designation A 185-64 or B.S. 4483, 1969: Standard Specifications for Welded Steel Wire Fabric for concrete reinforcement. It shall be used where shown on the Drawings.

3.9 Reinforcement shall be free from all loose or flaky rust and mill scale, or coating, including ice, and any other substance that would reduce or destroy the bend. Reduced section steel reinforcement shall not be used.

4. DELIVERY & STORAGE

4.1 Delivery

Steel reinforcement bars shall be kept in bundles firmly secured and tagged. Each bar or bundle of bars shall be identified by marks stamped on hot or cold or painted on or by any other means. The identifying marks shall contain the following information:

- Name of the producer or his trade.
- Standard to which the bars have been manufactured.
- The class type and strength.
- The diameter.
- The number of the test certificate.

4.2 Storage

The method of storage shall be approved by the Engineer. Reinforcing bars shall be stored in racks or platforms above the surface of ground and shall be protected free from scaling, rusting, oiling, coatings, damage, contamination and structural defects prior to placement in works. Bars of different diameters and grades of steel reinforcement shall be kept separately.

5. BAR BENDING SCHEDULES

The Contractor shall prepare bar bending schedules of all the reinforcing steel bars and these bar bending schedules shall be submitted to the Engineer for his approval. The Contractor shall obtain approval of the bar bending schedules before starting actual bar bending works.

6. FABRICATING, BENDING & PLACING

6.1 All metal for reinforcement shall be free from loose mill scale, loose rust, mud, oil, grease, or other harmful matter immediately before the concrete is placed.

6.2 Reinforcement is to be accurately placed as shown in the drawings, and secured against displacement by using 16 gauge G.I wire ties or suitable slips at intersections and supported from the formwork by using concrete, metal or plastic chairs and spacers or hangers of an approved pattern. Where concrete blocks are used for ensuring the cover, they shall be made of mortar not leaner than 1 part of cement to 2 parts of sand.

Where the concrete surface will be exposed to the weather in the finished structure, the portions of all accessories in contact with the form work shall be galvanized or shall be made of plastic.

6.3 Bars used for concrete reinforcement shall be fabricated in accordance with the dimensions shown in the bar bending schedule approved by the Engineer.

6.4 The cutting tolerance for all bars shall be j: 25mm.

6.5 Where an overall or an internal dimension of a bent bar is specified in theschedule, the bending, tolerance, unless otherwise stated, shall be as in Table 1.

Table 1 : Bending Tolerances

Dimensions of bent bars		Tolerance	
Over	Upto & including	Plus	Minus
mm	mm	Mm	mm
-	1000	5	5
1000	2000	5	10
2000	-	5	25

6.6 Bars shall be placed to the following tolerances:

1.	Concrete cover to formed surfaces	:	±	5 mm
2.	Minimum spacing between bars	:	-	5 mm
3.	Top bars in slabs and beams	:		
	a. Members 8 inch deep or less	:	±	5 mm
	b. Members more than 8 inch but not over 24 inch deep	:	±	10 mm
	c. Members more than 24 inch deep	:	±	25 mm
4.	Crosswise members : spaced evenly within	:		50 mm
5.	Lengthwise members	:	±	50 mm

6.7 Bars may be moved as necessary to avoid interference with other reinforcing steel, conduits, or embedded items. If bars are moved more than one bar diameter or enough to exceed the above tolerances, the resulting arrangement of bars shall be subject to approval of Engineer.

6.8 Vertical bars in columns shall be offset at least one bar diameter at lapped splices. To ensure pr 'per placement, templates shall be furnished for all column dowels.

6.9 Reinforcement shall not be bent or straightened in a manner that will injure the material.

No bars shall be bent twice in the same place, nor shall they be straightened after bending.

Unless permitted, by Engineer, reinforcement shall not be bent after being partially embedded in hardened concrete.

Bars which depend for their strength on cold working shall not be heated for any reason. Other kinds of reinforcement larger than 40 mm in dia. may be bent by the use of heat at cherry- red heat (not exceeding 840° C. Bars bent shall not be cooled by quenching.

6.10 No splice of reinforcement shall be made except as shown on the working drawings.

6.11 Welding shall be permitted for bars only under suitable conditions and with suitable safeguards in accordance with B.S 693, B.S 1856, or AWS D12.1, provided the type of reinforcement bar has the required welding properties.

Tack welding may be used to fix in position bars that cross each other, only with prior approval of the Engineer.

6.12 Exposed reinforcement intended for bonding with future extensions is to be effectively protected from corrosion. Protection is also to be provided to reinforcement partly built into concrete where the exposed part is to be built into later concrete.

6.13 No concreting is to be carried out until the reinforcement has been checked and approved by the Engineer.

6.14 Welding shall be done as in section 'Structural Steel Works'.

6.15 All detailing shall be done as per ACI standards ACI-315 and ACI-318.

7. Concrete clear cover for reinforcing steel shall be as described in the structure drawings. All reinforcing steel shall be held firmly in place before and during the placing of concrete by means of wires and supports adequate to prevent displacement during the course of construction.

8. MEASUREMENT & PAYMENT

8.1 General

Except otherwise specified herein or elsewhere in the Contract Documents. no measurement and payment will be made for the under mentioned specified works related to the relevant items of the Bills of Quantities. The cost thereof shall be deemed to have been included in the quoted unit rate of the respective items of the Bills of Quantities.

8.1.1 Providing and installing chairs, supports, hooks, spacers, binding wires, and laps not shown on Drawings including wastage and rolling margin.

8.2 Mild Steel and Deformed Steel

8.2.1 Measurement :

Measurement for acceptably completed works of reinforcement according to bar bending schedules approved by the Engineer shall be made by weight.

8.2.2 Payment:

Payment will be made for acceptable measured quantity of reinforcement on the basis of unit rate per tone quoted in the Bill of Quantities and shall constitute full compensation for all the works related to the item.

SECTION - 2200

PLAIN AND REINFORCED CONCRETE

1. SCOPE

The work under this section of the specification consists of furnishing all plant, labour, equipment, appliances and materials and in performing all operations in connection with the supply, manufacturers, transporting, placing, consolidating and curing of plain & reinforced concrete and its constituents. Reinforcing steel does not form part of this section and is described in section "2200".

2. GENERAL

2.1 Full co-operation shall be given to trades like electrical, mechanical and other services.

2.2 Suitable templates or instructions or both shall be provided for setting out of items not placed in the forms. Embedded items and other materials for mechanical and electrical operations shall have been completed, inspected. Tested and approved before concrete is placed.

2.3 For special concrete finish and for special methods of construction. Formwork shop drawings shall be designed and prepared by the Contractor at his own cost. Approval of shop drawings as well as that of actual samples of concrete finish shall be obtained before work is commenced.

3. APPLICABLE STANDARDS

Latest editions of the following Pakistan, British and ASTM Standards are relevant to these specifications wherever applicable.

3.1 Pakistan Standards

P S 232	Portland Cement (ordinary & rapid hardening)
P S 243	Natural aggregates for concrete
P S 279	Abrasion of coarse aggregates by the use of Los Angeles machine.
P S 280	Determination of aggregates crushing value.
P S 281	Organic impurities in sand for concrete aggregates
P S 282	Material finer than No. 200 B.S. test sieve in aggregates, method of test
P S 283	Soundness test for aggregates by the use of sodium sulphate or magnesium sulphate.
P S 284	Sampling aggregates for concrete PS 285 Sieve or screen analysis of fine and coarse
P S 286	Description and classification of mineral aggregates
P S 421	Sampling fresh concrete
P S 422	Slump test for concrete
P S 560	Making and curing concrete compression test specimen in the field.

PS	612	Sulphate-resistant Portland cement type 'A' and sampling fresh concrete in the laboratory.
PS	716	Mixing
PS	717	Compacting factor test for concrete
P S	746	Definitions and terminology of cements
P S	849	Making and curing concrete compression test cubes.

3.2 **ASTM (American Society for Testing and Materials)**

B.	370	Copper sheet and strip for building construction
C	33	Concrete Aggregates.
C	40	Organic impurities in sand for concrete.
C	87	Effect of organic impurities in fine aggregates on strength of mortar.
C	88	Soundness of aggregates.
C	94	Ready mixed Concrete.
C	109	Compressive strength of hydraulic cement mortars
C	117	Material finer than No.200 (0.075mm) sieve
C	123	Light weight pieces in aggregates.
C	125	Concrete and concrete aggregates.
C	127	Specific gravity and absorption of coarse aggregate.
C	128	Specific gravity and absorption of fine aggregate.
C	131	Resistance to abrasion of small size coarse aggregate.
C	136	Sieve or screen analysis of fine and coarse aggregate.
C	142	Clay lumps and friable particles in aggregates.
C	143	Slump of Portland Cement Concrete
C	150	Portland Cement
C	156	Water retention by concrete curing material
C	171	Sheet material for curing concrete.
C	185	Air content or hydraulic cement mortar. - -
C	188	Density of hydraulic cement.
C	191	Time of setting of hydraulic cement by vicat needle
C	260	Air entraining admixture for concrete.
C	289	Potential reactivity of aggregate.
C	309	Liquid membrane forming compounds for curing concrete.
C	330	Light weight aggregates for structural concrete.
C	331	Light weight aggregates for concrete masonry.
C	332	Light weight aggregates for insulating concrete.
C	494	Chemical admixtures for concrete.
C	535	Resistance to abrasion of large size coarse aggregates.
C	567	Unit weight of structural light weight concrete.
C	75	Aggregate sampling.
C	994	Preformed expansion joint filler for concrete.
C	1190	Concrete joint sealer (hot poured elastic type).
C	1715	Preformed expansion joint filler for concrete paving and structural concrete.
D	1752	Preformed sponge rubber and cork expansion joint fillers for concrete paving and structural concrete.
D	1850	Concrete joint sealer (cold application type).
E	11	Wire cloth sleeves for testing purposes.
E	96	Water vapour transmission of materials in sheet form.
E	154	Materials for use as vapour barrier under concrete slabs.

E 337 Relative humidity by wet and dry bulk psychrometer.

3.3 ACI (American Concrete Institute)

211 Recommended practice for selecting proportions for normal and heavy weight concrete.
214 Quality control charts
301 Specifications for structural concrete for building.
304 Recommended practice for measuring, mixing, transporting and placing concrete.
305 Hot weather concreting.
308 Recommended practice for curing concrete.
309 Recommended practice for consolidation of concrete
318 Building code requirement of reinforced concrete.
347 Recommended practice for concrete formwork.
512 Precast structural concrete in building.
517 Low pressure steam curing.
533 Fabrication, handling and erection of precast concrete wall panels.

3.4 British Standards

B.S 12 Portland cement, ordinary and rapid hardening.
B.S 410 Test Sieves
B.S 812 Methods for the sampling and testing of mineral aggregates, sand fillers
B.S 822 Concrete aggregates from natural sources
1201
BS 1881 Methods of testing concrete BS 3148 Tests for water for making concrete
BS 3837 Expanded polystyrene boards
BS 3869 Rigid expanded polyvinyl chloride for thermal insulation.
BS 3927 Phenolic foam materials for thermal insulation and building application
BS 4027 Sulphate-resisting Portland cement
CP 8110 Structural use of concrete
CP 114 Structural use of reinforced concrete in buildings
CP 116 Structural use of precast concrete
CP 5337 The structural use of concrete for retaining aqueous liquids.

In addition, the latest editions of other Pakistan and British Standards. American Concrete Institute Standards, American Society for Testing and Materials Standards and other Standards as may be specified by the Engineer for special Materials and Construction are also relevant.

4. MATERIALS

4.1 Aggregates

The sources of supply of all fine and coarse aggregates shall be subject to the approval of the Employer.

4.1.2 All fine and coarse aggregates shall be clean and free from clay. Loam, silt and other deleterious matter. If required, the Engineer reserves the right to have them washed by the Contractor at no additional expense. Coarse and fine aggregates shall be delivered and stored separately at site. Aggregates shall not be stored on muddy ground or where they are likely be become dirty or contaminated.

4.1.3 Fine aggregate shall be hard coarse sand, crushed stone or gravel screenings and shall conform to requirements of P S 243 and/or B.S.882 and/ or ASTM C-33. Only fine aggregate of grading zones 1 to 3 (BS882) shall be used.

4.1.4 Coarse aggregate shall be gravel or broken stone of hard, durable material free from laminated structure and conforming to P S 243 and/or B.S. 882 and/or ASTM C-33, graded as follows for use in mass concrete as in foundations:

Total Passing B.S. Sieve		**Percent by weight**
76.20mm (3 inch)	:	100
38.10mm (1-1/2 inch)	:	95-100
19.05mm (3/4 inch)	:	30-70
9.52mm (3/8 inch)	:	10-35
4.76mm (3/16 inch)	:	0-5

Coarse aggregate for all cast-in-place concrete other than mass concrete as for foundations shall be graded with the following limits:

Total Passing B.S. Sieve		**Percent by weight**
38.10mm (1-1/2 inch)	:	100
19.05mm (3/4 inch)	:	95-100
9.52mm (3/8 inch)	:	25-55
4.76mm (3/16 inch)	:	0-10

4.1.5 Light Weight Aggregates

Except as may be modified in the Contract Documents, the light weight aggregates for structural concrete shall comply in all respects with ASTM.C-330.

Light weight aggregate are aggregates prepared by expanding, calcining or sintering products such as blast furnace slag,clay diatomite, fly ash, shale or slate and aggregates prepared by processing natural materials such as pumice scoria, or tuff. The aggregate shall be composed predominantly of light weight cellular and granular inorganic material.

The unit weight of successive shipments of light weight aggregates shall not differ from the sample submitted for acceptance tests by more than 10%.

4.2 Cement

4.2.1 The cement shall be fresh and of approved origin and manufacture. It shall be one of the following as may be specified by the Engineer.

- Ordinary or Rapid Hardening Portland cement complying with the requirements ofP.S.232 or B.S.12 or ASTM C-150.
- Sulphate Resisting Portland/Cement complying with the requirements ofP.S.612 or B.S 4027 or ASTM C-150.

4.2.2 Unless otherwise specified, ordinary Portland Cement complying with the requirements of B.S.12 shall be used.

4.2.3 For all fair faced concrete it will be necessary to use approved cement with a view to obtain a light shade concrete as approved by the Engineer.

4.2.4 The Contractor shall supply to the Engineer at fortnightly intervals, test certificates with the appropriate standard in respect of the samples of cement from the work-site. These tests shall be carried out in a laboratory approved by the Engineer.

4.2.5 Only one brand of each type of cement shall be used for concrete in any individual member of the structure. Cement shall be used in the sequence of receipt of shipment, unless otherwise directed.

4.2.6 There shall be sufficient cement at site to ensure that each section of work is completed without interruption. If the cement is supplied by the Employer, the Contractor should inform the Employer, of his requirements sufficiently in advance of its use in construction.

4.2.7 Cement reclaimed from cleaning of bags or from leaky containers shall not be used.

4.2.8 The contractor shall provide and erect (at his cost) a suitable plain. dry, well ventilated, weather- proof and water-proof shed of sufficient capacity to store the cement.

4.2.9 The cement shall be used as soon as possible after delivery and cement which the Engineer considers has become stale or unsuitable through absorption of moisture from the atmosphere or otherwise shall be rejected and removed immediately from the site at theContractor's expense. Any cement in containers damaged so as to allow the contents to spill or permitting access of the atmosphere prior to opening of the container at the time of concrete mixing shall be rejected and removed immediately from the site at the Contractor's expense.

4.2.10 The mixing together of different types of cement will not be permitted.

4.3 Water

Only clean water from the city supply, tube well installed at the site or from other sources approved by the Engineer shall be used. The Contractor shall supply sufficient water for all purposes, including mixing the concrete, curing and cleaning plant and tools. Where doubt exists as to the suitability of the water, it shall be tested in accordance with B.S. 3148. Where water can be shown tocontain any sugar or an excess of acid, alkali or salt, the Engineer may refuse to permit its use.

In case of doubt, the Engineer may require that concrete mixed with water proposed to be used should not have a compressive strength lower than 90 percentof the strength of concrete mixed with distilled water.

4.4 Lightweight Concrete

The lightweight concrete shall conform to "Balcolite" concrete or equivalent approved by the Engineer. The unit weight should range between 50-60 Ibs/cu.ft. The properties of "Balcolite" lightweight concrete shall meet the manufacturer's specifications and shall have the approval of the Engineer prior to its use on the work.

4.5 Additive

All additives such as foaming and water proofing agents shall be from a manufacturer approved by the Engineer.

Air Entraining Admixtures conforming to ASTM C260, and other Admixtures conforming to ASTM C494 shall be used subject to approval of the Engineer.

5. NOMINAL CONCRETE MIXES

5.1 **Proportions** of Mix

5.1.1 Cement and aggregates:

The cement, fine aggregate and the coarse aggregate shall be weighed separately. The proportions of cement to fine aggregate and coarse aggregate shall be adjusted so as to provide the concrete of the required crushing strength when tested as set out in Table 1.

5.1.2 The Contractor shall regulate and arrange mixing of the ingredients for the designed mix of the concrete by weight-batching. The cost of designing the mix shall be borne by the Contractor.

5.1.3 Water/Cement/ratio:

The quantity of water used shall be just sufficient to produce a dense concrete of adequate strength and workability for its purpose. For all external work and foundations the water/cement ratio should notexceed 0.55.

5.1.4 Workability:

The workability shall be controlled by direct measurement of the water content, allowance being made for any water in the fine and coarse aggregates. The concrete shall be sufficiently workable to be placed and compacted, without difficulty, by the available means.

'Workability' shall be determined by either the slump or compaction factor tests as directed by the Engineer and these shall be performed in accordance with the methods given in P.S 422 and P.S. 177 or ASTM C-143. The slump or compaction factor for each class of concrete shall be determined during the preliminary test mixes and the value obtained shall not be modified without the written consent of the Engineer. Unless otherwise permitted or specified, the concrete shall be proportioned and produced to have a slump of 3 inch or less if consolidation is to be by vibration, and 5 inch or less if consolidation is to be by methods other than vibration. A tolerance of up to 1 inch above the indicated maximum shall be allowed for individual batches provided the average for all batches or the most recent 10 batches tested, which ever is fewer, does not exceed the maximum limit. Concrete of lower than usual slump may be used provided it is properly placed and consolidated.

5.2 Strength requirements for concrete

5.2.1 Concrete made with Portland cement shall comply with the strength requirements of Table 1.(Works Test).

Table 1 : Strength requirements for Portland cement concrete with aggregates complying with B.S. 882.

Class of Concrete	Nominal Mix by Volume	Cube Strength at 28 days after mixing & pouring (psi)	
		Preliminary test	Work test
(1)	(2)	(3)	(4)
A	1:1:2	5800	4500
B	1:1:5:3	5000	3750
C	1:2:4	4060	3000
D	1:3:6	2030	1500
E	1:4:8	1350	1000

5.2.2 All structural concrete shall conform to BS 5328-81.

5.2.3 Unless otherwise stated, the types of concrete shall be classified on the basis of compressive strength requirements.

5.2.4 The Contractor shall provide Mix Design by weight for each class of concrete. Manufacture 12 Nos. test cubes 6x6x6 inch in accordance with the Mix design batching by weight and test 3 cubes each at 3,7,14 & 28 days intervals in the presence of Engineer's Representative and submit all relevant data and results of tests for approval of the Engineer. The Contractor shall obtain approval from the Engineer in writing for eachMix design before producing the actual concrete for the Works.

No payments for producing the Mix design, manufacture of test cubes and testing shall be made. The Contractor shall include this cost in the relevant item of concrete.

5.3 Mixing

5.3.1 The concrete shall be mixed in an approved batch mixer conforming to the requirements of B.S. 1305. It shall be fitted with the manufacturer's plate stating the rates, capacity and the recommended number of revolutions per minute and shall be operated in accordance therewith. It shall be equipped with a suitable charging mechanism and an accurate water measuring device.

Mixing shall continue for the period recommended by the mixer manufacturer or until there is apparently a uniform distribution of the materials and the mass is uniform in colour, whichever period is longer. If it is desired to use a mixing period of less than 1-1/2 minute, the Engineer's approval shall be obtained in writing.

5.3.3 Controls shall be provided to ensure that the batch cannot be discharged until the required mixing time has elapsed. At least three quarters of the required mixing time shall take place after the last of the mixing water has been added.

5.3.4 The interior of the mixer shall be free of accumulations that will interfere with mixing action. Mixing blades shall be replaced when they have lost 10 percent of their original height.

5.3.5 Concrete shall be mixed only in quantities for immediate use. Concrete which has set shall not be retempered, but shall be discarded.

5.4 Placing

5.4.1 Before placing of concrete, formwork shall have been completed;water shall have been removed; reinforcement shall have been secured in place; expansion joint material, anchors, and other embedded items shall have been kept in position; and the entire preparation shall have been approved.

No concrete is to be placed into the foundation trenches until the ground to receive the same has been examined and approved by the Engineer for this purpose.

5.4.2 Concrete shall be deposited continuously, or in layer of such thickness that no concrete will be deposited on concrete which has hardened sufficiently to cause the formation of seams or planes of weakness within the section. If a section cannot be placed continuously, construction joints shall be located as shown in the Contract Documents or as approved by the Engineer. Placing shall be carried out at such a rate that the concrete which is being integrated with fresh concrete is still plastic. Concrete which has partially hardened shall not be deposited. Temporary spreader? in forms shall be removed when the concrete placing has reached an elevation rendering their services unnecessary. They may remain embedded in the concrete only if made of metal or concrete and if prior approval has been obtained.

5.4.3 The actual sequence of construction proposed by the Contractor shall be subject to the Engineer's approval before construction starts on any part of the structure, and this sequence shall not be varied without the Engineer's approval.

5.4.4 The concrete shall be placed as soon after it has been mixed as is practicable. Once the concrete has left the mixer, no more water shall be

added, although the concrete may be mixed or agitated to help maintain workability. The concrete shall not be used if, through any cause, the workability of the mix at the time of placing is too low for it to be compacted fully and to an acceptable finish by whatever means available.

The time between mixing and placing should be reduced if the mix is richer or the initial workability of the mix is lower than normal, if a rapid hardening cement or an accelerator is used, or if the work is carried out at a high temperature or exposed to a drying atmosphere.

The Contractor shall ensure that the delay between mixing and placing does not exceed 45 minutes under any circumstances. Any concrete which does not satisfy this requirement shall not be used.

5.4.5 The concrete shall be deposited as nearly as possible in its final position to avoid rehandling. In no circumstances may concrete be railed or made to flow along the forms by the use of vibrators. Concreting shall be carried on as a continuous operation using methods which shall preventsegregation or loss of ingredients.

5.4.6 The free fall of concrete shall not be allowed to exceed six feet and where it is necessary for the concrete to be lowered more than this depth, it is not to be dropped into its final position, but shall be placed through pipes fed by a hopper. When a pipe is used for placing concrete the lower end shall be kept inside, or close to the freshly deposited concrete. The size of the pipe shall be not less than 225mm diameter.

5.4.7 The workmen carrying concrete to the site, and all other workmen moving about on the reinforcement before the concrete is placed, shall move only along runways or planks placed for the purpose and no person shall be allowed to walk on the reinforcement itself.

5.4.8 Prior to the laying of concrete on load bearing masonry walls, bearing plates and at other points, as may be directed by the Engineer, the surface will be brought to a true. hard, smooth, level surface using cement sand mortar in the ratio of 1 volume of cement to 3 volumes of sand. Two layers of building paper weighing 400kg/sq.m (10 Ibs. per 100 sq.ft.) will then be laid flat to separate the concrete from the surface on which it is to be laid.

5.5 Construction Joints

5.5.1 Concreting shall be carried out continuously up to construction joints, the position and arrangement of which shall be predetermined by the Engineer.

5.5.2 Joints not shown on the drawings shall be so made and located as to least impair the strength of the structure and shall need prior approval of the

Engineer. In general, they shall be located near the middle of the spans of slabs and beams unless a secondary beam intersects a main beam at this point, in which case the joint in the main beam shall be offset a distance equal to twice the width of the secondary beam. Joints in walls andcolumns shall not be at the underside of floor slabs or beams, and at thetop of footings or floor slabs. Beams, brackets, columns, capitals, haunches and drop panels shall be placed at the same time as slabs. Joints shall be perpendicular to the main reinforcement.

5.5.3 All reinforcing steel shall be continued across joints. Key and inclined dowels shall be provided as directed by the Engineer. Longitudinal keys at least 40mm deep shall be provided in all joints in walls and between walls and slabs or footings.

5.6 Pre-Cast Concrete/Precast Jali

Pre-cast concrete units shall be fair faced, cast to the sizes and dimensions as indicated on the Drawings. The concrete used for pre-cast units shall conform to the specifications laid down for cast in situ reinforced cement concrete unless otherwise required and directed by the Employer.

The Contractor shall be required to submit a sample of pre- cast unit for the approval of the Engineer all pre-cast units shall strictly conform to the approved sample.

Pre-casting platform of the size and at the location approved by the Engineer shall be constructed. The concrete in one pre- cast unit shall be placed in one operation, in accordance with the details shown on the Drawings.

The material and design of formwork and the method of pre- casting the units shall be approved by the Employer.

The erection/installation and removal of the pre-cast units from the pre-casting platform shall not be permitted until and unless they are properly cured to the satisfaction of the Engineer.

All pre-cast units shall be smoothly finished to the required lines, grades. angles etc. Holes, grooves, pockets, hooks shall be provided as shown and/or as directed by the Engineer. The units shall be properly stacked on a platform without causing any cracks and damages. Curing of all the pre-cast units shall be done in accordance with the relevant BSS/approval of the Engineer.

5.7 Cement Concrete Pavements

For all concrete work relevant specification of this section shall apply.

5.7.1 Protection and Curing

- General Requirements :

  Concrete shall be protected adequately from injurious action by sun, rain, flowing water and mechanical injury, and shall not be allowed to dry from the time it is placed until the expiry of the

minimum curing periods specified hereinafter. Water curing shall be accomplished by keeping the surface of the concrete continuously wet by covering with water or with an approvedwater saturated covering. Where wood forms are left in place for curing, they shall be kept sufficiently damp at all times to prevent openings at the joints and drying out of the concrete. All portionsof the structure shall be kept moist for the full curing periods, specified hereinafter.

When liquid membrane curing compound is used the surface of the concrete shall be protected from traffic or other abrasive action that may break the membrane, for the full period of curing. The membrane curing compound shall be colourless or light coloured and shall be approved by the Engineer and shall comply with ASTM Designation 309.

- **Curing Periods**:

The curing period shall be at least 10 days, or as directed by the Project Engineer/ Employer.

- **Removal of Forms**:

The Contractor shall exercise great care in avoiding damage to joints, arises, dowel bars etc, while removing the forms. Under no circumstances will the use of pry bars between the forms and pavement be permitted. Side forms shall not be removed until at least 40 hours have elapsed from the time of completing the concreting of the slab which they contain. In no case shall forms be removed until the concrete has hardened sufficiently to permit removal without damage to the concrete. Concrete work shall be protected from damage during the removal of form work and from injury resulting from the storage or movement of material during construction.

5.7.2 Finishing

All unformed surfaces shall be finished with a wood float except as otherwise specified. Visible vertical surfaces shall have all projections and irregularities removed. The entire surface shall be rubbed if required by the Engineer, with a No. 16 carborundum brick, or other abrasive until even, smooth and of uniform appearance, and shall be washed clean.Plastering of surface, application of cement or other coating will not be permitted.

All exposed comers shall be chamfered, 25x25mm unless otherwise mentioned or shown on the plans or directed by the Engineer. Concrete surfaces which will be covered with other materials shall be screeded without floating.

5.8 Curing and Protection

5.8.1 Beginning immediately after placement, concrete shall be protected from premature drying, excessively hot or cold temperatures and mechanical injury, and shall be maintained with minimum moisture loss at a relative constant temperature for the period necessary for hydration of the cement and hardening of the concrete, The materials and methods of curing shall be subject to approval of the Engineer

5.8.2 For concrete surfaces not in contact with forms, one of the following procedures shall be applied immediately after completion of placement and finishing:

- Ponding or continuous sprinkling.
- Application of absorptive mats or fabric kept continuously wet.
- Application of waterproof sheet materials approved by the Project Engineer/ Employer.
- Application of other moisture-retaining covering as approved,
- Application of a curing compound conforming to ASTMC 309. The compound shall be applied in accordance with the recommendations of the manufacturer immediately after any water sheet which may develop after finishing has disappeared from the concrete surface. It shall not be used on any surface against which additional concrete or other material is to be - bonded unless it is proved that the curing compound will not prevent bond, or unless positive measures are taken to remove it completely from areas to receive bonded applications.

6. TEST OF CONCRETE QUALITY

6.1 The Contractor shall provide samples of concrete for testing at the Engineer's direction. Proper facilities shall be provided for making and curing the test specimens in accordance with PS 560 and PS 849. A competent person shall be employed by the Contractor whose first duty shall be to supervise all stages in the preparation and placing of the concrete. All test specimens shall be made and site tests carried out under his direct supervision.

6.2 Preliminary cube tests and works cube test shall be performed in accordance with PS 560 and PS 849 at the discretion of the Engineer. Works transverse tests shall be performed in accordance with sub-clauses 208 c and 610 d of CP 114. The standard of acceptance for preliminary and works tests shall be as given below.

6.3 The usual test for concrete with maximum size of aggregate up to 12mm is the 150 cube tested in compression. Details of making and curing compression

test cubes are given in PS 560, PS 849 and B.S. 1881 and details of the testing are given in Part 8 of B.S. 1881.

6.4 When the results of works cube tests show that the strength of any concrete is below the minimum specified, the Engineer may give instructions for the wholeor part of the work concerned to be removed and replaced at the expense of the Contractor. The Contractor shall bear the cost of any other part of his, or any other contractor's work, which has to be removed and replaced as a result of the defective concrete. If any concrete is held to have failed, the Engineer may order the proportions of that class of concrete to be changed in order to provide the specified strength.

7. FINISHING OF FORMED SURFACES

7.1 General

7.1.1 After removal of forms, the surfaces of concrete shall be given one or more of the finishes specified below in locations designated by the Contract Documents.

7.1.2 When finishing is required to match a small sample furnished to the Contractor, the sample finish shall be reproduced on an area at least 10 sq.m in an inconspicuous location designated by the Engineer before proceeding with the finish in the specified location.

7.2 As-cast Finishes

Unless otherwise specified or indicated on the Drawings the classes of finish shall apply as follows:

7.2.1 **Rough form finish**:

No selected form facing materials shall be specified for rough form finish surfaces. The holes and defects shall be patched. Fins exceeding 4mm in height shall be chipped off or rubbed off. Otherwise, surfaces shall be left with the texture imparted by the forms.

7.2.2 **Fair face finish**:

Fair face finish applies to concrete formed surfaces, the appearance of which is considered by the Engineer to be of special importance, such as surfaces of structures prominently exposed to public inspection. Surfaces of concrete structures requiring fair face finishas shown in the Drawings. Surface irregularities, measured as described in sub-clause 7.2.1, 'Rough form finish', shall not exceed 4mm for gradual irregularities and 6mm for abrupt irregularities, except that abrupt irregularities will not be permitted at construction joints. Abrupt irregularities at construction joints and elsewhere in excess of 6mm and gradual irregularities in excess of 4mm shall be

reduced by grinding so as to conform to the specified limits. Abrupt irregularities at construction joints shall be ground on level of 1 to 20 ratio of height to length.

7.2.3 Architectural Finish Concrete:

Architectural finish to concrete formed surfaces as shown on the Drawings is required by the Engineer where the architectural appearance of surfaces of structures exposed to public view is of special consideration and importance. The Contractor shall use approved special material for formwork and design the forms in conformity with the specified architectural patterns, textures and finishes in order to obtain first class architectural finish on formed concrete surface without any defect, irregularities, blemishes, imperfections and encrustations.

Samples:

1. Submit to the Engineer a minimum of two units or portions of units of each precast item required. Each pair of samples when accepted will describe the allowable limits between which variations can be acceptable.

2. Similar samples of in-situ concrete for approval by the Engineer. submit two samples, 600 sq.m. of each type of exposed in-situ the construction site.

Sample approvals of precast & in-situ concrete:

These samples will be reviewed and approved on the basis of colour, dimensional accuracy, finish of surfaces and general appearance. Thesame requirements for sample approval will be required for both precast and in-situ concrete exposed surfaces.

Forms

The contractor must maintain the forms unusually tight and braces to prevent movement, mal-alignment and bleeding that will result in sand streaks, honeycomb, fins, stain or unsightly appearance.

It wood forms are chosen to be used by the Contractor they shall be constructed of 20mm minimum thickness plywood constructed in a fashion to allow many re-uses with all surfaces sealed with a polyurethene varnish.

Edges, surfaces and corners of forms shall be sealed to prevent loss of any matrix or unequal absorption of water. Corners of wood forms shall be filled with suitable compound and all contact surfaces sealed with a polyurethene varnish.

Re-use of forms shall be subject to approval of the Engineer.

Curing:

Curing shall be done in shade (out of direct sunlight) and shall be for a minimum period of 4 days.

Finishing procedures:

"Finishing procedures for filling air void in smooth finished concrete developed by a formed surface".

While the concrete surface is still damp (not more than three days after removal of forms), apply a thin coat of medium consistency neat cement slurry by means of bristle brushes to provide a bonding coat within any pit or blemishes in the parent concrete; avoid coating large areas of thefinished surface. Before slurry has dried or changed colour, apply a dry (almost crumbly) grout comprised of one part cement, of the type and brand of cement used in the original concrete, to one and one-half parts clean masonry sand with a fineness modulus of approximately 2.25 and complying with the gradation requirements of the ASTM Specifications C144. Mix proper amounto of white cement and colouring with the parent mortar to produce a satisfactory colour match with the parent concrete after hardening. Use samples previously prepared.

8. REPAIR OF SURFACE DEFECTS

8.1 General

8.1.1 Any concrete failing to meet the specified strength or not formed as shown on drawings, concrete out of alignment, concrete with surfaces beyond required tolerances or with defective surfaces which cannot be properly repaired or patched in the opinion of the Engineer shall be removed at contractor's cost. The Engineer may reject an)' defective concrete andorder it to be cut out in part or in whole and replaced at the Contractor's expense.

8.1.2 All ties and bolt holes and all repairable defective areas shall be patched immediately after form removal.

8.2 Repair of Defective Areas

8.2.1 All honeycombed and other defective concrete shall be removeddown to sound concrete. The area to be patched and an area at least150mm wide surrounding it shall be dampened to prevent absorptionof water from the patching mortar. A bonding grout shall beprepared using a mix of approximately 1 part cement to 1 part fine sand passing a No.25 BS Sieve and shall then be well brushed into the surface.

8.2.2 The patching mixture shall be made of the same material and of approximately the same proportions as used for the concrete, except that the coarse aggregate shall be omitted and the mortar shall consist of not more than 1 part cement to 2-1/2 parts sand by damp loose volume. White Portland cement shall be substituted for a part of the grey portland cement on exposed concrete in order to produce a colour matching the colour of the surrounding concrete, as determined by a trial patch.

8.2.3 The quantity of mixing water shall be no more than necessary for handling and placing. The patching mortar shall be mixed in advance and allowed to stand with frequent manipulation with a trowel, without addition of water, until it has reached the stiffest consistency that will permit placing.

8.2.4 After surface water has evaporated from the area to be patched, the bond coat shall be well brushed into the surface. When the bond coat begins to loose the water sheen, the premixed patching mortar shall be applied. The mortar shall be thoroughly consolidated into place and struck off so as to leave the patch slightly higher than the surrounding surface to permit initial shrinkage; it shall be left undisturbed for at least 1 hour before being finally finished. The patched area shall be kept damp for 7 days. Metal tools shall not be used in finishing a patch in a formed wall which will be exposed.

8.2.5 Where as-cast finishes are specified, the quantity of patched area shall be strictly limited. The combined total of patched areas in as-cast surfaces shall not exceed 600sq.m. in each 10 sq.m. As-cast surface. This is in addition to form tie patches, if the project design permits ties to fall within as-cast areas.

8.2.6 Any patches in as-cast architectural concrete shall be indistinguishablefrom surrounding surfaces. The mix formula for patching mortar shall be determined by trial to obtain a good colour match with the concrete when both patch and concrete are cured and dry. After initial set surfaces of patches shall be dressed manually to obtain the same texture as surrounding surfaces.

8.2.7 Patches in architectural concrete surfaces shall be cured for 7 days. Patches shall be protected from premature drying to the same extent as thebody of the concrete.

8.3 Proprietary Materials

If permitted or required by the Engineer, proprietary compounds for adhesion or as patching ingredients may be used in lieu of or in addition to the foregoing patching procedures. Such compounds shall be used in accordance with the manufacturer's recommendations with prior approval of the Project Engineer/ Employer.

9. CONCRETE CONSTRUCTION TOLERANCES

Where tolerances are not stated in the specifications or drawings for any individual structure or feature thereof, maximum permissible deviations from established lines,grades and dimensions shall conform to the following. The Contractor is expected to set and maintain concrete limits. These allowable tolerances shall not relieve the Contractor of this responsibility for correct fitting of indicated materials. Those tolerances are not cumulative.

9.1 Variation from the plumb (or the specified batter for inclined walls.)

9.1.1 In the lines and surfaces of columns, piers, walls and in arises.

In any 10 ft. of length or height	1/4"
In any storey or 20 ft. maximum	3/8"
Maximum for the entire length or height.	1"

9.1.2 For exposed corner columns, control joint grooves and other conspicuous lines.

In any bay or 20 ft. maximum	1/4"
Maximum for the entire length or height	1/2"

9.2 Variation from the level or from the grades indicated on the drawings.

9.2.1 In floors, ceilings, beams soffits and in arises.

In any 10 ft. of length	1/4"
In any bay or 20 ft. maximum	3/8"
Maximum for the entire length	5/8"

9.2.2 For exposed lintels, sills, parapets, horizontal grooves and other conspicuous lines.

In any bay or 20 ft. maximum	1/4"
Maximum for the entire length	3/8"

9.3 Variation of the linear building lines from established position in plan and related position of columns, walls and partitions.

In any bay or 10 ft. maximum	1/2"
Maximum for the entire length	1"

9.4	Variation in the sizes and locations of sleeves, floor openings, and wall openings.	±	1/4"

9.5 Variation in corss-sectional dimensions of columns and beams and in the thickness of slabs and walls.

Minus	1/4"
Plus	1/2"

9.6 Footings

9.6.1	Variation in dimensions in plan	
	Minus	1/2"
	Plus (plus variation applied to concrete only, not to reinforcing bars or dowels).	1/2"
9.6.2	Misplacement or eccentricity	
	2 percent of the footing width in the direction of misplacement but not more than (applies to concrete only, not to reinforcing bars or dowels).	2"
9.6.3	Reduction in thickness	
	Minus 5 percent of specified thickness	
	Variation in Steps	
9.7.1	Rise	1/8"
	Tread	1/4"
9.7.2	In consecutive steps	
	Rise	1/16"
	Tread	1/8"

9.8 Tolerances for precast concrete construction

Forms must be true to size and dimensions of concrete members shown onthe plans and be so constructed that the dimensions of the finished productswill be within the following limits at the time of placement of these units inthe structure, unless otherwise noted on structural- architectural drawings:

9.8.1 Overall dimensions of members

9.8.2 Cross-sectional dimensions

Sections less than 3"

Sections over 3" and less than 1/8"

Sections over 18"

9.8.3 Deviations from straight line in long sections

Not more than 1/8" per 10ft.

9.8.4 Deviation from specified camber
± 1.5mm per 3 meter of span.

Maximum differential between adjacent
units in erected position 6mm.

9.9 Tolerances for Pavements

9.9.1 Departure from established alignment

9.9.2 Departure from established longitudinal grade on any time.

9.9.3 Departure from transverse template contour except-at transverse joints.

9.9.4 Departure from transverse template contour at transverse joints.

9.10 Pavements for Parking areas

The tolerances are twice the values listed for pavements.

10. ACCEPTANCE OF STRUCTURE

10.1 General

10.1.1 Completed concrete work which meets all applicable requirements will be accepted subject to the other terms of the Contract Documents.

10.1.2 Completed concrete work which fails to meet one or more of the requirements and which has been repaired to bring it into compliancewill be accepted subject to the other terms of the Contract Documents.

10.1.3 Completed concrete work which fails to meet one or more of the requirements and which cannot be brought into compliance may be accepted or rejected as provided in these Specifications or in the Contract Documents. In this event, modifications may be required to assure that remaining work complies with the requirements.

10.2 Dimensional Tolerances

10.2.1 Formed surfaces resulting in concrete outlines smaller than permitted by the tolerances of clause 9 shall be considered potentially deficient instrength and subject to the provisions of sub clause 9.4

10.2.2 Formed surfaces resulting in concrete outlines larger than permitted by the tolerances of clause 9 may be rejected and the excess material shall be subject to removal. If removal of the excess material is permitted, it shall be accomplished in such a manner as to maintain the strength of the section and to meet all other applicable requirements of function and appearance. Permission is required if excess material is to be removed in accordance with this clause.

10.2.3 Concrete members cast in the wrong location may be rejected if thestrength, appearance or function of the structure is adversely affected or if misplaced items interfere with other construction.

10.2.4 Inaccurately formed concrete surfaces exceeding the limits of Clause 9 or of Clause 5.1 of Section 'Formwork' shall be removed and replaced and those that are exposed to view, may be rejected and shall -be repaired or removed and replaced if required,

10.3 Appearance

10.3.1 Architectural concrete with surface defects exceeding the limitations of Sub-clause 5.1 of Clause 5 of the Section, 'Formwork' shall be removed and replaced.

10.3.2 Other concrete exposed to view with defects which adversely affect the appearance of the specified finish may be repaired only be approved methods.

10.3.3 Concrete not exposed to view is not subject to rejection for defective appearance.

10.4 Strength of Structure

10.4.1 The strength of the structure in place will be considered potentially deficient if it fails to comply with any requirements which control the strength of the structure, including but not necessarily limited to the following conditions.

Concrete strength requirements not considered to be satisfied in accordance with Clause 6 hereof.

Reinforcing steel size, quantity, strength, position or arrangement at variance with the requirements as listed under specification of 'Reinforcement' or in the Contract Documents.

Concrete which differs from the required dimensions or location in such a manner as to reduce the strength.

Curing less than that specified.

Inadequate protection of concrete from extremes of temperature during early stages of hardening and strength development.

Mechanical injury, construction fires, accidents of premature removal of formwork likely to result in deficient strength.

Poor workmanship likely to result in deficient strength.

10.4.2 Structural analysis and/or additional testing may be required when the strength of the structure is considered potentially deficient.

10.4.3 Core tests may be required when the strength of the concrete in place is considered potentially deficient.

10.4.4 If core tests are inconclusive or impractical to obtain or if structural analysis does not confirm the safety of the structure, load tests may be required and their result evaluated in accordance with British Standard, CP 110 or ACI Standard 318.

10.4.5 Concrete work judged inadequate by structural analysis or by results of a load test shall be reinforced with additional construction if so directed by the Employer or shall be replaced, at the Contractor's expense.

10.4.6 The Contractor shall pay all costs incurred in providing the additional testing and/or analysis required by this section.

10.4.7 The Employer will pay all costs of additional testing and/or analysis which is made at his request and which is not required by these Specifications, or by the Contract Documents.

11. MEASUREMENT AND PAYMENT

11.1 General

Except otherwise specified herein or elsewhere in the Contract Documents, no measurement and payment will be made for the under mentioned specified works related to the relevant items of the Bills of Quantities. The cost hereof shall be

deemed to have been included in the quoted unit rate of the respective items of the Bills of Quantities.

11.1.1 Providing, fixing, striking, etc. of formwork.

11.1.2 Providing, placing & fixing of anchor bolts or any other embedded parts.

11.1.3 Providing and installing all type of joints in concrete structure including expansion/contraction joints and its related material/ components.

11.1.4 Providing and installing P.V.C. water stop/Hydro - foil.

Providing and placing vopour barrier.

Water required for mixing, curing and other uses.

11.2 Plain and Reinforced Concrete

11.2.1 Measurement:

Concrete shall be measured as executed but no deduction shall be made for the following:

- Volume of any steel embedded in the Concrete.
- Volume occupied by water pipes, conduits etc. not exceeding 25 sq. c. meter cross- sectional area.
- Voids not exceeding 1 sq.ft. in work given in square meter. If any void exceeds 1 sq.ft. total void shall be deducted.

Voids which are not to be deducted as specified above, refer only to openings or vents which are wholly within the boundaries of measured areas. Openings or vents which are at the boundaries of measured areas shall always be subject to deductions irrespective of size.

Concrete work shall be classified and measured separately as listed under items of Bills of Quantities.

Junction between straight and curved works shall in all cases be deemed to be included with the work in which they occur.

Measurement of walls shall be taken between attached columns piersor pilaster. The thickness of attached columns, piers, or pilaster shallbe taken as the combined thickness of the wall and the columns, piers or pilaster. Attached or isolated columns, piers, pilaster, andthe like (except where caused by openings) having a length on plan not exceeding four times the thickness shall classified as columns.

Those having a length over four times the thickness and are caused by openings in wall shall be classified as walls.

Columns shall be measured from the top of footing/ footing beams or floor surfaces to the *underside of beams or slabs as the case may* be. Where the width of beams is less than the width of columns, the extra width at the junction shall be included in the beams.

The depth of the beams shall be measured from bottom of the slab to the bottom of the beams except in case of inverted beams where it shall be measured from top of slab to the top of beam.

The Cross-section of the beam shall be the actual cross-section below or above the slab.

Measurement of acceptably completed works of plain and reinforced cement concrete will be made on the basis of number of cubic foot concrete placed and compacted in position within the neat lines of the structure as shown on the Drawings or as directed by the Employer.

11.2.2 **Payment**:

Payment will be made for acceptable measured quantity of plain and reinforced cement concrete on the basis of unit rate per cubic foot quoted in the Bills of Quantities and shall constitute full compensation for all the works related to the item.

11.3 Light Weight Concrete

11.3.1 Measurement:

Measurement of acceptably completed works of light weight concrete will be made on the basis of number of cubic foot of the placed and compacted in position as shown on the drawings or as directed by the Employer.

11.3.2 Payment:

Payment will be made for acceptable measured quantity of light weight concrete on the basis of unit rate per cubic foot quoted in the Bills of Quantities and shall constitute full compensation for all the works related to the item.

11.4 Pre-cast Reinforced Cement Concrete Planks

11.4.1 Measurement:

Measurement of acceptably completed works of Pre- cast Reinforced Cement Concrete Planks will be made on the basis of net actualvolume in cubic foot of planks casted and installed in position as shownon the Drawing or as directed by the Employer.

11.4.2 Payment:

Payment will be made for acceptable measured quantity of pre-cast concrete planks on the basis of unit rate per cubic foot quoted in the Bills of Quantities & shall constitute full compensation for all the works related to the item.

SECTION - 2800

STRUCTURAL STEEL WORKS

1. SCOPE

The work covered by this section, consists of supply of all material, labour, plant, equipment and appliances including welding, bolts, nuts, washers, anchor bolts, embedded parts etc, fabrication, erection and painting in accordance with the specifications and as per drawings and as directed by the Engineer.

2. DRAWINGS

Design drawings shall be prepared by the Engineer and supplied to the Contractor. These shall contain main dimensions, sizes of members, typical details of joints.

Workshop drawings shall then be prepared by the Contractor from the design drawings supplied and submitted to the Engineer for approval.

3. MATERIAL

Except otherwise stated in the drawings, the material specifications shall conform to the following. Wherever necessary the Contractor may use equivalent alternative material subject to approval of the Engineer.

3.1 Structural Steel

Structural steel for structures shall conform to the requirements of ASTM A-36 or equivalent

3.2 Steel Forging

Steel forging shall conform to the requirements of ASTM A235.

3.3 Steel Casting

Steel casting shall conform to the requirements of ASTM A27.

3.4 Welding

Welding Electrodes for manual shielded metal arc welding shall conform to AWS A 5.1 latest edition or the A 5.5 latest edition. Equivalent locally manufactured electrodes may be used subject to the approval of the Engineer.

3.5 Common Bolts, Anchor Bolts, Nuts and Washers Bolts and Nuts shall conform to the requirements of ASTM A 307.

3.6 High Strength Bolts

High strength carbon steel bolts including nuts and washers shall conform to the requirements of ASTM A325 latest editions and of AISI B18.2

3.7 Washers

Cut Washers : Shall be of structural grade steel and shall conform to the dimension of the manufacturer's regular standard for plain washers for the size of bolts used.

3.8 Cast Iron

Shall conform to the requirements of latest edition of ASTM A 48.

4. FABRICATION

The Contractor shall notify the Engineer about any problems or doubts/errors discovered in the drawings for clarification/rectification well in time to prevent any fabrication errors. Fabrication shall not be commenced until approval has been obtained from the Engineer.

4.1 Straightening of Material

Rolled material, before being worked upon must be straightened within tolerances by ASTM specifications A6 Straightening, necessarily shall be done by mechanical means or by the application of a limited amount of localized heat. The temperature of heated areas, as measured by approved methods, shall not exceed 1100°F for A 514 steel or 1200°F for other steels.

4.2 Cutting

As far as possible cutting must be done by shearing. Oxygen cutting shall be done where shear cutting is not possible and shall preferably be done by Machine. All edges shall be free from gauges, notches or burs. If necessary the same shall be removed by grinding.

4.3 **Holes Punching Drilling**.

Holes shall be punched where thickness of the material is not greater than the diameter of bolt +3 mm. Where the thickness of the material is greater the holes shall either be drilled or sub-punched and reamed to size. The die for all sub-punched holes and the drill to all sub-drilled holes shall be at least 1.58 mm smaller than the nominal diameter of the rivet or bolt. Holes for A514 steel plates over 13 mm thick shall be drilled.

4.4 Welding

4.4.1 General :

The execution and inspection of welding will be done in accordance with the provisions of the American welding society code for welding in Building construction, D1.0. No welding for piping/electrical supports shall be made transversely to any tension flanges of trusses, beams or columns.

4.4.2 Automatic sub-merged Arc Welding :

For all built-up members, ie. sections fabricated from plates and flat bars or compound rolled sections, plate and box girders, where long continuous, welding is to be done, should be executed by Automatic submerged Arc Welding process in accordance with relevant AWS specifications.

4.4.3 Maximum and minimum size and lengths of fillet welds shall be in accordance with AISC specifications.

Surface to be welded shall be free from loose scale, slag, rust, grease, paint or any other foreign matter except mill scale which withstands vigorous wire brushing.

4.5 Tolerances

A variation of l mm is permissible in the over all length of members with both ends finished for Contact bearing. The bearing surfaces prepared to a common plane by milling.

Members without end finished for contact bearing which are to be framed to other steel parts of the structure shall have a variation from detailed length not greater than 3 mm.

5. SURFACE PREPARATION/PAINTING

5.1 Surface Preparation

All structural steel material i.e. rolled steel sections, plates, pipes, flat bars, chequered plates shall be cleaned free from loose scale, rust, burrs slag, etc. by means of sand blasting.

5.2 Painting

a) Immediately after surface preparation all material shall be given one prime coat of rust preventive paint.

b) After fabrication one shop coat of prime paint and then one coat of enamel paint shall be applied.

c) One final coat of enamel paint shall be applied after erection of all components.

d) The type of primer and enamel paints to be applied shall be as specified on the drawings.

e) All other requirements for the specified paint system shall be in accordance with the paint manufacturer's specification/ recommendations.

f) The Contractor shall use the best quality of the type of paint specified and shall get the same approved by the Engineer.

g) Steel work/Surfaces not to be painted

i) Steel work to be encased/embedded in concrete or surface in contact with concrete or grout shall not be painted, but shall be given a cement wash after sand blasting.

ii) Machined finished surfaces shall not be painted but shall be coated with rust preventive compound, (approved by the Engineer) immediately after finishing. Such surfaces shall also be protected with wooden pads or other suitable means for transportation. Un-assembled pins, keys, and bolt thread shall be greased and wrapped with moisture resistant paper.

6. INSPECTION AND TESTS

6.1 Manufacturer's Work Test Certificate for all material used shall be furnished by the contractor for Engineer's scrutiny and approval.

6.2 Rolling tolerance of all shapes and profile according to AISC shall be in accordance with the provisions of the American Society for Testing and Materials Designation A.6. These shall be checked by the Contractor before being worked upon and shall be rejected if found not within limits.

6.3 The Contractor shall arrange for analysis and test of all material rolled locally at a testing laboratory selected by the Engineer.

6.4 Inspection of Welding.

The inspection of welding shall be performed in accordance with the American Welding Society specifications, as directed by the Engineer.

6.5 Rejection

Materials or workmanship not in reasonable conformance with the provisions of these specifications shall be rejected at any time during the progress of the work or the completion and erection at site.

7. MISCELLANEOUS STEEL WORKS

The work covered shall include furnishing, fabricating, installing and painting miscellaneous steel work including the following:

Steel Louvered Doors, Windows and Ventilators

Steel Gate

Steel Grill

Steel Fence

Steel Ladder

Steel Ladder Rungs

Steel Railing

Steel Mast

Steel Grating

All steel fabricated items shall conform to the drawings, details and instructions of the Engineer. Contractor shall submit detailed shop/erection drawings of the above listed items to the Engineer for approval. Drawing, material, fabrication, surface preparation shall conform to the applicable requirements of relevant clauses of these specifications. Any proposed deviation due to field conditions and availability of local material shall be submitted to the Engineer for approval.

8. MEASUREMENT & PAYMENT

8.1 General

Except otherwise specified herein or elsewhere in the Contract Documents, no measurement and payment will be made for the under mentioned specified works related to the relevant items of the Bill of Quantities. The cost there of shall be deemed to have been included in the quoted unit rate of the respective items of the Bill of Quantities.

The rates quoted by the Contractor in the Bill of Quantities shall include works to be executed under this specification in any floor and at any height.

8.1.1 Nuts, bolts hold fasts, screw, rivets, heads, fillets, welds welding rods, locks, rollers, rolling tracks etc.

8.1.2 Anti-corrosive prime coat.

8.1.3 Cleaning with sand blasting.

8.1.4 Painting.

8.1.5 All metal embedded parts, metal fittings and fixtures required for the operational process.

8.1.6 Steel main frame, cutting, welding, embedding, painting etc. in steel ladder/rungs/fence/gate, etc.

8.2 Steel Louvered Door/Windows/ventilators, Steel Gates, Steel Fence and Grill.

8.2.1 Measurement

Measurement of acceptably completed works of Steel Louvered Door/Windows/ventilators, Steel Gates, Steel Fence and Grill will be made on the basis of actual area in square foot fabricated & installed in position as shown the drawings or as directed by the Engineer.

8.2.2 Payment

Payment will be made for acceptable measured quantity of Steel Louvered Door/Windows/ventilators, Steel Gates Steel Fence and Grill on the basis of unit rate per square foot quoted against the respective item in the Bills of Quantities and shall constitute full compensation for all the works related to the item.

8.3 Steel Embedded Parts

8.3.1 Measurement

Measurement of acceptably completed works of steel embedded parts will be made on the basis of number of tons of steel parts provided and embedded in position as shown on the drawing or directed by the Engineer.

8.3.2 Payment

Payment will be made for acceptable measured quantity of steel embedded parts on the basis of unit rate per ton quoted in the Bills of Quantities and shall constitute full compensation for all the works related to the item.

8.4 Steel Ladder and Steel Grating

8.4.1 Measurement

Measurement of acceptably completed works of Steel Ladder and Steel Grating will be made on the basis of number of M. Ton of Steel Ladder and Steel Grating fabricated, provided and installed in position as shown on the drawing or directed by the Engineer.

8.4.2 Payment

Payment will be made for acceptable measured quantity of Steel Ladder and Steel Grating on the basis of unit rate per Tonne quoted against the respective item in the Bills of Quantities and shall constitute full compensation for all the works related to the item.

8.5 Steel Ladder Rungs

8.5.1 Measurement

Measurement of acceptably completed works of Steel Ladder Rungs will be made on the basis of number of Steel Ladder Rungs fabricated, provided and installed in position as shown on the drawing or directed by the Engineer.

8.5.2 Payment

Payment will be made for acceptable measured quantity of Steel Ladder Rungs on the basis of unit rate per number quoted in the Bills of Quantities and shall constitute full compensation for all the works related to the item.

8.6 Steel Railing

8.6.1 Measurement

Measurement of acceptably completed works of Steel Railing will be made on the basis of actual length in running foot of Steel Ladder Railing fabricated, provided and installed in position as shown on the drawing or directed by the Engineer.

8.6.2 Payment

Payment will be made for acceptable measured quantity of Steel Railing on the basis of unit rate per running foot quoted in the Bills of Quantities and shall constitute full compensation for all the works related to the item.

8.7 Steel Mast

8.7.1 Measurement

Measurement of acceptably completed works of Steel Mast will be made on the basis of number of Steel Masts (job) fabricated, provided and installed in position as shown on the drawing or directed by the Engineer.

8.7.2 Payment

Payment will be made for acceptable measured quantity of Steel Mast on the basis of unit rate per job quoted in the Bills of Quantities and shall constitute full compensation for all the works related to the item.

SECTION - 4200

BRICK MASONRY

1. SCOPE

The work under this section of the Specifications consists of furnishing all plant, labour, equipment, appliances and materials and performing all operations in connection with the furnishing and installing brick masonry in position including Portland cement and sand mortar & masonry, complete in strict accordance with this section of the Specifications and applicable drawings, and subject to the terms and conditions of the Contract.

2. MATERIALS

Portland cement for mortar shall conform to the applicable requirements specified in the section "Plain and Reinforced Concrete".

Sand for mortar shall be furnished by the Contractor and shall conform to the applicable requirements for sand specified in the section "Plain and Reinforced Concrete".

Water used in the manufacture of brick and in the preparation of mortar shall be free from objectionable quantities of silt, organic matter, alkali, salts and other impurities, and will be tested and approved by the Engineer.

3. MORTAR

Mortar for first class brick masonry, except where otherwise directed by the Engineer, shall consist of one part Portland cement to six parts of damp loose mortar sand by volume and sufficient water to produce proper consistency for the intended use. Where directed by the Engineer for increased workability, hydrated lime putty, approved by the Engineer, shall be added to the mortar but shall not exceed 25 percent, by volume of the dry cement.

Methods and equipment used for mixing mortar be such as will accurately determine and control the amount of each separate ingredient entering into the mortar and shall be subject to the approval of the Engineer. Mortar shall be mixed only in sufficient quantities for immediate use and all mortar not used within 30 minutes after addition of water to the mix shall be rejected. Retempering of mortar shall not be allowed.

The mixers shall be thoroughly cleaned and washed at the end of each day's work.

4. BRICK

All bricks, except otherwise specified, shall be of first class quality made from good brick earth, free from saline deposit and shall be hand mounlded. They shall be thoroughly burnt without being verified, shall be regular, uniform in shape and size with sharp and square edges, parallel faces and of deep red or copper colour. First class bricks shall be homogeneous in texture and shall emit a clear ringing sound when struck, and shall be free from flaws, cracks, chips, stones and modules of lime. First class brick in an over dried condition shall not absorb more than 1/5 of its weight of water when immersed one hour in water at 21 to 27 degrees centigrade and shall show no signs of efflorescence or subsequent drying. The average compressive strength of five representative first class bricks shall be not less than 165 Mpa and not less than 10 Mpa for any individual brick.

All bricks shall be manufactured by the Trench Kiln Method or other standard methods approved by the Engineer. The earth used in manufacturing bricks shall be carefully selected and shall be free from objectionable quantities of lime, gravel coarse sand, roots, or other organic matter. Salts shall not exceed 0.3 percent and calcium carbonate shall not exceed 2.0 percent.

The moulds used in the manufacture of bricks shall be thoroughly sanded before each use and shall be sufficiently larger than the size of the bricks being manufactured to allow for shrinkage in drying and burning. Oversize, irregular and worn moulds shall be destroyed. Each finished brick for brick masonry shall be 9 inch by 4 ½ inch by 3 inch in size and shall weight between 3.2 to 4.2 kilograms. All bricks shall have a “frog” ¼ inch deep on one face.

Second class bricks shall be used at places specified in the drawings and Bills of Quantities.

Samples of first and second class bricks shall be submitted to the Engineer with test reports for his approval. Bricks of approved samples shall only be used in the works, if at any time, during the progress of the work, use of substandard material is found by the Engineer, such work shall be rejected and the Contractor shall replace the rejected workat his cost.

5. PLACING

The methods and equipment used for transporting the bricks and mortar shall be such as will not damage the brick nor delay the use of mixed mortar. Brick shall not be placed during rains sufficiently heavy or prolonged to wash the mortar from the brick. Mortar already spread which becomes diluted by rain shall be removed and replaced before continuing with the work. All brick to be used in brick masonry shall be moistened with water for three to four hours before they are used by a method which will ensure that each brick is thoroughly and uniformly wetted. All bricks shall be free from water adhering to their surface when they are placed in the brick masonry.

Bricks shall be laid "frog" upward with mortar joints and in English and Flemish bond as shown on the Drawings or as directed by the Engineer. Both bed and vertical joints shall be ¼ inch in thickness completely filled with cement mortar as specified herein, and each brick shall be bedded by firmly tapping with the handle of the trowel. All horizontal joints shall be parallel and all vertical joints in alternate courses shall be directly over oneanother. Excess mortar at the outer edges shall be removed and joints drawn straight with the edges of a trowel and a straight edge. All anchors and similar work required to be embedded in the brick masonry shall be installed as the work progresses. At the completion of the work all holes or defective mortar joints shall be cut out and repointed.

Where shown on the drawing the exterior faces of the walls shall be finished by striking the joints as the work proceeds. The joints shall be struck by raking the green mortar after the brick work has been laid and finishing the joint with a pointing tool. Horizontal joints shall be struck to form a weathered joint and vertical joints shall be struck with a V notch. Care shall be taken that the striking tools do not develop a cutting edges as the object of striking the joint is to compress the mortar into the joints.

The exposed faces of all brick masonry shall be thoroughly cleaned and left bare with struck joints as specified above.

Anchoring

All brick masonry walls shall have a continuous reinforced, as per drawing.

6. CURING AND REPAIR

All brick masonry shall be water cured and shall be kept wet for at least seven days by an approved method which will keep all surfaces to be cured continuous wet. Water used for curing shall meet the requirements of the Specifications for water used in the manufacture of bricks.

If, after the completion of any brick masonry work, the brick is not in alignment or level, or does not conform to the lines and levels shown on the Drawings, or shows a defective surface, it shall be removed and replaced by the Contractor at his expenses unless the Engineer grant permission, in writing, to patch or replace the defective area.

7. SCAFFOLDING

Contractor shall provide safe scaffolding of adequate strength for use of workmen at all levels and heights at his own expense. Scaffolding which is unsafe in the opinion of the Engineer shall not be used until it has been strengthened and made safe for use of workmen. Cost of scaffolding etc., shall be included by the Contractor in the unit rate for masonry items.

Damage to masonry from scaffolding or from any other cause shall be repaired by the Contractor at his own cost.

8. TOLERANCES

All brick work shall be erected plumb and true to line and level with maximum variation in any storey height or any length of wall being one mm in one meter. The maximum tolerance in the length, height or width of any single masonry unit shall be ± 1/8 inch.

9. DAMP PROOF COURSE

All damp proof course unless otherwise specified shall consist of class 'C' cementconcrete 2 inch thick, mixed with 2.5 kg of puddle / bag of cement or other approved quality water proofing compound as per manufacturer's specifications and shall be laid atrequired levels as per drawings and instructions of the Engineer. The D.P.C. shall be tamped, consolidated, leveled and edges and corners made to the requirements of the relevant drawings including finishing and curing complete. All damp proof courses shall be laid over approved water proofing as specified on the Drawings.

10. MEASUREMENT AND PAYMENT

10.1 General

Except otherwise specified herein or elsewhere in the Contract Documents, no measurement and payment will be made for the under mentioned specified works related to the relevant items of the Bills of Quantities. The cost thereof shall be deemed to have been included in the quoted unit rate of the respective items of the Bills of Quantities.

10.1.1 Cutting & chiseling of masonry, wherever required.

Cement sand mortar used in laying bricks including wastage.

Curing and repairing the masonry work.

Damp proof course of class 'C' concrete including damp proof materials.

10.2 Brick Masonry

10.2.1 **Measurement**:

In case of different thickness of slab in different areas or room of for any other reason whatsoever, if chiseling of masonry is required, the Contractor shall do so at his own cost where, for any reason whatsoever, the height, of the wall is short of ceiling height, of the actual height shall be made good with 1:2:4 nominal mix concrete. This concrete shall neitherbe measured nor be paid under item of concrete but will be paid for under item of wall masonry. Similarly where the lintel heights are such that the Contractor has to chisel the masonry or provided cast-in-place concrete to make up the height of the course, no payment will be made for chiseling, but where such cast-in-place concrete is provided, payment for the same will be made at the unit rate for masonry. Measurement of acceptably completed works of brick masonry will be made on the basis of number ofcubic meter provided and installed in position as shown on the drawings oras directed by the Engineer.

18.2.2 **Payment**:

Payment will be made for acceptable measured quantity of brick masonry work on the basis of unit rate per cubic meter quoted in the Bills of Quantities and shall constitute full compensation for all the works related to the item.

SECTION – 4500

CARPENTRY AND JOINERY

1. SCOPE

The work covered under this section of Specifications consists of providing all material, labour, plant, equipment, appliances and performing all operations connected with the fabrication and erection of all woodwork, mill work, construction assembly, surfacefinish treatment and building in of all cabinet type items, supports etc. of wood or metal and incidentals, associated woodwork appurtenances, procuring and applying preservatives, installation of "Finish Hard Ware" in connection with finish woodwork as per details shown on the Drawings or as directed by the Engineer. The scope of this section is covered with detailed specifications as laid down herein.

2. APPLICABLE STANDARDS

Latest editions of following British and ISO Standards are relevant to these specifications wherever applicable.

2.1 ISO (International Organization for Standardization)

1891 Bolts, screens, nuts and accessories-Terminology and nomenclature.

1097 Plywood - Measurement of dimensions of panels.

1098 Veneer ply wood for general use-General requirements.

2427 Veneer ply wood with rotary cut veneer for general use-Classification by appearance of panels with outer veneer of beech.

2429 Ply wood - Veneer ply wood with rotary cut veneer for general use-Classification by appearance of panels with outer veneers of brand leaved species of tropical Africa.

3804 Ply wood-Determination of dimension of test pieces.

3805 Ply wood-Determination of density.

3806 Ply wood-Determination of moisture content.

6442 Door leaves-Measurement of defects of general flatness.

6443 Door leaves-Measurement of dimensions and of defects of squareness.

6444 Door leaves-Test of behavior under humidity variations.

2.2 BSI (British Standards Institution)

459 Wooden doors.

1186 Quality of timber and workmanship in joinery.

1127 Hinges

1331 Builder's hardware for housing.

1567 Wood door frames and linings nails.

1202 Nails

1203 Specifications for synthetic resin adhesive for ply wood.

1204 Synthetic resin adhesives for wood.

1282 Guide to choice, use and application of wood preservatives.

1494 Fixing accessories for building purposes.

1579 Connectors for timber.

3842 Treatment of ply wood with preservatives.

3 MATERIALS

3.1 Timber

3.1.1 Hard Wood:

Hard wood shall comprise of Oak and Teak.

3.1.2 Softwood:

All soft wood shall consist of cedrous deodar (referred in the document as deodar) having density of 500-600 kg/m-^{3}, wood locally known as 'Partal' to be used in framing where specified.

3.1.3 General Characteristics:

All the timber shall be in accordance with the requirements of BSI No: 1186, 'Quality of Timber and Workmanship in Joinery'.

The whole of the timber shall be from the heart of sound and fully grown tree, uniform in substance, straight in fiber, first class quality properly seasoned, free from large or loose dead knots, open shakes and excessive sapwood. The scantlings of all timbers shall be bright, sound and square edged. The moist-ire content of timber shall not be more than ten (10) percent.

3.1.4 Preservation of Wood:

Prior to installation of all finish wood works in their respective positions, preservatives shall be applied to safeguard the wood work against fungus, termite and bores.

The preservatives shall be of the best available quality of solignam oil (clear) as approved by the Engineer. The method of application shall be strictly in accordance with the manufacturer's instructions. The treatment and application of all the preservatives shall comply with the requirements of BS-CP 98:1964.

3.1.5 Adhesive:

The adhesives shall conform to the requirementsof BSI No. 745 "Animal Glues for Wood" or as directed and approved by the Engineer.

3.1.6 Nails and Screws :

All nails and screws shall comply with requirements of BSI NO. 1202 and BSI NO. 1210 respectively.

3.2 Ply Wood

3:2.1 The ply wood shall comply in all respects with BSI No. 1455:1963. All the ply wood shall only be obtained from manufacturers approved by the Engineer.

Ply wood used for doors, panelings and other similar works shall be to the thickness and size as shown on the Drawings or as directed by the Engineer. The grade shall be first quality and the face and back shall be free from end joints, dead knots, overlaps, patches and other similar defects. The surfaces shall be free, smooth for painting or polishing.

3.2.2 The veneer shall be of the required thickness and quality including base veneer and shall be impregnated with an approved adhesive and machine compressed. Such machine pressed veneered wood shall be fixed on all sides of the inner core wood (soft wood of approved quality) after it has been treated with water resistant hot setting glue.

4. SAMPLES

All samples of the material used for the work under this Section of Specification shall be approved by the Engineer and same type of material shall be used throughout the work. If the Engineer desires to get the material tested, this will be got done by the Contractor at his own cost from a laboratory approved by the Engineer.

5. FABRICATIONS

5.1 General

'Unwrought' timber shall be used. Sawing shall be done true to the size and dimensions to finally meet the requirements of specified sizes and dimensions of the finished work.

All framing shall be joined as shown on the Drawings or as directed by the Engineer. All joints shall be secured with sufficient number of nails. The Contractor shall perform all necessary mortising, tenoning, grooving, matching, tonguing, housing, rebating and all operations required for the correct jointing. The Contractor shall also provide all metal plates, screws, nails and other fixing - material that may be ordered by the Engineer for the proper execution of the joinery work. Fabrication that develop defects due to bad workmanship or unsound materials not conforming to these specifications and the directions of the Engineer, shall be cut out and replaced at Contractor's own expense before the expiry of the maintenance period.

5.2 Doors

5.2.1 Verify design and size of doors required for each opening. Door thicknesses shall be 1-1/2" unless otherwise indicated.

5.2.2 Fabricate flush wood doors in accordance with the following requirements.

Cores

Edging of doors and shutters shall be of hard wood and cores shall be soft wood (solid core) planed to a smooth uniform thickness. All doors and shutters shall have Deodar wood lapping on all edges as per details shown on the drawing.

Face Panels

- Door facing on each side of door shall consist of three or more veneered piles of teak wood.

- Veneer plies shall have total minimum thickness of 1/8" before sanding.

- Door veneers shall be bonded to each other, and to core unit with approved adhesive and machine compressed.

6. PROTECTION OF MATERIALS

All materials and assembled units shall be protected from weather and stored in such a way as to prevent decay and attack by fungus and termites.

7. WOODEN DOORS

7.1 Materials

7.1.1 First class Deodar wood as approved by the Engineer shall be used for the door frames and full/half glazed and paneled shutters.

7.1.2 The ply wood and veneering shall be of selected best quality as approved by the Engineer.

7.2 Exterior and Interior Door Frames

All exterior and interior door frames shall be constructed of given thickness with planted on stops, nailed in place, jambs and beads shall be housed and nailed and glued together.

The door frames shall be secured in place by means of mild steel anchors screwed in place and built into the masonry as it is being constructed. There shall be one such anchor near the top and bottom of each jamb but not over 900mm intervals between the top and bottom anchors.

7.3 Exterior and Interior Wooden Doors

The exterior and interior wooden door shall, unless otherwise shown or specified, be of the paneled type, flush and type as shown on the Drawings or as directed by the Engineer.

All the door shall conform to the following requirements:

Paneled doors shall be constructed in accordance with the requirements of Part 1 of British Standard Specification No. 459 with the additional requirements that panels in exterior openings shall be assembled with waterproof glue, glued tacked in place. Flush door shall comply with BS1 459 Part-2 and shall consist of solid core Deodar wood ply veneer 40mm thick shutters as shown on drawings.

7.4 Door Shutters

The shutters will be fixed to the frames with approved quality brass fittings as per hardware schedule.

7.4.1 All doors, shutters shall be fabricated in a workman- manner strictly to the correct sizes and shapes as shown on the Drawings or as directed by the Engineer.

7.4.2. The door shutters shall have solid core as shown on the Drawings. It shall be built in sections, properly joined and glued together, both sides being covered with Teak veneered ply of the required thickness and approved quality. The surfaces shall surface shall be prepared for painting or polishing.

7.4.3. The arrangements of inner core for solid shutters shall be approved by the Project Engineer/ Employer. It shall be so adjusted that circulation of air is free and uninterrupted. Minute holes shall be provided in edges at suitable places to admit and exit air.

7.4.4. Each door shall be constructed so as to permit the installation of hinges, knobs and locks in the position shown on the Drawings.

7.4.5. Completed door shall be sound, rigid and free from defects and warp. All edges shall have Deodar wood lapping and shall be aligned and smooth, joints shall be close fitting, hard wood dowelled or mortised framed and of strength to maintain frame and of strength to maintain the structural properties of the member connected. All adjoining faces and edges shallbe flush and smooth. Edges shall be rectangular and solid.

7.5 Fitting, Hanging and trimming

All the doors shall be fitted, hung and trimmed as hereinafter specified and as indicated on the Drawings.

Doors shall have a clearance of 4 mm at sides and top unless otherwise directed by the Employer and shall have 5 mm clearance at bottom. Doors shall be hung and trimmed with hardware as specified. All the locks shall be installed at the same height and shall be located at height as directed by the Employer.

7.6 Hardware

Hardware shall be of Yale or equivalent best quality available in Pakistan and first class finished material as per attached hardware schedule. The Contractor shall obtain prior approval from the Employer for quality, shape, pattern and brand of the hardware materials by providing samples and catalogues, etc., and shall provide and fix only the approved hardware materials.

Hardware shall be carefully and securely fitted. Upon handing over the work, hardware shall be demonstrated to operate freely. Keys shall be placed into respective locks and upon acceptance of the work keys shall be tagged anddelivered to the Employer.

7.7 Quality Assurance

7.7.1 Tolerance: Doors shall be fabricated to following tolerances

- Size: Plus or minus 1.6 mm overall dimensions.
- Maximum Warp: 3 mm
- Squareness: Maximum diagonal difference 3 mm (between length of diagonal measured on face of door from upper right corner to lower left corner and length of diagonal measured from upper left corner to lower right corner).

7.7.2 Manufacturer's Qualifications: The manufacturer of doors herein specified shall have been in business of manufacturing doors of typespecified for minimum period of five years.

7.8 Submittals

7.8.1 Provide manufacturer's literature completely describing products.

7.8.2 Provide shop drawings showing door types, details and locations, referred to the door type and hardware group shown on door and hardware schedules.

7.8.3 Provide certificates stating that doors were constructed with timber of the species specified having moisture content and meeting equilibrium and relative humidity requirements.

7.8.4 Submit samples of face veneers for selection of colour and pattern.

7.8.5 Procurement of materials shall be made only after the shop drawings and samples have been approved by the Employer.

7.9 Product Delivery, Storage and Handling

7.9.1 Deliver and store products in waterproof, protective containers with seals unbroken and labels intact until time of use.

7.9.2 Keep products dry, stack products off ground on level platforms, fully protected from weather, including direct sunlight?

7.9.3 Identify type, size and location of each door before delivery in order to permit installation at correct location.

7.10 Installation

7.10.1 Install doors at correct openings and assure smooth swing and proper closer with frames.

7.10.2 Install finish hardware in accordance with manufacturer directions.

8. KITCHEN CABINET / WOODEN CABINETS / WARDROBES / DRESSERS / SHELVES / SEATS

All cabinet / wardrobes / shelves / seat including fittings, fixtures and hardware's shall be supplied of approved manufacturer and shall be of best quality fabricated by using materials and details as shown on the drawings.

8.1 Shop Drawings

The Contractor shall submit detailed shop Drawings on the basis of the manufacturer's specifications including all fittings, fixtures and hardware and the same shall be got approved from the Employer before fabrication. Samples of materials to be used in cabinets, wardrobes, and shelves / seat together with specifications and literature shall be supplied to the Employer for his approval prior to start of the works. The colour shade shall be as approved.

8.2 Installation

All cabinets, wardrobes and shelves / seat shall be installed in position by the manufacturer's skilled workmen specialized in the job. Works shall be executed accordance with approved shop drawings and the manufacturer's instructions.

The Contractor shall inspect delivered cabinets, wardrobes seats and shelves and related parts for indication or location, size required by field measurements, finishing hardware and similar preliminary works. Verify locations for installation, required floor and wall finishes, painting and other related work. Cabinets / wardrobe, shelves and seats shall exactly flush the floor and wall surfaces. Cut and fit accurately scribe strips at wall surfaces, walls. Firmly attach to bases. Secure wall cabinet to blocking. Concealed fasteners, all joints surfaces shall be smooth and even. Doors and other moving parts shall exactly fit in the frame. Refit, if necessary to ensure proper and easy operation. Refit, if necessary, all cabinets, wardrobes and shelves hardware, test for proper operation, remove for painting and other finishing and properly replace in position with all fittings and accessories.

All work shall be thoroughly protected from damage at all times by suitable methods approved by the Employer. Adjacent works shall similarly be protected from damage. Any damage or disfigurement shall immediately made good at Contractor's expense.

8.3 The works offered under this item should allow a reasonable choice variation of design / colour, etc., to suit individual taste / needs, i.e. one standard design may not apply to all houses of one type.

8.4 Cabinet work will be coordinated with employer / owner supplied items (if any) such as cooking range etc.

8.5 Kitchen cabinet work, generally all framing will be in treated hardwood with portions' etc., in best quality commercial plywood. All exposed surfaces will be covered by approved laminates. Exposed edges, if any, will be covered by polished hard wood lipping. Where approved counter tops for kitchen will be 1 inch thick selected marble on painted M.S. framing.

Best quality hinges, metallic drawer guides (with bearing) and breakable plastic handles will be used. Samples and shop drawings to be approved by Employer.

8.6 Wardrobes

Wardrobes (and similar works) will be made of deodar wood. Internal partitions will be of high density laminated boards. Shutters will have a (deodar wood) louvered front backed by laminated plywood. All louvers and exposed deodar wood edges / faces will be polished. Best Quality hinges metallic drawer guiders (with bearing) unbreakable plastic handles locks catches etc., will be used. Shoe rack (inside wardrobe) will consist of 13 mm dia (hollow) chrome plated M.S. rods. (Samples and shop drawing to be approved).

9. DEFECTIVE WORK

In the event of non-conformance to specification and drawings, the wood works shall be rejected by the Employer and the Contractor shall remove and replace the rejected work by new work of same specifications.

10. SURFACE PREPARATION

The surfaces of all wood works shall be prepared in the manner as directed by the Employer for polishing and painting.

11. MOCK-UP SAMPLE

After approval of shop drawings and tests etc., the contractor shall submit at his own cost one mock-up sample of each type of wood works complete with all fixing, fixtures accessories prior to the actual fabrication of the bulk.

The samples shall be returned to the Contractor for incorporation in the works after installation of at least 80% of the works.

12. MEASUREMENT & PAYMENT

12.1 General

Except otherwise specified herein or elsewhere in the Contract Documents, no measurement and payment will be made for the under mentioned specified works related to the relevant items of the Bill of Quantities. The cost thereof shall be deemed to have been included in the quoted unit area of the respective/items of the Bills of Quantities.

12.1.1 All finished hardware fittings like locks, handles etc., in carpentry and joinery works.

12.1.2 Prime coat, painting and polish lacquer in carpentry and joinery works.

12.1.3 Anti termite treatment to wood works with solignam oil (clear).

12.1.4 Adhesives.

12.1.5 Wooden hand rail with all accessories with paint and polish etc.

12.2 Wooden Door

12.2.1 Measurement

Measurement of acceptably completed works of all types of wooden doors will be made on the basis of net actual area in square foot fabricated and installed in position as shown on the Drawings or as directed by the Employer.

12.2.2 Payment

Payment will be made for acceptable measured quantity of all types of wooden doors on the basis on unit rate per square foot quoted in the Bill of Quantities and shall constitute full compensation for all the works related to the item.

12.3 Wooden Wardrobes

12.3.1. Measurement

Measurement of acceptably completed works of wooden wardrobes / cabinets / dressers / shelves / seats will be made on the basis of net actual area in square foot of wooden wardrobes / cabinets / dressers / shelves / seats fabricated and installed in position as shown on the Drawings or as directed by the Employer.

12.3.2. Payment

Payment will be made for acceptable measured quantity of wooden wardrobes / cabinets / dressers / shelves / seats on the basis on unit rate per square foot quoted in the Bill of Quantities and shall constitute full compensation for all the works related to the item.

12.4 Kitchen Cabinets

12.4.1 Measurement

Measurement of acceptably completed works of kitchen cabinets will be made on the basis of net actual length in foot of kitchen cabinets provided, fabricated and installed in position as shown on the Drawings or as directed by the Employer.

12.4.2 Payment

Payment will be made for acceptable measured quantity of kitchen cabinets on the basis on unit rate per foot quoted in the Bill of Quantities. The unit shall include all cost of shutters, partitions, shelf, drawers, marblecounter, M.S. angle, deodar wood framing, battens and backing, imported hardware fittings and polishing and shall constitute full compensation for all the works related to the item.

12.5 Wooden Wardrobes

12.5.1. Measurement

Measurement of acceptably completed works of stair case railing will be made on the basis of actual length in foot and provided, fabricated and installed in position as shown on the Drawings or as directed by the Employer.

12.5.2. Payment

Payment will be made for acceptable measured quantity of stair case railing on the basis on unit rate per foot quoted in the Bill of Quantities. The unit rate shall include all cost of teak hand rail M.S. solid balustrade, polishing powder coated paint and shall constitute full compensation forall the works related to the item.

SECTION – 6600

FLOOR AND WALL FINISHES

1. SCOPE

The work under this section of Specifications consists of furnishing all plant, labour, material, appliances and equipment and performing all operations in connection with installing of cement concrete floors and floor finishes including bases, skirting and wainscots, complete in strict accordance with this section of the specifications and the applicable drawings and subject to the terms and conditions of Contract. The scope of this section of specifications is covered with detailed specifications as laid down herein.

2. APPLICABLE STANDARDS

Latest editions of following Pakistan, ISO, British & ASTM standards are relevant to these specifications wherever applicable.

2.1 Pakistan Standard

P.S. 232	Ordinary Portland Cement.

2.2 ISO (International Organization for Standardization)

R 680	Chemical analysis of cements Main constituents of Portland Cement.
R 681	Chemical analysis of cements Minor constituents of Portland Cement.

2.3 ASTM (American Society for Testing and Materials)

C 482	Bond strength of ceramic tile to Portland cement.
C 648	Breaking strength of ceramic tile.
C 650	Resistance of ceramic tile to chemical substances.
C 798	Colour permanency of glazed ceramic tile.
D 2859	Flammability of finished materials vinyl-asbestos tile or flooring.
D 3564	Application of floor polished to maintain vinyl-asbestos tile or flooring.
E 84	Surface burning characteristic of building materials.

F 141 Resilient floor coverings, definitions of terms.

F 510 Resistance to abrasion of resilient floor coverings.

2.4 BSI (British Standard Institutions)

882 Pt. 2 Course and fine aggregates from natural sources.

1199 Sands for external renderings, internal plastering with lime and Portland cement and floor screed.

1201 Pt. 2 Aggregates for granolithic concrete floor finishes.

Glazed ceramic tiles and tiles fitting for internal walls.

1286 Clay tiles for flooring.

5442 Classification of adhesives for use in Construction Pt-1 Adhesives floor use.

203 Tile flooring.

204 In-situ Floor Finishes.

209 Pt. 1 Care and Maintenance of floor surface, wooden flooring.

3. MATERIAL

3.1 Cement

Cement shall be ordinary Portland cement conforming to B.S. 12 or PS 232.

3.2 Sand

All fine sand shall be obtained from sources approved by the Employer. The grading shall conform to B.S. 882 Grading Zone1 and 2 of which the gradation limits are as follows:

Percentage (by weight) passing

B.S. Sieve	Grading Zone 1	Grading Zone 2
3/8” (9.53mm)	100	100
3/16” (4.765mm)	90-100	90-100
No. 7	60-95	75-100
No. 14	30-70	55-90
No. 25	15-34	35-59
No. 52	5-20	8-30
No. 100	0-10	0-10

3.3 Coarse Aggregate

Coarse aggregate shall be crushed or uncrushed gravel or crushed stone, angular or rounded in shape and shall have granular, crystalline or smooth surface free from friable, flaky and laminated pieces, mica and shale. It shall not contain matter injurious to concrete. All coarse aggregate shall conform to BSS NO. 882 and shall be graded as follows:

B.S. Sieve	% Passing by weight
1" (25.40 mm)	100
3/4" (19.05 mm)	90-100
3/8" (9.53mm)	20-55
3/16" (4.765mm)	0-10

The aggregate shall be stored on properly constructed paving or as directed by the Employer.

There shall be a physical partition between the stockpiles of coarse and fine aggregate. If required aggregate shall be washed and screened to the satisfaction of the Employer. Sieve analysis of the aggregates to be used in the works shall be carried out as and when required by the Employer. All aggregate shall be subject to the approval of the Employer.

Any aggregate not found to be of the specified / approved standard shall be rejected by the Employer and all such rejected material shall be removed from sitewith-out delay.

Floors, sub-base or base constructed with rejected aggregate shall be dismantled and rebuilt at the expense of the Contractor.

3.4 Not Used

3.5 Water

Water used for mixing concrete, curing or any other operation of the works specified herein shall be fresh, clean and free from organic or inorganic matters in solutions or in suspension. Only water of the approved quality shall be used for all constructional purposes:

3.6 Quarry Tiles

Quarry tiles shall be local best quality of size as per drawings. The thickness and colour shade shall be as per sample approved by the Employer. These tiles shall conform to BS 1281.

3.7 Porcelain Tiles

Porcelain tiles shall be imported, approved quality & size as per drawings. The thickness and colour shade shall be as per sample approved by the Employer, the tile shall conform to BS 1281.

3.8 Ceramic Tiles

Ceramic tiles shall be local, best quality white or any / other colour. The size of tiles shall be approved by the Employer, and shall conform to BS 1281 as per samples. The Employer can select different colour and designs of the approved tiles for use in different locations and houses so that a reasonable variety can be offered to owners of different house.

3.9 Terrazzo Tiles

Terrazzo tiles shall be first grade mechanically compressed type conforming to PS-531. Tiles shall be of sizes specified on the drawings with a topping of 10mm thickness composed of 1:2 cement marble chips, the base being 1:2 cementmortar. The colour quality and size of chips shall be as per Employer's direction.

3.10 Cleaning Compound

The compound used for all cleaning of terrazzo shall be an approved neutral chemical cleaner free from acid and alkali or any other material that will affect the colour or otherwise damage the terrazzo and shall not affect the conductivity of terrazzo floors.

3.11 Vitrified Clay Tiles

Vitrified clay tiles shall be first quality of local manufacturer approved by the Employer. The size shall be as approved by the Employer.

4. CEMENT CONCRETE FLOORING

The materials for C.C. flooring shall be same as already specified under clause-2, "Materials".

4.1 Composition of Concrete

Concrete shall be composed of Portland Cement, sand, coarse, aggregate and water, all well mixed and brought to the proper consistency. The Contractor shall mix the ingredients as indicated on the Drawings. The proportions of the various ingredients shall be determined from time to time during the progress of the work and tests shall be made of samples of the aggregate and the resulting concrete. The mix proportions and appropriate water-cement ratio will be determined on thebasis of the production of concrete having required workability, density, impermeability, durability and required strength.

4.2 Mixing Concrete

The concrete ingredients shall be mixed in a batch mixer for not less than 1-1/2 minutes after all ingredients, except the full amount of water, are in the mixer. The Employer reserves the right to increase the mixing time when the Charging and mixing operations fail to produce a concrete batch in which the ingredients are uniformly distributed and the consistency is not uniform.

The concrete shall be uniform in composition or consistency from batch to batch except when changes in composition or consistency are required. Water shall be added prior to, during and following the mixer charge. Excessive over mixing requiring addition of water to preserve the required concrete consistency will not be permitted. The concrete ingredients shall be mixed by volumetric measurement in purpose made boxes approved by the Employer.

4.3 Construction

The base coarse of the floor shall comprise of brick ballast of 2 inches (approx: 50 mm) mesh size. The base coarse shall be thoroughly compacted by suitable power rammers to the total consolidated thickness as shown on the Drawings and as approved by the Employer. The interstices shall be filled with smaller size brick. The base coarse shall be blinded with sand and the whole surface watered. Over the well compacted base coarse, a layer of concrete of the required grade and thickness shall be laid, in panels of the sizes as indicated on the Drawings and as approved by the Employer.

After the C.C. bed has been cured, as directed by the Employer, it shall be roughened and well watered before floor finishing is laid. The floor finish shall comprise of cement concrete of required grade and shall be laid in panels to the required thickness as shown on the Drawings or as directed by the Employer. The concrete after laying will be thoroughly rammed and mortar worked up to the top and smoothed with a steel trowel. The edge of each section into which the floor is divided should be defined by wooden screeds of the approved width and of a depth equal to the depth of the floor concrete.

Freshly placed concrete floor and completed floor portions as finished shall be protected to prevent loss of water by covering with damp Hessian, water proof paper, damp sand or other approved material, and shall be kept constantly damp for a period of four days or longer after concreting as directed by the Employer. The concrete shall be allowed to dry out slowly over a period of three days after wet curing is completed.

5. INSTALLATION OF TILE FLOORING

The contractor should note that all tiles before installation should be sorted out in a proper way acceptable to the Employer, no under / over sized and damaged tile should be used.

When setting out the tiles, care shall be taken to establish the correct elevation for the floor. A gauge rod shall be used, indicating the overall measurement of a given numberof tiles with specified joint width to reduce cutting.

After the floor has been machine finished, it should be covered with white, non-staining sand or rags to protect it while other work is being done. After removal, the floor shall be thoroughly scrubbed.

5.1 General

The base shall be prepared by laying cement concrete of specified grade and of thickness as shown on the drawings, or specified in the Bill of Quantities.

The curing period of the setting bed shall be as directed by the Employer. As large an area of setting bed shall be spread at one time as can be covered with tiles before the mortar has set. Surplus mortar shall be removed. The thickness of setting bed in any space shall not be less than 12.5 mm.

Floor and wall surfaces to receive the tiles shall be thoroughly cleaned of all dirt, dust, oil and other objectionable matters. Tiles shall be laid out from the centre line of each space in an outward direction and the pattern should be made symmetrical with a minimum number of cut tiles.

Joints between the tiles shall be of uniform width. Tiles shall be cut with a suitable cutting tool and rough edges shall be rubbed smooth. Tiles shall be laid tothe straight edges.

5.2 Terrazzo Tiles

The terrazzo tiles will be laid to the required lines, levels and graded over asetting bed of cement sand mortar comprising of 1 part of cement and 4 parts of sand by volume. The thickness of cement concrete shall be as per Bill of Quantities.

After seven days, the terrazzo tile floors shall be machine ground to a true even surface using various grades of abrasives stones, as required and directed by the Employer. After the first grinding the floor shall be grouted with the same colour composition as used for its manufacturer. The grout shall be of the consistency of thick cream and shall be brushed over the floor to fill in the joints and after 72 hours the grouting coat shall be removed by grinding till a smooth and even surface is obtained. Areas and portion of the floor inaccessible for the grinding machine shall be ground and rubbed by hand. The final gloss shall be given by polishing the surface to the satisfaction of the Employer.

5.3 Ceramic Tiles

The ceramic tiles shall be laid to the required lines, levels and grades over a setting bed of cement sand mortar comprising of one part of cement and 4 parts ofsand by volume and the joints filled with neat white or grey cement including vertical and horizontal covers. The tile floor shall be kept wet for at least 72 hoursand no traffic should be allowed on the tiles during curing period.

5.4 Quarry Tiles

The quarry tile shall be laid to the required lines, levels and grades over a setting bed of cement sand mortar comprising of 1 part of cement and 4 parts of sand by volume.

The sides shall be buttered with cement mortar with adjacent tiles laid in the same manner in the required pattern, with a thin joint in proper level and line. The joints shall then be thoroughly cleaned with wire brush and pointed with neat cement of the same colour as the tile.

Care shall be taken to see that full tiles are used as far as possible. Where this isnot possible, the edge tile shall be neatly cut with an electric saw and the edges rubbed smooth. In case of patterned tiles, the tiles shall be laid in such a way that the pattern ends symmetrically on two sides.

Quarry tiles shall be cured for 7 days with water and then thoroughly cleaned and dried. Notwithstanding anything written above, the manufacturer's printed instructions regarding laying shall be strictly followed.

5.5 Cement Concrete / Vitrified Tiles / Porcelain Tiles

The cement concrete and vitrified clay tile / porcelain tiles shall be laid to the required, lines, levels and grades over a setting bed of cement sand mortar comprising of 1 part of cement and 4 parts of sand by volume.

6. TERRAZZO FLOORING CAST IN SITU

5.6 Mix

The terrazzo mixes be composed by weight as follows:

Plain terrazzo for all floors and bases indicated at terrazzo and not otherwise specified, shall be composed of one part cement, white or grey, and 2 parts of marble chips of the sizes and colours hereinafter specified.

5.7 Preparation for Terrazzo

The grade and thickness of concrete as shown on the Drawings shall be laid as underbed to receive terrazzo. The surface of the bed shall be roughened for bounding with the terrazzo finish. If the surface is too smooth it shall be roughened with a toothed chisel and, prior to laying the terrazzo the bed shall be cleaned of all dirt, oil grease and extra loose material.

5.8 Division Strips

Terrazzo floors and bases shall be divided by glass or aluminum strips. The division strips between field work and borders shall have exposed tops in full width of the strips. The division strips shall be set immediately after the spreading of the underbed. The strips being partially embedded therein, securely anchored tothe sub-floor and grouted solid.

All division strips shall be ste, straight to lines and to the proper level to ensure that the tops of the strips will show uniformly after grinding and smoothening operations are completed and joints and intersections shall be fitted tight. Strips shall be braced to prevent bulging during the placing of terrazzo.

Unless otherwise shown on the drawings, the divisions in field work of large areas shall not exceed 3 feet x 3 feet and in small areas shall not exceed 24 inch x 3/8 inch.

Edging strip shall be placed at door ways between terrazzo and types of flooring and along the edges of all terrazzo bases or borders and adjoining other types of floor finishes or floor covering. The edging strips at door ways shall be placed in line with the step face of doors. All edging strips shall be anchored and grouted solid in the underbid or to the concrete sub-floor and braced to prevent bulging as specified for division strip.

5.9 Laying Terrazzo

The sub surface shall be swept clean, thoroughly moistened, but not saturated, and slushed with a coating of neat cement grout approximately 3.5 mm in thickness. The underbid consisting of class 'C' cement concrete screed shall be spread and brought to a level not less than 25 mm below the finished floor level. The dividing strips shall be installed in the green underbid. The terrazzo mix shall be spread, tamped and rolled into a compact mass not less than 25 mm thick. After the rolling additional aggregate mix shall be sprinkled over the surface to fill up all depressions, to take up excess moisture and to permit the terrazzo to be trowel led to a level, dense and even surface, slightly above the finish line of floor. This level, shall allow for the surface grinding necessary to expose the specified area of aggregate, and to produce smooth, level floors free of waves and depressions.

Seasoning

The completed terrazzo shall be allowed to season for 6 days during which time it shall be kept moist and free of traffic. The curing shall be accompanied by (1) covering with approximately 25 mm thickness of sand; or (2) covering with building paper of mats; or (3) sprinkling with water at every 10 hour interval.

Surface

Following the curing period, the terrazzo shall be machine ground to a true, even surface using a No. 24 grit followed by a No. 80 grit or finer abrasive stone. After the first grinding, the floors shall be thoroughlygrouted with the same cement and colour composition as specified for the matrix of the terrazzo mix. The grout shall be of the consistency of thick cream, and shall be brushed over the floor to eliminate all pits and thoroughly fill the surface for final grinding.

Finishing

Not less than 72 hours after application, the grouting coat shall be removed by grinding. In the later stages of grinding, the grid stones or other abrasive used in the grinding machine shall be of a grain or fineness that will give the surface smooth finish. Small areas, inaccessible portions and corners which cannot be reached by the grinding machine shall be ground and rubbed by hand.

Protection

The walls and all surfaces of the finished work of other trades shall be properly protected from damage and spoiling during the process of grinding and washing of the terrazzo. After the finish grinding has been completed and the surface treatment applied, the terrazzo work shall be covered and protected with material approved by the Employer until completion of work of all other trades.

Cleaning and Coating

Prior to placing the protective covering, the terrazzo floor shall be approved by the Employer. After the work of all other trades has been completed and the protective covering removed, all terrazzo work shall be washed with cleaning compound, mixed with warm water and using a fine abrasive where necessary to remove any stains or cement smears. Theterrazzo shall be allowed to dry thoroughly and shall be given a sealing application of preservative material. The sealing material shall be applied in accordance with the manufacturer's directions, leaving all terrazzo work in clean condition as approved by the Employer.

Dado / Skirting

The ingredients of dado / skirting shall be one part of cement and two parts of marble chips varying from Nos. zero to 2. Skirting shall be laid over a base of plaster of specified thickness. The thickness of dado / skirting layer shall be as specified. The surface shall be grinded and polished to the satisfaction of the Employer.

7. MEASUREMENT AND PAYMENT

General

Except otherwise specified herein or elsewhere in the Contract Documents, no measurement and payment will be made for the undermentioned specified works related to the relevant items of the Bill of Quantities.

The cost thereof shall be deemed to have been included in the quoted unit rate of the respective items of the Bill of Quantities.

Loss and wastage of material due to consolidation, erosion and settlement.

All types of joints (expansion, contraction and construction joint etc.).

Class 'C' cement concrete screed base and 1:4 cement sand setting mortar.

Finishing, washing and polishing works of ceramic, quarry, terrazzo, vitrified tiles / porcelain tiles.

Non metallic floor hardener for hardened floor.

Water proofing agent for water proof cement concrete floor.

1:4 cement sand rough cast plaster.

Cement Concrete Floor

Measurement

Measurement of acceptably complete works of cement concrete floor steel trowelled finish will be made on the basis of net actual area in square foot laid in position as shown on the Drawings or as directed by the Employer.

Payment

Payment will be made for acceptable measured quantity of cement concrete floor steel trowelled finish on the basis of unit rate per squarefoot quoted in the Bills of Quantities and shall constitute full compensation for all the works related to the item.

Ceramic Tile Floor

7.3.1 Measurement

Measurement of acceptably completed works of ceramic tile in floor will be made on the basis of net actual area in square foot of floor laid in position as shown on the Drawings or as directed by the Employer.

Payment

Payment will be made for acceptable measured quantity of ceramic tile floor on the basis of unit rate per square foot quoted in the Bills ofQuantities and shall constitute full compensation for all the works related to the item.

Ceramic Tile Dado

7.4.1 Measurement

Measurement of acceptably completed works of ceramic tile in dado will be made on the basis of net actual area in square foot of dado laid in position as shown on the Drawings or as directed by the Employer.

Payment

Payment will be made for acceptable measured quantity of ceramic tile in dado on the basis of unit rate per square foot quoted in the Bills of Quantities. The unit rate shall include all cost of cement, sand, mortar backing and polished teak wood beading and shall constitute full compensation for all the works related to the item.

Terrazzo Tile in Floor / Terrazzo Cast in Situ Floor

7.5.1 Measurement

Measurement of acceptably completed works of terrazzo tile in floor, respectively will be made on the basis of net actual area in square foot of floor, riser and tread laid in position as shown on the Drawings or as directed by the Employer.

Payment

Payment will be made for acceptable measured quantity of terrazzo tiles in floor, on the basis of unit rate per square foot quoted in the Bills of Quantities and shall constitute full compensation for all the works related to the item.

Vitrified Clay Tile Floor / Porcelain Tile

7.6.1 Measurement

Measurement of acceptably completed works of vitrified clay tile / porcelain tile in floor will be made on the basis of net actual area in square foot of floor laid in position as shown on the Drawings or as directed by the Employer.

Payment

Payment will be made for acceptable measured quantity of vitrified clay tiles / porcelain tile in floor on the basis of unit rate per square foot quoted in the Bills of Quantities and shall constitute full compensation for all the works related to the item.

Terrazzo Skirting / Terrazzo Threshed / Clay Tile Skirting

7.7.1 Measurement

Measurement of acceptably completed works of Terrazzo skirting / terrazzo threshed / clay tile skirting will be made on the basis of net actual length in running foot provided and laid in position as shown on the Drawings or as directed by the Employer.

Payment

Payment will be made for acceptable measured quantity of Terrazzo skirting / terrazzo threshed / clay tile skirting on the basis of unit rate per running foot quoted in the Bills of Quantities and shall constitute full compensation for all the works related to the item.

SECTION – 6700

PAINTING

1. SCOPE

The work under this section of Specifications consists of furnishing all materials, plant, labour, appliances and equipment and performing all operations in connection with surface preparation, mixing, painting concrete works, gates, frames, walls, ceiling and all such surfaces as shown on the Drawings and / or as directed by the Employer. The scope of this section of specifications is covered with detailed specifications as laid down herein.

2. APPLICABLE STANDARDS

latest editions of following British Standards are relevant to these specifications wherever applicable.

BSI (British Standards Institution)

Specification for mineral solvents (white spirits and related hydrocarbon solvent) for paints and other purposes.

Lead based priming paint for wood work.

Lead based priming paint for iron and steel.

Sprayed metal coatings.

Paint colour for building purposes.

CP. 231 Painting of building.

CP. 3012 Cleaning and preparation of metal surfaces.

3. GENERAL

Except as otherwise specified, all painting shall be applied in conformity with BS CP 231 “Painting of Building” as applicable to the work.

The Contractor shall repair at his own expense all damaged or defective areas of shop-painted metal work and structure steelwork. Metal surfaces against which concrete is to be placed will be furnished shop-painted and shall be cleaned prior to being embedded in concrete.

Except as otherwise specified, all concrete and plastered surfaces are to be painted.

The Employer will furnish a schedule of colours for each area and surface. All colours shall be mixed in accordance with the manufacturer's instructions.

Colours of priming coats (and body coat where specified, shall be lighter than those of finish coat). The Employer shall have unlimited choice or colours.

Samples of all colours, and finishes shall be prepared in advance of requirement so as to delay work and shall be submitted to the Employer for approval before any work is commenced. Any work done without such approval shall be redone to the Employer's satisfaction, without additional expense to the Employer. Samples of each type of paint shall be on separate 300 x 300 x 3 mm tempered hard board panels. Manufacturer's colour chart shall be submitted for colour specifications and selection.

4. MATERIALS

All materials shall be acceptable, proven, first grade products and shall meet or exceed the minimum standards of reputable manufacturers as approved by the Employer.

Colours shall be pure, non-fading pigments, mildew-proof sun-proof, finely ground in approved medium. Colours used on – plaster and concrete surfaces shall be lime-proof. All material subject to the Employer's approval.

Approved quality distemper paint shall be used for painting where specified on the drawings as directed by the Employer.

The plastic emulsion / weather shield paint similar as approved by the Employer shall be used where specified on the drawing as directed by the Employer.

All material shall be delivered to site in their original unbroken containers or packages and bear the manufacturer's name, label, brand and formula and will be mixed and applied in accordance with his directions.

5. DELIVERY STORAGE AND CONTAINER SIZES

Paint shall be delivered at site in sealed containers which plainly show the type of paint, colour (formula or specifications number) batch number, quantity, and date of manufacture, name of manufacturer and instruction for use. Pigmented paints shall be supplied in containers not larger than 20 liters. All materials shall be stored under cover in a clean storage space which should be accessible at all times to the Employer. If storage is allowed inside of the building, floors shall be kept clean and free from paint spillage.

6. SURFACE PREPARATION

All oil, grease, dirt, dust, loose mill scale and any other foreign substance shall be removed from the surface to be painted, polished and white washed by the use of a solvent and clean wiping material. Following the solvent cleaning. The surfaces shall be cleaned by scraping, chipping, blasting, wire brushing or other effective means as approved by the Employer.

In the event of surfaces become otherwise contaminated in the interval between cleaning and painting, recleaning will be done by the Contractor at no additional cost.

All the surfaces to be painted with approved quality Weather Shield paint or approved equivalent shall be free from dust, dirt, fungus, lichen, algae etc. Oil paint, varnish and lime wash should always be removed by scraping and washing.

7. APPLICATION

7.1 All paint and coating materials shall be in a thoroughly mixed condition at the time of application. All work shall be done in a workman like manner, leaving the finished surface free from drips, ridges, waves, laps and brush marks. All paint shall be applied under dry and dust free conditions. Unless approved by the Employer paint shall not be applied when the temperature of the metal or of the surrounding air is below 7 degrees centigrade. Surfaces shall be free from moisture at the time of painting.

All primary paint (Alkali Resistance) shall be applied by brushing. The first coat of paint shall be applied immediately after cleaning. When paint is applied by spraying, suitable measures shall be taken to prevent segregation of the paint in the container during painting operation.

Effective means shall be adopted for removing all free oil and moisture from the air supply lines of the spraying equipment.

Each coat of paint shall be allowed to dry or harden thoroughly before the succeeding coat is applied. Surfaces to be painted that will be inaccessible after installation shall be completely painted prior to installation.

Two coats of weather shield paint shall be applied over a prime coat according with the manufacturer’s instructions or as directed by the Employer.

Only as such material should be mixed as can be used up in one hour. Over-thinning will not be permitted. After the first coat the surfaces will be soaked evenly four or five times and the second coat shall be applied after leaving for at least overnight.

7.2 Where shown on Drawings all exterior finishes shall be painted with Weather Shield paint in approved colours as per manufacturer's specifications. The number of coats shall be as mentioned in the Bills of Quantities.

7.3 Plastic emulsion paint of the approved make and shade shall be applied to surfaces as shown on Drawings. The number of coat shall as indicated in the Bills of Quantities.

7.4 Polyvinyl Distemper of the approved make and shade shall be applied to surfaces as shown on Drawings. The number of coats shall be as mentioned in the Bills of Quantities.

7.5 Polishing

After fine sanding by a skilled operator, one coat of clear polish should be rubbed in by hand using a cloth or pad, be allowed to dry and buffed up with worn fine sand paper or steel wool to remove raised grain. A second coat of clear polish should then be applied.

8. JOB CONDITIONS

Observe manufacturer's recommended minimum and maximum temperature but do not apply paint or finish to any surface unless ambient temperature is 10 degree C or above or less than 43 degree C. No painting shall be done above 90% relative humidity.

Place drop cloths to adequately protect all finished work.

Remove and replace all items of finish hardware, device plates, accessories, lighting fixtures or other removable items.

In no case shall any finish hardware or other finished item that is already fitted into place be painted, unless otherwise specified.

9. QUALITY ASSURANCE

All paint for any one surface shall be top quality, of one manufacturer and approved by the Employer. Deep tone accent colours shall be used and the unavailability of final coat colours may be the basis for rejecting materials for any one surface.

10. SCHEDULE OF MEASUREMENT OF PAINT AREA

10.1 Irrespective of prime coats and number of paint coats applied to exposed painting surface area of column, walls, projections; ceilings and other surfaces (Except gates, doors windows and ventilators) shall be measured as per actual paintsurface area for single time only and paid in accordance with quoted rate of Bill of Quantities.

11. MEASUREMENT AND PAYMENT

General

Except otherwise specified herein or elsewhere in Contract Documents, no measurement and payment will be made for the under mentioned specified works related to the relevant items of the Bill of Quantities. The cost thereof shall be deemed to have been included in the quoted unit rate of the respective items of Bill of Quantities.

11.1.1 Preparatory works, including preparatory materials, scraping, scratching, and blasting, cleaning, priming, protection of finished works etc.

Painting

Measurement

Measurement of acceptably completed respective type of painting works will be made on the basis of net actual areas in square foot of the surface painted as shown on the Drawings or as directed by the Employer.

Payment

Payment will be made for acceptable measured quality of respective type of painting on the basis of unit rate per square foot quoted in the Bill of Quantities and shall constitute full compensation for all the works related to the item.

White Wash

Measurement

Measurement of acceptably completed works of white wash to interior surfaces will be made on the basis of net actual areas in square foot of the surface applied with white wash as shown on the Drawings or as directed by the Employer.

Payment

Payment will be made for acceptable measured quality of white wash to interior surfaces on the basis of unit rate per square foot quoted in the Bills of Quantities and shall constitute full compensation for all the worksrelated to the item.

Bituminous Coating / Painting

Measurement

Measurement of acceptably completed works of bituminous coating / painting to all exposed concrete surfaces in contact with earth will be made on the basis of net actual areas in square foot of the surface painted as shown on the Drawings or as directed by the Employer.

Payment

Payment will be made for acceptable measured quality of bituminous coating / painting paint to all exposed concrete surfaces in contact with earth on the basis of unit rate per square foot quoted in the Bills ofQuantities and shall constitute full compensation for all the works related to the item.

SECIFICATION

ELECTRICAL WORKS

TECHNICAL SPECIFICATIONS

CONTENTS

SECTION - 16010
BASIC ELECTRICAL REQUIREMENTS

1. SCOPE

The work shall include furnishing all materials, labour, plant, and supporting services for the complete supply, installation, testing and commissioning of:

a) RCC pipes, cable ducts, and other raceway for power & communications systems

b) Earthing & bonding

c) MV & LV Cables

d) Distribution switchgear

e) Interior lighting, fans & fixtures

f) External-lighting

g) Uninterruptable Power Supply System

h) Voice/Data Structured Cabling System

i) Fire Alarm System

j) Public Address System

k) CCTV System

l) Testing and commissioning of the entire electrical system.

The Contractor shall be responsible for providing within his bid price any additional equipment and or make modifications in the electrical equipment/material to suit the requirement of the equipment offered by him for ensuring proper operation of the system as approved by the Employer.

The Contractor shall ensure all necessary co-ordination with the works of other Contractor and shall be responsible for any loss or damage caused due to his fault or negligence, and shall rectify the same at his own cost.

All allied and small works and materials, even if not specifically mentioned in the specifications and BOQ but required for completeness of the job, shall be deemed to have been included in the contract/BOQ.

2. GENERAL

a) Electrification work shall be carried out by a licensed Electrical Contractor, in conformity with the 16th Edition of the UK IEE "Regulations for Electrical Installations", the "Electricity Act, 1910", the "Electricity Rules, 1937", in accordance with the requirements of the local Electric Inspector of the WAPDA & to the satisfaction of the Project Engineer/Employer.

b) It shall be the responsibility of the Contractor to serve notices on, submit documents to, and to have the installation passed by the relevant Authorities, and obtain all necessary approvals and sanctions at no extra cost to the Employer. Official fees for electrical inspections and approvals shall be paid by the Contractor at actuals.

The Contractor shall take care not to damage the existing structures, services and equipment during execution of work. If so done, he shall repair and make good all losses at his own cost. The cost of any civil work (cutting, chasing, welding, plinths, foundations, excavation, back-filling, connecting, grouting, shoring, de-watering, making good, etc.) associated with any item of the electrical works shall be included in the quoted price for the electrical item.

c) The Contractor shall take extreme care in maintaining proper supply where required to all working areas during the installation period, so there is no disruption in the Employer's working schedule. All the above shall be done at no extra cost.

d) The Employer will supply the required drawings, installation manuals, technical data, and instructions as received from the manufacturers of any Owner supplied equipment. However, the Contractor shall take full responsibility of technically correct handling, installation, testing and commissioning of the equipment, whether or not the manufacturer's instructions are made available to him with the delivered equipment.

e) It shall be presumed that the spaces and access shown in the tender drawing are adequate and proper for the equipment to be supplied by the Contractor, unless so notified by the Contractor at the time of submission of the bid.

3. ELECTRICAL SERVICE CONNECTION

It shall be the Contractor's responsibility to file all applications and give all notices to the power supply authority (WAPDA) for provision of the electrical load required as a result of this work and to seek quotation for installation, furnishing & connection of the required electrical power complete in all respects, well in time so as not to delay the testing, commissioning and utilisation of the building. Official receipted expenses and costs shall be paid by the Contractor at actuals.

All requirements of the WAPDA will be determined by the Contractor at an early stage, and any equipment provided by him will be deemed to be in line with the WAPDA's requirements. Space and access for WAPDA -related equipment shall be determined and defined by the Contractor at an early stage to facilitate construction of the sub-station spaces.

When the installation is complete, the Contractor shall intimate the power supply authority and make such tests as required by them to demonstrate conformance with the regulations prior to their connection to the installation. The extent of work specified represents the minimum requirements and includes

energisation of the building electrical loads. The extent of the work shall extended as required to include, at no increase in cost to the Contractor the compliance & fulfilment of all requirements of the local power supply authority for an installation of this type.

4. MATERIALS AND WORKMANSHIP

All materials, equipment, accessories, fixtures & fittings shall be new of latest model and in accordance with specifications of the British Standards Institute, International Electrotechnical Commission and Pakistan Standards Institute. A manufacturer's written guarantee, valid for at least 18 months from date of delivery or 12 months from the date of commissioning, shall be supplied for all equipment. Samples & detailed manufacturer's shop drawings (including dimensional plans, elevations, sections, line and wiring diagrams, foundation details, component characteristics and data, etc.) shall be approved by the Project Engineer/Employer before purchase or fabrication. Routine tests at the manufacturer's works shall be witnessed by the Employer, and test certificates (in duplicate) shall be provided to him. Three copies of the manufacturer's operating instructions and technical literature, bound into a Maintenance Manual, along with the "as-built" drawings, shall be supplied free of cost by the Contractor.

All workmanship shall be first class, and undertaken by licensed workmen, skilled in the particular type of craft. For specialised systems (voice/data, fire-alarm, PA), installation and commissioning shall be undertaken under the supervision of an engineer trained at the respective manufacturer's factory.

The Contractor shall provide "Danger Boards" on all panels and "Shock Charts" wherever required to comply with the requirements of Electricity Rules at no cost to Employer.

The cost of all civil works associated with any item of electrical works, shall be included in the bid price for electrical works. No separate payment for such works will be made.

All microprocessor based systems shall (hardware plus software) shall be year 2002 compliant.

5. SHOP DRAWINGS/AS-BUILT DRAWINGS

The Contract Drawings are schematic and are intended to enable the Contractor to prepare his estimate and submit a tender.

Checking of the Contractor's Shop Drawings by the Engineer, shall not relieve the Contractor of his responsibility for compliance with the design intent, co-ordination or with any other obligations and requirements under the Contactor.

The Contractor shall allow in his Tender for providing:

Shop Drawing:
2 – copies of shop drawing for preliminary checking by Employer
4 – copies of finally approved shop drawing for onward transmission

As-Built Drawing
2 – copies of As-built drawing for preliminary checking by Employer
4 – copies of finally approved As-built drawing + reproducible drawing for onward transmission

All drawings prepared by suppliers, manufacturers and/or Contractors shall be endorsed with the Contractor's own name title block and drawing number and the Contractor shall take full responsibility for such drawings in accordance with his obligations under the contract.

Sample & detailed manufacturer's shop drawings (including dimensional plans, elevations, section, line and wiring diagrams, foundation details, component characteristics and data, etc.) shall be got approved by the Project Engineer/Employer before purchase or fabrication.

6. CLIMATIC CONDITIONS

Equipment and materials supplied shall withstand, under all conditions of continuous operation and without developing any defects, the following environmental conditions:

Region	Max. Temp. °C	Min. Temp. °C	Max. Relative Humidity %	Altitude (above Sea Level) m
Islamabad	42	3	90	591
Karachi	40	9	83	4
Lahore	42	3	90	214
Peshawar	42	1	87	355
Quetta	35	-7	80	1580
D.I.Khan				

7. EQUIPMENT PROTECTION

Unless otherwise noted, all equipment supplied shall conform, as a minimum, to the following protection classes, in accordance with BS 5490:

Indoor	IP 40
Outdoor	IP 54

With the exception of material specified to be hot-dip galvanised (after fabrication), or otherwise specified, all metal work (steel conduit and accessories, outlet and pull boxes, trunking, straps, brackets, hangers, frames, etc.) shall be given a protective treatment consisting of degreasing, derusting, two coats of zinc-chromate/ red-lead primer, and resin-bonded powder coat finish (70µm thickness, 150µm on edge) during manufacture. After installation on site, any damaged metal work shall be given another coat of paint. Painting of steel conduits shall be to BS 1710 for colour coding purposes.

All metal-work located outside buildings shall be protected against corrosion by a hot-dip galvanised coating, to BS 729, before installation.

8. STANDARDS AND TYPICAL DESIGNS

The specification either cites or implies British/IEC Standards. Other comparable European and U.S. Standards and typical designs are acceptable, providing that they in no way detract from the quality, safety, operability, or durability of the equipment and material furnished. However, when other standards or typical designs other than those cited or implied are offered by the Contractor, he shall set these forth in detail in his proposal.

9. ABBREVIATION FOR STANDARDS

The standards, codes of practice and recommendations of the following Societies or institutions have either been used in the specification and or cited here as a general level of quality for equipment, material and workmanship.

Abbreviations for international institutions are given below:

International Electrotechnical Commission	IEC
European Committee for Standardisation	CEN
International Standards Organisation	ISO

Abbreviations for some European/US societies & standards institutions are as follows:

Association Francaise de Normalisation, France	AFN
British Standard Institution, UK	BSI
Dentsches Institute fur Normung, Germany	DIN
Institution of Electrical Engineers, UK	IEE
Chartered Institution of Building Services Engineers, UK	CIBSE
Electronic Industries Association, USA	EIA
Telecommunication Industries Association, USA	TIA
Building Industry Consulting Services International, USA	BICSI

Abbreviations for Pakistani institutions are given below:

Pakistan Standards Institution	PSI
Water and Power Development Authority	WAPDA
Pakistan Telecommunications Company Ltd	PTCL

10. TESTING & COMMISSIONING

Stage wise testing of the installation shall be carried out at site before/after commissioning of equipment and shall include the following as a minimum:

a) Polarity test for switches, MCB's, MCCB's and fuses

b) Earthling resistance tests, and earth loop resistance tests

c) Megger tests, on switchgear and cables

d) Tests as specified for special electrical systems.

e) The control systems shall be tested for correct operation by trial run and simulation of all operating and fault conditions.

f) All routine tests on equipment shall be performed at the manufacturer's works in the presence of the Employer or his representative prior to delivery of equipment. Test results and certificate shall be provided in triplicate, to the Employers.

g) Operation, testing and commissioning of the entire installation.

h) Copies of final test reports and values shall be provided to the Project Engineer/Employer in triplicate.

11. EXTRA WORK:

a) Written approval from the Employer shall be obtained before any extra/additional work is carried out.

b) Rate analysis of extra item is to be prepared and enclosed, (on the basis of cost plus twenty percent overheads, profit, etc.) with the bills.

12. SAFETY PROGRAM

a) The Contractor shall strictly follow at his own cost the Safety Programme outlined below and such additional measures as the Engineer or Engineer's representative may determine to be reasonably necessary.

i) Prior to commencement of work the successful Contractor shall submit safety programme for discussion with the Employer and the Engineer.

ii) The Contractor shall prepare a plan of the Works' Site to assure that storage areas for materials and equipment are located on the project/work site for maximum efficiency. This plan will be subject to the approval of the Engineer.

iii) Activities between different operations and different crafts will be co-ordinated.

iv) The Contractor shall lay out and provide an efficient access system with information and directional signs posted as necessary.

v) All employees will be instructed on safe work method.

vi) The Contractor shall advise all his supervisory staff of their responsibility for the prevention of injury to persons or damage to property or equipment in their respective areas of supervision.

vii) Safety will be included in all job planning. This will include providing safe construction equipment and vehicles, protective equipment necessary for protection of workmen, and establishing methods for safe operation.

viii) Good housekeeping will be maintained at all times.

ix) Scaffolds, ladders, ramp", runways etc. will be constructed properly and maintained in safe conditions.

x) Ample fire protection will be provided and fire hazards guarded, by the Contractor.

xi) Adequate lighting, ventilation etc. will be provided as necessary, by the Contractor.

xii) Equipment will be properly and regularly inspected and maintained by the Contractor to the satisfaction of the Engineer.

xiii) The Contractor will assign to his employees only such duties as are within their physical and mental capabilities.

xiv) The Contractor will hold monthly meetings with his supervisory staff and the man incharge at the lower level will hold safety meetings of 10 to 15 minutes with his crew each week.

xv) First Aid facilities will be provided at job sites, the services of doctors and hospitals made available, and all supervisors instructed in handling of injured employees.

xvi) Adequate toilet facilities will be provided, maintained in a hygienic condition and their use enforced by the Contractor.

b) Accident reports will be furnished to the Engineer for onward transmission to the Employer within 2 days of the reported accident.

Copies of the safety programme will be supplied by the Contractor to the Engineer and will be promptly posted in all offices in use of projects/works under this Contract.

c) At all construction sites the following instructions shall be followed:

- availability of safety (hard) hats, which should be worn by anyone visiting or working within the designated work area
- controlled entry to the designated work area
- proper distribution of temporary electric power (use of RCDs/ELCBs, switch gear, cabling, socket outlets)
- proper guarding of shafts, stairs and floor edges up, to a height of 42".
- proper access stairs and ladders with handrails
- properly demarcated passageways, which are kept clear of materials, equipment, and rubbish
- daily cleaning of debris and rubbish from the site
- adequate temporary lighting
- proper housekeeping to reduce slipping and tripping hazards.
- proper protection to pedestrians and adjoining buildings
- Contractor's All-risk Insurance policy to be inplace.

d) To ensure safety of all people on the Site during the construction process, including Contractors' personnel and Employer's representatives, the following procedures shall be adopted by all Contractors for the use of temporary electricity supply.

i) Work shall generally be carried out in accordance with 16th Edition of UK IEE Wiring Regulations, BS CP 1017 "Distribution of Electricity

on Building Sites", and the Pakistan "Electricity Rules, 1937" all legal formalities of the Electric Inspector's office shall be complied with.

ii) Construction of cables used shall be as follows:

- ◊ to fixed distribution boards and fixed equipment, PVC/PVC/SWA/PVC, to BS 6346.
- ◊ to moveable plant, flexible armoured cables, to BS 6116.
- ◊ to welding electrode-holders, flexible cables to BS 638.
- ◊ to portable tools and hand-lamps, flexible cords to BS 6500

iii) Installation of cables shall be as follows:

- ◊ outdoors, directly buried at least 500mm below grade, with tile covers and cable markers (at minimum 10 meter intervals and at bends), and in RCC pipe at road/traffic crossings.
- ◊ indoors, clipped to the surface at least 3000mm above floor/ground level.

Strain relief shall be provided at termination of all cables at equipment, plugs, etc.

iv) Double earthing, with stranded copper conductors, shall be used to establish a TNS system. No separate earthing electrodes are required at each location.

v) A main distribution board, to BS 4363, of totally enclosed sheet-steel construction (IP 54) shall be provided, with 30mA trip residual current device(s) for the earth-leakage protection of circuits. Short-circuit and overload protection shall be provided by circuit-breakers of the appropriate rupturing capacity.

vi) Plugs, sockets, and accessories of a robust, unbreakable construction, to BS 4343, shall be used for all equipment. Portable tools, to BS 2769, shall preferably be of double-insulated construction and be operated at 110V.

vii) A layout drawing of the proposed temporary installation with schematics, cable sizes and routes, earth conductors, and protection details shall be had approved from the Employer. After installation, test results (insulation resistance, earth-loop impedance, etc.) shall be submitted, re-testing shall be done every three months.

13. TESTING & COMMISSIONING

Stage wise testing of the installation shall be carried out at site before/after commissioning of equipment and shall include the following as a minimum:

LIST OF APPROVED MANUFACTURERS/SUPPLIERS

All equipment and materials provided under this contract shall be procured from the following manufacturers/suppliers only. Alternatives may be had approved from the Project Engineer/Employer before the bid is submitted.

1.	Cables	Pakistan Cables Ltd., Karachi Pioneer Cables Ltd., Karachi AGE Cable Ltd.,Karachi
2.	Cable Lugs & Ferrules	BICC, UK Rema, Germany Cembre, Italy
3.	H.D.B.C.	Pakistan Cables Ltd., Karachi Pioneer Cables Ltd., Karachi AGE Cable Ltd.,Karachi
4.	Cable Tray/Trunking/Ladder	BRC AL-Burhan (Pvt) Ltd PESCO, Karachi EZZI Engineering, Karachi
5.	Back-boxes, pull boxes	Hussain & Co., Karachi MK Electric, UK Clipsal, Australia
6.	PVC Conduit & Accessories	Galaxy (GALCO), Karachi Beta pipes, Lahore
7.	RCC Pipes	Pakistan Pipe & Construction Co., Ltd., Karachi.
8.	Steel Conduit & Accessories	Hilal Industries, Karachi International Industries, Karachi
9.	G.I. Pipes	International Industries, Karachi Steelex, Karachi.

10.	Light Switches, etc.,	Clipsal, Australia ABB, Singapore
11.	Switches, Sockets etc.,	Legrand, Germany ABB, Singapore Clipsal, Australia
12.	LV Switchgear	Siemens Pakistan, Karachi Libra Engineers, Karachi Hussain & Co. Karachi Babar Brothers, Karachi Sunbeam Engineers, Karachi
13.	Circuit Breakers Moulded type with toggle Switch	(TERASAKI/FUJI/MG/ABB/LEGRAND)
14.	Contactors	
15.	Light Fixtures	Philips Electrical Industries of Pakistan, Karachi Thermec Engineering Co. Karachi Ohms, Karachi Clipsal, Australia
16.	Ballast/Choke (230V)	Philips, Australia Helvar, Finland Schwabe, Germany
17.	Emergency Lights	Gent, UK Legrand, France Menvier, UK
18.	Fire Alarm System	Simplex, USA Gent, UK Honeywell, USA Kidde, UK Photain Control, UK Siemens,Switzerland
19.	Voice/Data Structured Cabling System	Awia(Lucent), USA Krone, Germany Siemens/Corning,Germany Clipsal/Molex, Australia
20.	Telephone PABX System	Siemens, Pakistan Alcatel, Karachi

21.	Fans	Climax, Gujranwala Millat, Karachi Asia, Gujranwala
22.	Hand Dryers	Siemens, Germany National, Japan Starmix, Germany
23.	Public Address System	Philips, Holland TOA, Japan Bose, USA National, Japan
24.	UPS	Liebert, USA Exide, USA Merlin Gerin, France
25.	Voltage Stabilizer	Watford, UK Claude-Lyons, UK
26.	CCTV	Philips (BURLE), USA Pelco, USA
27.	Indicating Lights/Push Buttons	Telemechanique, France Fuji, Japan Baco, France
28.	LV Current/Potential Transformers	Riken, Taiwan Fico, Pakistan Carlo Gavazzi, Germany
29.	COS	K&N/Telemechanique/Baco
30.	Voltmeters/Ammeters	Saci, Spain Hobut, Uk GEC, UK

SECTION – 16110

RACEWAYS

1. Cable Trays

Where required, PVC sheathed wiring shall be run in admiralty pattern perforated (with holes over at least 30% of the plan area) pre-galvanised sheet steel cable tray (spot welds, cables entry knockouts, end cuts, etc., treated with cold-galvanising imported zinc paint) of the specified gauge to BS 4678/NEMA, supported with 10mm dia HDGAF hangers, galvanised steel guy wires, or heavy-duty brackets at 3.3m intervals.

Where required, wiring shall be run on pre-galvanised sheet steel cable ladders (spot welds, cables entry knockouts, end cuts, etc., treated with cold-galvanising imported zinc paint), to BS4678/1499/NEMA fabricated from welded 1.5mm (16 b.g) sheet steel, in 2.44 minimum lengths, with slotted rungs. Provisions shall be made in each section for strapping the cables, clamping circuit protective conductors, and having slip fit, interlocking connector couplings. Suspension and support from the structure at 5m maximum intervals shall be mechanically adequate for the weight of the cables. No welding to the structure shall be permitted. Factory made connectors shall be used at joints.

Bonding links shall be provided at each joint and secured by screws, nuts and shockproof washers. The bonding links shall make contact with the metal of the trunking or fitting, and continuity shall not depend on contact through the screws, nor on removal on site of paint finish from ferrous metal.

2. Cable Trunking

Where required, wiring shall be run in pre-galvanised sheet steel cable trunking (spot welds, cables entry knockouts, end cuts, etc., treated with cold-galvanising imported zinc paint) of the specified gauge complete with all fittings and accessories, manufactured and installed in accordance with BS 4678/NEMA. The trunking shall be constructed with return flanges. Trunking covers shall be secured by anchored turn-buttons and locking bars, and minimum length of individual sections shall be 2.44m. The trunking shall be suspended/supported from the structure at maximum 2m intervals with straps and hangers fabricated from minimum 6mm dia HDGAF bars, or supported by angle-iron brackets. Conduit drops from the trunking shall also be supported with hangers. Factory made connectors shall be used at joints.

Junctions (tee and 4-way) in multi-compartment trunking shall be double depth to avoid reduction in cabling space. Cables in vertical runs shall be supported by pin racks, prongs, or bridging pieces. Fire barriers shall be provided at each floor level. Allowance for expansion shall be incorporated.

Bonding links shall be provided at each joint and secured by screws, nuts and shockproof washers. The bonding links shall make contact with the metal of the trunking or fitting, and continuity shall not depend on contact through the screws, nor on removal on site of paint finish from ferrous metal.

Where required, wiring shall be run in screened floor or surface PVC trunking as specified, complete with all fittings and accessories, manufactured and installed in accordance with BS 4678.

3. Conduit

Where required, wiring shall be carried out in electrical grade rigid PVC conduit, to BS 4607/6099, minimum 20mm dia, clipped to the surface with heavy, enamelled metal spacer bar saddles, at intervals specified in the IEE Regulations (rawl plugs and 32mm minimum length screws shall be used for fixing the saddles), or concealed in the structure with at least 38mm of concrete cover. Flexible PVC conduit with appropriate glands shall be used for terminating all connections to recessed lighting fixtures in false ceiling.

Where required, wiring shall be carried out in heavy gauge (1.6mm minimum wall thickness, Class B) screwed steel conduit, to BS 31, minimum 20mm dia, protected (Medium, Class 2) with two coats of red oxide anti-corrosion primer and two coats of stoving enamel, clipped to the surface.

Conduit accessories, to BS 31, shall be cast-iron or of 16 b.g sheet steel, with protective treatment as above. Conduit terminations shall be provided with soft, rounded, brass bushes and lock nuts. Saddles shall be of the heavy-duty hospital-type, and shall be installed at spaces recommended by the IEE Regulations. Additional supports in the form of 40mm x 3mm flats or 40mm x 40mm x 3mm angle iron shall be provided wherever necessary. No welding to the structure shall be permitted. Flexible steel conduit shall be used with appropriate glands for terminating all cinnections to security/fire alarm equipment in false ceiling.

Where required, external wiring shall be carried out in extra light-quality hot-dip galvanised steel pipe, to BS 137, minimum 15mm dia, installed as above. All accessories (bends, sockets, reducers, couplers, checknuts, etc.) shall also be galvanised.

Flexible steel conduit, to BS 731/6099, shall be used for final connections to motors and other equipment subject to vibration and movement. The flexible conduit shall be encased in water-proof plastic, retained with jubilee-clips. Ends of the conduit shall be welded to brass couplers/adapters.

Underfloor runs of conduits shall have at least 50mm of concrete cover, and be well sealed against the ingress of moisture.

4. Under Floor Ducts

Where required, cabling shall be laid in reinforced cement concrete pipes to ASTM C-14/C-76, with bores that are smooth and entirely free from rough spots, sharp edges, imperfections, and protuberances. The pipes shall be installed minimum 600mm below grade, with 75mm thick fine riddled-soil/sieved sand bedding under and 50mm thick cover over the pipe. Joints in pipe shall be made by wrapping one lap of a tarred gasket around the spigot of one pipe and placing it into the collar of the other pipe. The joint shall be filled with cement-sand (1:1) mortar.

Where required, cables shall be run in communication cable duct of overall size 300 x 300mm, provided with 4 Nos 100mm dia hollow openings with chamfered edges. It shall be precast with fair face surface and constructed with class 'B' reinforced cement concrete (1: 1.5: 3) well cured. The openings shall be smooth and free of any burrs or sharp edges. The internal diameter of the openings, shall not vary more than + 1.5 percent from the designed diameter. The wall thickness shall not be less then that shown in the design by more then 5 percent or 5mm whichever is greater. The cable ducts shall be rejected on account of fracture, cracks passing through the wall, defects that indicate imperfect proportioning, mixing, mouldings, surface defects indicating honey-combing or open texture, damaged ends, where such damage would prevent making satisfactory joint. The cable duct shall be as per PTC specifications and requirements, and laid with bedding and cover as detailed above.

Where required, communications systems wiring shall be run in PVC pipe (Class D or E), to BS 3505, buried 600mm below grade, with 75mm thick fine riddled-soil/sieved sand bedding under, and 50mm thick cover over the pipe. The whole shall be covered with protective bricks before backfilling.

RCC draw-pits shall be constructed as per drawing to facilitate the pulling of cables. Size and locations of the pits shall take into account minimum bending radius of installed cables, nature of the site, and locations of other services. Draw-pit covers shall be load-bearing RCC, sealed with a sand-cement (1:1) mortar.

Raceway runs shall be neatly and symmetrically laid out, with at least 150mm clearance from other service pipes, with pull boxes at not greater than 10m intervals. No sharp bends or tees shall be used. The entire conduit system shall be completed before wiring is installed. Conduits shall be tested for continuity, and obstructions cleared by use of a cutting material or other approved device, and cleaned out before commencing the installation of wires.

SECTION – 16120

WIRES & CABLES

1. LV Cables

The LV cables, to BS 6346, shall be 3-core or 4-core, compacted stranded copper conductor, PVC insulated, laid up with suitable fillers to make a circular shape. Where required, the cable shall be galvanised steel wire armoured over an extruded PVC bedding and provided with an overall black PVC sheath. The voltage rating shall be 600/1000V, and the cores shall be colour-coded. the size, specification, and make of the cable shall be embossed on the sheath at 0.5 metre intervals (maximum).

2. Building Wire and Cable

Cable and conductors shall be PVC insulated, PVC sheathed with copper conductors, single/multicore, 450/750 volt grade for light and socket circuits and 600/1000 volt grade for motor and power circuits, to BS 6004 & BS 6346.

The neutral and phase conductors shall be coloured black and red/yellow/ blue respectively. The circuit protective conductors shall be of hard drawn stranded bare electrolytic copper above the size of $6mm^2$ (12 SWG), with a green/yellow sleeve at terminations, and for $6mm^2$ and below a green/yellow PVC insulated conductor shall be used. For isolated earthing of data/ computer systems, a cream coloured PVC insulated conductor shall be used.

3. Internal Cable Installation

In general, installation work shall be in accordance with the manufacturer's recommendations and IEE Regulations.

Each circuit shall have its own separate neutral, and the "looping in" system for wiring shall be used. Joints shall be made at main switches, distribution boards and panels, socket outlets, light and fan points and switch boxes only; no joints shall be made in joint boxes, nor will any "through joints" be allowed.

PVC/PVC 3-core flexible cords, shall be used for connection to the luminaries and fixtures from the ceiling rose/outlet box, through 3-terminal PVC connectors. Soldered or crimped tinned copper lugs, shall be used on the termination of cables and conductors $10mm^2$ and larger. All multi-core cables shall be provided with compression glands, of the correct size and type, at panel entry positions.

Power cables shall be installed on walls/structure, on cable trays, in cable ducts, and in underfloor cable trenches. All installation material and fixing accessories such as spacers, clamps, saddles, brackets, glands, lugs, pins, nuts, bolts, plugs, etc. shall be provided by the Contractor without additional cost.

Single and multi-core cables in conduit and pipe shall be pulled after the entire raceway system has been completed, dried out, and cleared of all obstructions, using a wire brush and cutting mandrel.

The cables shall be installed on the surface of walls/structure by using heavy duty spacer saddles and clamps at intervals in accordance with IEE Regulations. The saddles and clamps shall be made of cast-iron or steel (hospital-type) of approved design. Line up saddles and clamps shall be used where more cables than one are to be installed. The saddles shall be fixed to the wall/structure by means of nylon plugs and steel bolts.

The cables installed in the under-floor trenches shall be laid in single tier, when laid on the bed of the trench. Cables shall also be clamped on the walls of the trench by means of heavy spacer saddles and clamps of insulated material, or fixed on brackets grouted into the side of the trench, at maximum of 600mm intervals. The centre to centre distances between cables shall be equal to twice the diameter of the cable (75mm minimum and 150mm maximum). All cables shall be spaced at least 25mm from trench walls.

Cables installed on cable trays/ladders shall be pulled over shave pulleys installed on temporary brackets. The cables shall be spaced apart at distances equal to twice their overall diameter, and tied down with straps or cord. Cables in trunking shall be tied on circuits.

4. External Cable Installation

In general, the installation of external cables shall be carried out in accordance with the manufacturer's recommendations and IEE Regulations. The bending radius (as a multiple of the overall cable diameter, d_o) shall not be less than

600/1000V PVC cable	$12d_o$
6350/11000V XLPE cable	$15d_o$

even during handling, pulling, and installation. A total maximum of 5% of the cable length shall be provided as slack (at termination positions, in draw-pits, etc.).

Cables shall generally be laid parallel to roads and foot paths, within the appropriate services reservations. During excavation, laying and backfilling, the adjacent and intersecting service pipes and runs shall not be damaged or disturbed.

Cable drums shall be carried on suitable trailers and unloaded near point of use. Any rolling shall only be in the direction of the arrow marked on the drum. If hoisting equipment is not available, ramp boards (max 1:4) with a winch or a coil of rope around the drum shall be used. The cable shall be laid out by jacking/propping the drum on an axle/spindle, and a braking plank installed below. Care shall be taken to see that the manufacturer's recommended pulling tension is not exceeded. Cable rollers shall be installed at maximum 2m spacing (1.2m for heavy cables) and at bends. A cable stocking or pulling eye shall be attached to the leading edge of the cable for pulling purposes. Cables shall not be laid if the temperature is below 0°C.

The following methods shall be employed for laying cables.

i) Laying out from a trailer
ii) Laying by hand
iii) Laying by motor-driven rollers
iv) Pulling by winches

If cable is to be carried by hand (un-supported by rollers), men shall stand 4 to 6m apart along the route. Flaking of cables ("figure-eight method") may be employed, taking care to prevent infringement of the minimum bending radius requirement.

Directly buried cables & raceways shall be laid with the minimum cover shown below:

Type of Cable/Raceway	In Open Ground and Under Pavement (mm)	Under Road Way (mm)
MV Cable	800	1000
LV Cable	600	800
Communication Cable	600	800
RCC Pipe	550	600
Communication Duct	300	500
PVC pipe	600	–

For directly buried cable, excavation shall be carried out in accordance with BS6031, and shall be kept free of water and protected against damage or collapse. Before cables are laid, the bottom of the trench shall be graded evenly, cleared of loose stones, and then covered for the full width of the trench with 75mm thick fine riddled-soil/sieved-sand bedding (in compacted 50mm layers). After cables are laid, a 50mm thick sand cover shall be laid over the cable, with 50mm thick protective bricks/tiles provided along the entire length. The first layer of back fill shall be placed manually and compacted by hand punning until a thickness of 150mm over the cover tile is reached. Additional layers shall be laid in 150mm increments and may be compacted mechanically.

When cable trenches are opened all cables shall be laid as quickly as possible. The Engineer's approval shall be obtained before a trench is back filled, but generally backfilling shall be commenced within 24 hours of cable lying and the work completed speedily.

The minimum spacing between cables of various types shall be as shown below:

Type of Cable	MV (mm)	LV (mm)	Communication (mm)	Equipment, Pipe Work, etc. (mm)
MV	50	300	300	300
LV	300	25	150	300
Communication	300	150	50	200

Multi-core cables in pipe and duct shall be pulled after the entire raceway system has been completed, dried out, and cleared of all obstructions, using a wooden mandrel (300mm length, dia 10mm less than pipe dia) to ensure correct alignment.

After installation of cables in underground ducts and pipes, the cable shall be supported from the bottom end of the pipe and the pipe ends shall be properly plugged and sealed to prevent ingress of water or vermin.

Underfloor cable trenches shall be constructed by others. All installation materials and fixing accessories such as hangers, spacers, clamps, saddles, brackets, brass compression glands, lugs, pins, nuts, bolts, plugs, etc. shall be provided by the Contractor without additional cost.

On completion of laying, terminating, and jointing of the cables and CPCs, a plan (1:500) shall be prepared, containing the following details:

i) Type of cables, X-sectional area of conductors, rated voltage.
ii) Year of manufacture, month and year of lying.
iii) Actual laid lengths between centres of the joints, and between them and the sealing ends.
iv) Exact locations and depths of cables and joints in relation to fixed points.

The electrical values of the completed installation shall be measured and recorded:

i) Insulation resistance between conductors and between conductors and earth/armour.
ii) Conductor resistance, using a suitable measuring bridge, of all cores.
iii) Capacitance between conductors and between conductors and earth/ armour.

5. Cable Terminations & Joints

Cable terminations, joints and accessories shall meet with the cable manufacturer's approval, and work shall be carried out by specialists who are fully qualified and competent.

The cable ends shall be kept properly sealed with heat-shrink caps until jointing or termination work commences. Joints and terminations shall be of the outdoor or indoor type, as required.

Conductor connections and terminations shall be made with compression ferrules and lugs, to BS 91 using a hydraulic crimping tool (with a complete set of dies) capable of high pressures.

Cable entries into panels shall be made with brass cable glands, to BS 6121, of the correct sizes and types, to ensure proper support and sealing of the cable, and good earthing of the armour.

6. Cable Markers

Cable markers shall be made of concrete, 600mm square by 100mm thick with impressed characters. They shall be made of grade 20 concrete, as defined in CP110, with 10mm aggregate. The wording shall be "MV CABLE", "LV CABLE" or "COMMUNICATIONS CABLE" as appropriate, together with circuit details, as instructed by the Engineer; In addition, the word "JOINT" shall be added where appropriate.

The cable markers shall be installed flush with the finished ground level on the precise line of the cable.

The cable markers shall be located at every point where a cable enters a building, sub-station, plinth or feeder-pillar, at each joint, and along the route of the cable at intervals not exceeding 45m.

SECTION - 16130

BOXES

Outlet boxes, pull boxes, inspection boxes, switch and socket outlet boxes, fan regulator boxes, etc., to BS 4662, shall be of 18 gauge sheet steel, drusted, degreased, rust-proofed with two coats of zinc chromate primer and powder-coat finished, complete with earthing terminal.

All boxes shall have ample wiring space, and boxes used outdoors shall be weather-proof.

Alternatively, boxes shall be constructed of 18 gauge galvanized sheet steel, bent and fumed.

SECTION - 16140

WIRING DEVICES

1. SWITCHES, SOCKET AND ACCESSORIES

Switches, to BS 3676, sockets to BS 196/546/1363, ceiling roses to BS 67, dimmers to BS 5518 (with RFI suppression to BS 800) etc. generally to BS 5733, shall be of white moulded plastic, all insulated type, suitable for flush mounting. Plastic cover plates, where used, shall be white, non-yellowing, atleast 5mm thick, with bevelled edges.

Switches shall be of the piano type, having integral moulded face plate, 1,2, or 3 gang. 20/16 amps switch socket outlets shall be of the 3 pin shuttered type with integral switch.

Industrial power sockets shall be of the splash-proof (IP44) shuttered type, flush-mounting, to IEC 309/BS4343.

Externally, all switches, sockets and accessories shall be of a heavy duty cast construction, splash-proof (IP44).

All other outlets (computer, data-cable, stabilised power, telephone, intercom, etc.) shall have face-plates that exactly match the design of switches and sockets, so that the whole appears as one uniform range of accessories.

SECTION - 16170

EARTHING & BONDING

1. Grounding

LV panels, boxes, steel conduit, and all related/extraneous metal work are to be protectively earthed (PE) with stranded H.D.B.C., to BS 125. All joints are to be compression jointed, or cad-welded, and protected against corrosion; and CPC terminations of equipment are to be provided with compression lugs. Each panel or equipment body is to be connected at two points by two independent circuit protective conductors (one of which may be the cable armouring), tapped from the earth connecting point or the main CPC loops. Metallic raceway is to be earthed at termination points with clamps that go down to bare metal.

The earthing electrode shall comprise of:

a) 3m length 13mm dia copper rod 99% purity.

b) Tinned copper plate, 600mm×600mm×3.2mm, 99% purity buried at least 300mm below permanent water level at 8.0mm below ground level, which ever is less. A mixture of charcoal and salt (3:1) shall be used as packing 300mm around the earth plate.

The earthing electrode shall be connected with an appropriate sized copper conductor cable in G.I./PVC pipe upto copper testing/terminal block 800mm×50mm×20mm.

An arrangement of watering the electrode shall be provided at ground level in a 600mm×600mm concrete watering/inspection chamber with C.I. cover.

Neutral earthing (N.E) shall be done with PVC insulated cables connecting the neutral bar of the LT panel to the substation earth bar.

The earthing system shall be bonded to the rebars of the building foundation and UG water tank, with approved rebar clamps/welding of already laid steel reinforcement bars within the structural concrete around the entire periphery of the basement retaining wall to form a continuous loop with clamps to vertical rebar at column positions.

SECTION - 16425

SWITCHBOARDS

Main and sub-main panels, distribution boards, and lighting panels, to BS 5486/4752, shall be of the cubicle type, totally enclosed, dust-proof, floor/surface/flush-mounting type, fabricated from 16 gauge sheet steel, derusted, degreased, rust-proofed, with two coats of zinc-chromate/red-lead, and painted with two coats of enamel, with hinged covers, and metal safety plates. The equipment shall be rated 400 volts, and be suitable for operation on the utility supply. Boards shall be factory assembled, ready wired, and shall be complete with adequately rated electrolytic copper phase, neutral, and earth busbars, suitable clamps, jointing and termination accessories, line-up terminals, earthing bolts, etc.

Miniature circuit breakers (MCBs) and moulded case circuit breakers (MCCBs), to IEC 947-2, shall be of the moulded-type with operating lever protruding through the metal safety plate Switch-fuses and load break switches (AC 23), to BS 5419, incorporating HRC fuses, to BS 88, shall be of the heavy duty, metal-clad type, complete with all accessories. Motor starters, to BS 4941, shall be of the push-button, magnetic-contractor (AC-3) type, with single-phasing prevention, ambient-temperature compensated, overload relays, with Type 2 short-circuit protection to IEC 947.

Indicator lights, push buttons, etc., to BS 4099 IEC 947, shall be rated 250V, and CTs shall be of Class 0.5 for tariff metering purposes, and 1.5 for indicating purposes. The CTs shall have suitable burden and over-current (saturation) factors.

All switchgear shall be installed as per manufacturer’s instructions. Wall and flush-mounting boards shall be fitted with proper holdfasts. Proper-sized knockouts in the panel bodies shall be made to accommodate conduit entries and glands, so that the entry of dust, vermin, etc., is excluded.

The short circuit ratings (dynamic and thermal) of all switch gear assemblies shall be equal to or greater than the SC level (IEC 947-2, Icu at 415V) shown on the schematic diagram/BOQ. The characteristics of the protective devices shall be such as to provide selective discrimination.

The neutral & earth bus bars shall be of same size as phase bars.

SECTION – 16475

SWITCHGEAR

1. CIRCUIT BREAKER SWITCHGEAR

Detailed characteristics and data, including discrimination charts, cascading charts, thermal stress limitation curves and temperature derating factors shall be made available as required. The Contractor shall choose the particular types of circuit breakers to give proper discrimination and adequate back-up protection to all circuit elements (like cables, switches, contactors, etc.).

Rupturing capacities of the circuit breakers shall be in accordance with IEC 947-2, Icu and Ics at 415V.

2. AIR CIRCUIT BREAKERS (ACBS)

The air circuit breakers shall comply with IEC 947-2, be suitable for isolation, and shall be fully tropicalized (T2). The circuit breakers shall be designed to be maintained. The electrical endurance (CO at Un = 690V) shall be equal to the mechanical endurance, and shall not be less than 10,000 cycles without maintenance. The operating mechanism shall be of the stored-energy spring-type, with motor operator for spring charging where required (it shall also be possible to charge the springs by hand).

ACB contacts shall be maintenance free in normal usage, with a mechanical wear indicator. All electrical auxiliaries shall be field adaptable without adjustment. The over-current protection shall be of the analogue solid-state type, with the following characteristics:

- general application
  - long time protection
    - adjustable from 0.4 to 1 times sensor rating
  - short time protection
    - adjustable from 2 to 10 times setting made on the long time protection
    - time delay setting adjustable from instantaneous to 0.3s.
- generator set protection
  - long time protection
    - adjustable from 0.4 to 1 times sensor rating
    - time delay adjustable from 20 to 480s at 1.5 times setting made on the long time

- short time protection
  - adjustable from 1.6 to 10 times the setting made on the long time protection
  - time delay adjustable from instantaneous to 0.3s

3. MOULDED CASE CIRCUIT BREAKERS (MCCB)

MCCBs shall comply with IEC 947-2, be of the circuit breaker disconnector type, and shall be maintenance-free and fully tropicalised (T2). They shall be designed for horizontal or vertical mounting or reverse feeding, without any adverse effect on electrical performance.

The operating mechanism shall be quick-make, quick-break type, trip-free, with all poles opening or closing simultaneously (except for the neutral pole, if required, which shall be of

The advance-closing, late-opening type). The operating toggle shall clearly indicate the ON, OFF and TRIP positions.

All electrical auxiliaries (shunt trip, UV trip, auxiliary contacts, motor mechanism, etc.) shall be of the plug-in type, with built-in control terminals, and shall be field installable.

The trip unit shall be internally energised, and shall have the following characteristics

- thermal overload and magnetic short circuit type (adjustable, where required), or
- solid-state type, with
  - long time protection
    - adjustable from 40% to 100% of the sensor rating
    - time delay adjustable from 15 to 480 seconds at 1.5 times the setting made for long time delay.
  - short time protection
    - adjustable from 1.5 to 10 times the sensor current rating
    - time delay adjustable from instantaneous to 0.35 seconds
  - instantaneous
    - adjustable from 2 to 15 times the nominal current rating

4. MINIATURE CIRCUIT BREAKERS (MCBS)

MCBs (rated 1 to 100A) shall comply with BS EN 60-898 or IEC 947-2, and be suitable for DIN-rail mounting, and shall be maintenance-free and fully tropicalised (T2). It shall be designed for horizontal or vertical mounting, or reverse feeding, without any adverse effect on electrical performance.

The operating mechanism shall be quick-make, quick-break type, trip-free, with all poles opening or closing simultaneously (except for the neutral pole, if required, which shall be of the advance-closing, late-opening type). The operating toggle shall clearly indicate the ON and OFF/TRIP positions.

The individual operating mechanism of each pole of a multi pole MCB shall be directly linked within the MCB casing and not by the operating handles.

Each pole shall be provided with bi-metallic thermal element for overload protection and magnetic element for short-circuit protection.

The tripping characteristics shall be

- Type 2/BS EN60-898, or Curve B/IEC 947-2 for 10A & 15A MCBs
- Curve MA/IEC 947-2 for motor starter back-up protection

5. EARTH LEAKAGE CIRCUIT BREAKERS (ELCBS)

Earth leakage circuit breakers (ELCB), or residual current devices (RCDs), to BS 4293, shall be protected against nuisance tripping due to transients and shall be sensitive to pulsating DC fault currents. All ELCBs shall be provided with backup protection adequate for the fault level at the point of installation. Single pole MCB's of appropriate kA/Amp rating may be used for providing backup protection to 2-pole/4-pole ELCB's.

The ELCBs shall have an electrical life of at least 4000 operations, and a mechanical life of at least 20,000 operations, and shall be equipped with a positive contact position indicator and a "test" button.

6. LOAD-BREAK SWITCHES

Load-break switch, to IEC 947-3, shall be of AC22 switching duty on general lighting and power panels. Motor feeders and panels shall be equipped with AC23 duty switches.

7. CONTACTORS

Magnetic contactors, to IEC 947-4-1, shall be of utilisation category AC-1, AC-2, AC-3, etc., as required for lighting control, motor control etc., and shall be of mechanically latched type.

8. MOTOR CONTROL CENTRE (MCC)

In addition to compliance to above, motor-starter feeders, as shown, with MCCB back-up protection (type 2 to IEC 947) motor-protection (AC3-duty) magnetic contactors, 3-pole differential-type thermal overload relay with "hand/auto-reset" , "on/off" push buttons, "hand/off/auto" selector switch, "on/off/trip (Definite overload)" indicating lights, 2 C/O spare auxiliary contacts, CT and ammeter (with overload/starting range), PTC thermistor relay (19kW & larger), remote-control/ indication provisions, remote audio/visual alarm for each outgoing circuit.

SECTION - 16500

INDOOR LIGHTING

1. Light Fixtures

a) Fluorescent light fixtures to BS 4533 & IEC 598, and of safety classification: class 1 to IEC 598 part 1, shall be of 0.6mm electro galvanised sheet steel, with anti-corrosion base treatment of the metal and brilliant white anti yellowing stove enamelling, with deep drying by infra-red lamps. Wire entry holes shall be bushed, and all screws, nuts and bolts shall be of the corrosion-resistant type. All components, high-efficiency florescent lamps, noiseless, low-loss high p.f. chokes, rotary location type lamp holders, glow starters with radio-interference suppression and holders, matching capacitors in a duo circuit to improve the p.f. to 0.95 etc., shall be compatible and meeting or exceeding the specified performance & safety specs and of the best available quality.

b) Fluorescent light fixtures to CIBSE Lighting Guide 3 (LG3) "Lighting for Visual Display Terminal's", 1996 & Health & Safety (DSE) Regulations, 1993 should limit the calculated luminance to 200cd/m^2 or less at angles as categorised below:

Category	Luminance Limit Angle
1	55°
2	65°
3	75°

The manufactures shall provide calculations & tests as specified in CIBSE (LG3) Appendix A2.1 & A2.2 establishing:

i) Compliance to specified category luminance limiting angle.

ii) The luminance of any spot of area 500mm^2 (25mm diameter) should not exceed 500cd/m^2 at any angle above luminance limit angle.

c) Air handling light fixtures shall be of the following type as shown on the drawings, and shall be designed for quite draught free operation:

i) Air handling light fixtures with return air provision only.
ii) Air handling light fixtures with supply and return air provisions.

iii) Air handling light fixtures with return air provisions and dummy supply air slots for compatibility.

Return air provision shall consist of slots in the light fixtures that allow return air to flow over the lamps and into the low pressure ceiling void.

Supply air provision shall consist of slots of suitable size along the two long sides of the light fixtures. Slot shall allow air diffusion parallel to the ceiling. The supply air plenum shall be provided with a ∅ 150mm spigot with butterfly damper to allow connection to the ducting system.

The characteristics of the above air handling light fixtures shall be as follows:

Supply air volume	240	m^3/h (min.),
	340	m^3/h (max.)
Return/exhaust air volume	290	m^3/h
	310	m^3/h (max.)
Max. Sound power level	35	[dB (A)]
Max. Pressure drop	40	Pa
Temperature difference between room and supply air	10	°C
Permitted room air velocity	0.38	[m/s]

d) Incandescent and H.I.D. fixtures, to BS 232/1950/4533 and IEC 598 shall be of heavy gauge corrosion-proof metal construction, with brass/porcelain lamp holders. The diffusers shall be of first grade heat resisting glass, 3mm thick, free from voids or opal plexi formed material, as required. High bay fittings shall be of the through venting type.

e) Edison screw lampholders to BS 6776, IEC 238, low voltage tungsten halogen lamp holders to BS 51001 & IEC 61. Fluorescent lamp holders to BS 6702, IEC 400 shall be of white polycarbornate with phosphor bronze contacts, G13 socket as DIN 49653, IEC 7004-51 for 26mm (T8) fluorescent tubes.

2. Louvers

a) Specular louvers shall be manufactured from pre-anodised (coil anodised) 99.99% pure aluminium, 2μ thick, anti-glare, anti-iridescence, having specular reflectivity values above 83 at longitudinal & transverse testing directions at 45° to BS 6161 Part 12 Method and diffuse reflectance of less than 10. The louvers shall have a cut-off angle not exceeding 60°.

b) LG3 rated light fixtures shall have double parabolic reflector louvre in specular pre-anodised (coil anodised) 99.99% pure aluminium, 2μ thick, anti-glare, anti iridescence, having specular & diffused reflectance values as above.

3. Lamps

a) Tubular fluorescent lamps to BS 1853 & IEC 81 shall be of energy saving type with max tube dia of 26mm, of colour rendering group 1B to DIN 5035. The economically useful service life shall be more than or equal to 7500 hours.

b) Compact flourescent lamps to BS 6982 & IEC 901 shall be of energy saving type, with built in electronic ballast, with E27 base to IEC 61-1, 7004-21, of colour rendering group 1B to DIN 5035, with economiocally useful service life of more than 10,000 hours.

c) Low voltage (12V) tungsten halogen lamps to BS 1075 & IEC 357 shall be suitable for operation in open light fixtures to IEC 598. Dichroic mirror reflector shall reduce the amount of infrared heat in the light beam by 66% with no loss in visible light. The lamp capsule shall be coated with UV control quartz to limit the UV radiations.

Step down transformers for low voltage halogen lamps magnetic, 240/12V shall ensure that lamp operates at rated voltage (12V).

4. Control gear

a) Low loss ballast for fluorescent tubes to IEC 920/921 shall be of low loss, i.e having operating power losses less than or equal to 6 Watts at rated load & voltage. The ballast shall limit the harmonic current of the lighting circuit to values as specified in EN 60921. The ballast should operate without any unpleasant "humming" noise. The control gear must ensure flicker free operation of lamp at supply voltage variations of $\pm$10V.

b) Capacitors for power factor correction to BSEN 61048-9 in parallel applications shall be rated at 250V and maximum capacitive tolerance of $\pm$10% and in series rated at 450V and maximum capacitive tolerance of $\pm$4% Capacitors shall have a life time equal to or more than that of ballast. The capacitance shall be rated according to ballast & lamp wattage to increase & maintain p.f. above 0.9.

5. Installation

a) The surface mounting incandescent or fluorescent light fittings shall be installed with the fixture back, flush with the ceiling surface. Nylon plugs shall be used for fixing the fixture on the ceiling or wall. The pendant type fluorescent light fittings shall be hung from the ceiling by two 20mm dia 16 SWG white enamelled tubes having swivel-joint type hanger at the top for fixing directly on to the recessed outlet box or on the ceiling.

b) It is the responsibility of supplier to ensure that light fitting supplied shall be compatible with the false ceiling installed and fit exactly into the false ceiling. The recessed type fluorescent or incandescent light fittings shall be installed recessed in the false ceiling by cutting the false ceiling to the required dimensions, such that the frame of the fittings overlaps the ceiling. The fluorescent fittings to be installed in a row shall utilise end plates to fix the fixtures ends in level so as to form a continuous row without break or void. All recessed fittings shall be supported from the structural ceiling, independent of the false ceiling.

SECTIO - 16530

SITE LIGHTING

1. OUTDOOR LUMINARIES

Outdoor luminaries, to BS 4533 and IEC 598, shall be a weatherproof, robust construction, protection class IP23 minimum, with heavy-gauge metal work constructed for exposure to the atmosphere, and protected against corrosion. Parts which have to be removed for access to the interior shall be properly neoprene-gasketed to restrict the entrance of moisture, dust, and insects. A filter shall be provided to allow the lamp chamber to "breathe". Trunnion and stirrup mountings and similar parts shall be hot-dip galvanised. Luminaries shall be vandal resistant, and openable only with tools. Reflectors shall be of the electrolytically brightened and polished aluminium type, anodised for protection against corrosion. The photometric performance of the luminaries shall be as specified. Diffusers shall be of first- grade heat-resisting glass or acrylic, 3mm thick, free from voids and imperfections, or opal plexi-formed material. Lamp holders shall be of brass or porcelain.

Internal wiring of luminaries shall be carried out with heat-resistant cables, and additional protective sleeves applied at critical points. Terminal blocks, with earth terminal and HRC fuse, shall be provided in the base, suitable for through connection to further luminaries.

All components (lamps, ballast, starters, ignites, capacitors, etc.) shall be of one manufacturer, and compatible to ensure long life, efficiency, and freedom from damage. Ballasts shall be of the low-loss type, to BS 4782, and capacitors, to BS 4017, shall improve the power factor to greater than 0.9. All control gear shall be housed in the pole/post base.

Foundations for lighting columns, poles, posts and pedestal shall be class C21 nominal mix concrete, with sulphate-resisting cement used where required by the Engineer. The dimensions of the foundations shown are minimum and shall be increased suitably to conform to the recommendations of the manufacturer (agreed to by the Engineer) and the particular site conditions. Forms of foundations shall be true to line and grade and the exposed portions shall present a neat appearance. Conduit ends and anchor bolts shall be held in place with a template till concrete sets. Plumbing of the column/pole shall be accomplished with the levelling nuts before placing of mortar: shims, or similar devices, will not be allowed.

Lighting poles shall be of a stepped steel tubular construction, to BS1840/BS4360/ BS4848, manufactured from steel pipes made to BS 1387 and API-5L-Grade B, rolled from steel strips of minimum tensile strength 40kg/mm with a minimum wall thickness of 3.25mm. All joints in tubular sections shall be hot-swaged, and aesthetically acceptable to the Engineer.

Lighting posts shall be of medium-gauge steel pipe construction, to BS 1387, with a minimum wall thickness of 3.65mm. Posts shall be in one piece, without welded joints.

The decorative base or pedestal where required, shall be of cast-iron, to BS 1452, with a minimum thickness of 10mm. A compartment shall be provided with a hinged door large enough to afford easy access to control gear, fuses and termination of cables. Hinged doors shall be provided with tamper-proof locks, the same pattern of lock being used throughout: six keys shall be provided to the Engineer.

Painting of the column, pole, post, bracket arms, cast-iron base shall be carried out as follows:

a) Surface preparation: All surfaces shall be blast cleaned.

b) Primer: Two coats of Kemobel chlorinated rubber (CR) metal primer 572 - 9 shall be applied by brush. Twenty-four (24) hours drying shall be allowed between coats. Primer dry film thickness in 2 coats - 2/2.5 mils.

c) Under Coat: Three coats of Kemobel CR Thick coat 572 - PK - 835 shall be applied by brush. Twenty-four (24) hours drying shall be allowed between coats. Under-coat dry film thickness in 3 coats 8/10 mils.

d) Finish Coat: Two coats of Kemobel CR finish smoke gray or as required by the Engineer. Twenty-four (24) hours drying shall be allowed between coats. One coat to be applied after erection and any patch repairs. Dry film thickness in 2 coats - 2/2.5 mils.

SECIFICATION

PLUMBING WORKS

SPECIFICATIONS FOR PLUMBING WORKS

SUB-CONTENT

SECTION – 5100

PLUMBING

1. SCOPE

The work under this section consists of providing all materials and equipment and performing all the work necessary for the complete execution and completion, including testing and commissioning of all systems of plumbing works as shown on the Drawings and / or specified herein and / or as directed by the Engineer. The systems included in plumbing works are as follows:

i) Cold and Hot Water Supply
ii) Sanitary Drainage
iii) Fire Protection
iv) Roof Drainage

All the above named systems shall be complete in all respects including extension of these internal systems up to the specified limits outside the building as indicated on the drawings.

2. GENERAL

All the materials and equipments shall be of the specifications mentioned herein and the Contractor shall submit the sample, necessary catalogues, sketches, the name of manufacturer and guarantee if necessary, before installation. The system shall be installed after the Engineer approves it. All material and equipment shall be new and unused.

It is specifically intended and must be agreed to by each Contractor submitting a bid, that any material or labour which is usually furnished as a part of such equipment and which is necessary for its proper completion and best operation shall be furnished as a part of this Contract without any additional cost whether or not shown in detail on the drawings or described in detail, in the specifications.

Approval of material and equipment by the Engineer shall not absolve the Contractor of the responsibility of furnishing the same of proper size, quantity, quality and all performance characteristics to efficiently fulfill the requirements and intent of the Contract Documents.

The Contractor shall be responsible for his work until its completion and final acceptance, and shall replace any of those that may be damaged, lost of stolen without any additional cost. All openings left in floor for passage of lines of water supply, soil, waste, vent, etc. shall be covered and protected.

All open ends of pipes shall be properly plugged to prevent any foreign material from entering the pipe.

Misuse of plumbing fixtures to be installed under this Contract is prohibited during the currency of the Contract.

All metal fixture trimmings shall be thoroughly covered with non-corrosive grease which shall be maintained until all work is completed.

Upon the completion of work, all fixtures and trimmings shall be thoroughly cleaned, polished and left in first class condition.

Before erection, all pipes, valves, fittings, etc. shall be thoroughly cleaned of oil, grease or other material.

All special tools for proper operation and maintenance of the equipment provided under this Contract shall be delivered at no additional cost.

This Contractor shall allow in his bid for cost of all cutting, making holes and subsequent making it good to the desired finish as per approval of the Engineer. No separate payment shall be made for this item.

This Contractor shall allow in his bid for cost of providing protective painting or coating as specified in the relevant sections and no claim shall be entertained for this item.

All pipes shall be properly installed as shown on the drawings and / or as directed by the Engineer, and shall be as straight as possible forming right angles and parallel lines with the walls and other pipelines. The position, gradients, alignment and inverts shall be as shown on the drawings and / or as directed in writing and set out by the Engineer.

The arrangement, positions and connections of pipe fittings and appurtenances shall be as shown on the drawings. The Engineer reserve the right to change the location etc. Special precautions shall be taken for the installation of concealed pipes as shown on the drawings and / or as required. Should it be necessary to correct piping so installed, the Contractor shall be held liable for any injury caused of other works in the correction of piping. The Contractor shall closely coordinate with other works during the entire stageof execution.

A minimum distance between different services shall be maintained as shown on the Drawings and / or as approved by the Engineer.

Pipes should be installed in such a manner that minimum distance should always be maintained between pipe and wall, beams, columns, etc. pipes shall be supported on hangers and brackets as shown on the drawings or as directed by the Engineer.

Waste-water outlet from each fixture shall be individually trapped.

Each vent terminal extent to the outer air and be so installed as to minimize the possibilities of clogging and the return of foul air to the building.

When the roughing-in is completed, the plumbing system shall be subjected to test prior to concealing the roughing-in, in order to ascertain that all threads and connections are watertight.

Cast iron soil and drainage fittings for change in direction shall be used as follows:-

* Vertical to horizontal: short sweep or long-turn for diameter 3 inches and larger; long sweep or extra-long turn for less than 3 inches. Dia.

* Horizontal to vertical: quarter bend or short turn.

All fittings with hubs shall be aligned so that the hub faces upstream.

No drainage or vent piping shall be drilled.

All exterior openings provided for the passage of piping shall be properly sealed with snugly fitting collars of metal or other approved rodent-proof material securely fastened into place.

Joints at the roof, around vent pipes, shall be made water-tight by use of load, copper, galvanized iron, or other approved finishings or flashing material. Exterior wall openings shall be made watertight.

Each length of pipe and each pipe fitting, trap, fixture, and device used in a plumbing system shall have cast, stamped or indelibly marked on it the marker’s mark or name, the weight, type, and classes of the product, when such marking is required by the approved standard that applies.

Where different sizes of pipes, or pipes and fittings are to be connected, the proper size increasers, or reduction or reduced fittings shall be used between the two sizes.

Any fitting or connection which has an enlargement, chamber, or recess with a ledge, shoulder, or reduction of pipe area that offers an obstruction to flow through the drain pipe is prohibited.

Each fixture trap shall have a water seal of not less than 2 inches and not more than 4 inches.

Full S, bell, crown vented trap and traps / depending for their seal upon the action of movable parts are prohibited.

No fixture shall be double trapped.

Where fixture comes in contact with wall and floors, the joints shall be watertight.

Piping in ground shall be laid on a firm bed for its entire length.

Piping in the plumbing system shall be installed without undue strains and stresses. Vertical piping shall be securely held to keep the pipe in alignment and carry the weight of the pipe and contents. Horizontal piping shall be supported to keep it in alignment and prevent sagging. Hangers and anchors shall be of metal of sufficient strength to maintain their proportional share of pipe alignments and prevent rattling. Hangers and anchors shall be securely attached to the building under construction. It must be clearly understood that the Contractor shall be fully responsible for hangers and supports and shall obtain prior approval of design as to the shape, material, dimensions, spacing etc.

Piping in concrete or masonry walls or footings shall be placed or installed in sleeves which will permit access to the piping for repair or replacement. Roof drain leaders installed inside columns shall be permanently embedded in concrete.

The indirect waste piping from food handling equipment etc. shall so discharge that the air gap between the indirect waste and the building drainage system is at least twice the effective diameter of the drain served.

3. COLD & HOT WATER PIPES AND PIPE FITTINGS

3.1 SCOPE

The work under this section of the specifications consists of providing all plant, equipment, appliances, material and labour for proper supply and installation of G.I. Pipes and pipe fittings for cold and hot water supply including jointing, clamping, cleaning, painting etc. both above ground and underground and embedded in walls as shown on the Drawings or as specified herein.

3.2 G.I. COLD AND HOT WATER PIPES & FITTINGS

3.2.1 Material

The galvanized pipes shall be of Class "B" and conform to British Standard Specifications 1387 for "Steel Tubes and Tubular suitable for screwing to BS 21 pipe threads".

All screwed tubes and sockets shall have BS pipes thread in accordance with BS 21. In order to prevent damage to the leading thread, the ends of the sockets shall be chamfered internally.

A complete and uniform adherent coating of zinc will be provided for galvanized pipes.

Every tubes shall be tested at the manufacturer's works to a hydraulic test pressure of 4.90 Mpa and hall be maintained at the test pressure sufficiently long for proof and inspection.

Tubes which are bundled shall be secured together by rope or soft iron or other suitable material.

The threads of all tubes shall be effectively covered with a good quality grease or other suitable compound, and each tube above 2 inches nominal bore shall have a protecting ring affixed to the unsocketed screwed end.

All pipe fittings up to 3 inches dia shall be of malleable cast iron. Pipe fittings above 3 inches dia shall be of approved material and specifications as decided by the Engineer.

3.2.2 Installation

The run and arrangement of all pipes shall be as shown on the Drawings and as directed during installation. All vertical pipes shall be erectedplumb and shall be parallel to wall and other pipes. All horizontal runs of piping shall be kept close to walls. If required to change the location etc. during the currency of the work, the Contractor will do so at no additional cost.

Screwed joints in G.I. pipes shall be made perfectly tight, without the use of any filler except approved jointing compound or tape. Wherever required to make flanged joints, they shall conform to BS 10 Table D.

Furnish and install all pipe passing through floors and walls with sleeves of G.I. sheet, 18 gauge, the inside dia of which shall be at least 1/2 inches greater than the outside of the pipe passing through it. Sleeves in exterior walls and pits shall have anchor flanges and space between pipe and sleeve shall be caulked and sealed watertight. At waterproof locations, an two coats of enamel paint over a coat of red oxide primer.

3.2.3 Pipework Supports

All supports, clips, steel rods and hangers shall be of mild steel painted with two coats of approved metallic zinc primer.

All clips and brackets shall be equipped with 1/3 inches sectional rubber liners (shore-hardness A 40+50).

Pipework supports shall be installed in order to allow free movement due to expansions and contraction. Supports shall be arranged adjacent tojoints, changes of direction and branches.

Each support shall carry the overall weight of pipework and water to be borne by it. The intervals between pipe supports shall not exceed the following:

maximum interval between supports (feet)

	Steel pipes		
Nominal Dia inch	Horizontal Bare	Horizontal Insulated	Vertical
½	6	6	6
¾	8	8	8
1	9	9	9
1-1/4	9	9	9
1-1/2	10	10	12
2	11	11	13
2-1/2	12	12	14
3	12	12	14
4	13	13	15
5	14	14	16
6	16	16	18
8	16.5	15	20

Single pipes hung from floor slabs shall be supported on rod hangers. Where two or more pipes are involved a channel or angle from shall be fitted to the underside of slab by two hangers and the pipes shall besupported from the channel iron by rod hangers and flat iron hands.

All hanger rods shall have double nuts and beveled washers to allow the hanger rod to swing.

Multiple pipe runs along walls shall be supported on purpose made substantial angle and channel frames securely fixed to the wall, floor and ceiling as necessary. All pipes shall be arranged to slide on the steel supports and U-bolts shall be provided to form a rigid guide.

Exposed pipe work shall be supported on channel, angle iron or with U-bolts to form a rigid guide.

All U-bolts, except used as anchors, shall have a pair of nut and washers on each leg with the supporting steel flange clamped tight between the pair of nuts to form a rigid guide and allowing the pipe to slide axially. U-bolts shall be provided on alternate pipe bracket.

Small pipework running along skirtings shall be supported by standard built-in or screw-on type clips.

Pipes shall be individually supported. Pipes shall not hung from other pipes.

Points at which pipes pass through walls, floors, connections to plant, equipment and heat emitters, etc. do not constitute points of supports for the pipes.

Vertical pipes shall be supported at the base or at anchor pints to withstand the total weight of the riser. Brackets from risers shall not be used as a means-of support for the riser.

Supports for insulated water pipework shall be arranged that the supporting steel work does not come into contact with the pipe surface.

Vibration isolators to be provided with the hangers as approved by the Engineer.

3.2.4 Testing and Commissioning

All water distribution system shall be tested whole or in part to 1 1/2 times the working pressure. The contractor shall pay for all device, materials, supplies, labour and power required for the test. The test will be run for two hours at the specified pressure and there should be no leakage in the system. Defects revealed by the test shall be repaired and the whole test rerun until the system proves to be satisfactory.

After all the pipes and fixtures have been properly laid and tested, they shall be flushed clean with water and then disinfected with water solution of chlorine of at least 50 ppm strength for a contact period of 6 hours. The system will be finally flushed with clean water.

3.2.5 Measurement and Payment

Measurement for G.I. cold water and hot water pipes shall be in running foot length and the work to be done shall include earth work, providing and fixing of pipe, pipe fittings, jointing, hangers, clamps and brackets, sleeves, insulation, cutting and breaking concrete and then making it good applying protective painting, coating, cleaning, testing and disinfecting etc. and the measurement will be for the full work specified herein. Payment will be made at the unit rate of bid per running foot length of G.I.cold water and hot water pipes. The amount bid shall be the full payment for completion of the work in all respects as specified herein.

3.2.6 Payment will be made at the unit rate of bid per running foot length of G.I. cold and hot water pipes.

3.2.7 The amount bid shall be the full payment for completion of the work in all respects as specified herein.

4. SOIL, WASTE, VENT & RAIN PIPES & PIPE FITTINGS

4.1 SCOPE

The work under this section of the specifications consists of providing all plant, equipment, appliances, material and labour for supply and proper installation of soil, waste and vent pipes and pipe fittings including clamping, cleaning, painting etc. as shown on the drawings or as specified herein.

4.2 CAST IRON SOIL, WASTE AND RAIN WATER PIPES AND FITTINGS

4.2.1 Material

The cast iron pipe shall conform to British Standard 416 for "Cast Iron spigot and socket soil, waste and ventilating pipes and fittings" with socket and spigot or hubless ends. Cast iron pipe below ground shall conform to BS 437 "cast iron spigot and socket drain pipe and fittings" with socket and spigot ends. The joint shall be lead caulked or elastomeric (Rubber Ring) to BS 2494.

Cast iron pipe shall be centrifugally (spun) cast.

The quality of material shall be according to B.S.S. No. 1452 for Grade 10.

The contractor shall supply coated pipes and fittings. The coating composition shall be of tar basis or a mixture of natural bitumen with a suitable hardner and natural asphalt. The coatings shall be smooth, tenacious, sufficiently hard, not to flow when exposed to a temperature of 63^0C and not so brittle at zero degree centigrade that it chips soft when scribed lightly with the point of a pen knife.

Every pipe shall be tested at the manufacturer's work to a hydraulic test pressure of 0.07 Mpa. Every pipe and fitting shall ring clearly when tested for soundness by being struck all over with a light hammer.

4.2.2 Installation

All cast iron soil pipes and fittings shall be installed to the lines and grades shown on the drawings or as directed by the Engineer. When required to be installed above ground floor level, suitable and substantial number of hangers and supports of approved type and make shall be provided. No piping shall be hung from the piping of other system. Clamps shall be provided on not more than 5 feet centres or a minimum of one hanger per each length of pipe whichever is smaller. Where excessive numbers of fittings are installed, additional clamps will be provided.

all steel clamps, hangers and support etc. shall be given one coat of red oxide primer and two coats of synthetic enamel paint. All exposed C.I. soil / vent pipes shall be given two coats of synthetic enamel paint. Materials for painting shall be high quality product of well known manufacturer and will be approved by the Engineer before using. The instructions of the manufacturer regarding all painting work shall strictly be adhered to.

Caulked joints for cast iron bell-and spigot soil pipe shall be firmly packed with oakum or hemp and filled with molten lead not less than 1 inch deep and not to extend more than 1/8 inch below the rim of the hub. Rubber ring joints shall also be allowed. No paint, varnish or other coatings shall be permitted on the jointing material until after the joint has been tested and approved.

Pipes passing through walls, floors, etc. shall be provided with sleeves of approved design. All vent pipes to be installed in the system shall be provided with approved cowl and will rise at least 2'-6" above the roof.

The entire system of drains, waste, and vent piping inside the building shall be tested by this Contractor under a water test. Every portion of the system shall be tested to a hydrostatic pressure equivalent to at least 10 meter head of water. After filling this Contractor shall shut off water supply and shall allow to it stand two hours, under test during which time there shall be no loss or leakage.

The Contractor shall furnish and pay for all devices, materials, supplies, labour and power required in connection with all tests. All tests shall be made in the presence of and to the satisfaction of the Engineer.

The Contractor shall also be responsible for the repair of this work & other trades work that may be damaged or disturbed by the tests.

Defects disclosed by the tests shall be repaired. Defective work shall be replaced with new work without extra cost of the Employer. Tests shall be repeated as directed, until all work is proven satisfactory.

All fixtures shall be tested for soundness, stability or support and satisfactory operation.

4.3 MEASUREMENT AND PAYMENT

Measurement for C.I. pipes, pipes shall be in running foot length and the work to be done shall include earth work, providing and fixing of pipe, pipe fittings, jointing, cutting and breaking concrete and then making it good, applying protective painting, cleaning, testing and the measurement will be made for complete work specified herein.

Payment will be made at the unit rate of bid per running foot length of pipe. The amount bid shall be full payment for the work specified herein.

5. PLUMBING FIXTURES

5.1 SCOPE

The work under this section of the specifications consists of providing all material and labour for supply and proper installation of plumbing fixtures of wash basin, kitchen sinks, laboratory sinks, water closets, urinals, etc. alongwith all their accessories, water inlet connection waste outlet connection etc. complete in all respect as specified herein or as shown on the Drawings and / or as directed by the Engineer.

5.2 MATERIALS AND INSTALLATION

5.2.1 General Requirements

Materials shall conform to the latest referenced standard specifications and other provisions stipulated herein and shall be new and unused.

All fixtures shall be of best quality and finish and shall be of approved manufacture, shape and size.

Prior to the procurement of the materials, the Contractor shall be required to prepare and submit to the Engineer for his approval, a complete schedule of materials to be used in the works together with a list of the names and addresses of the manufacturers and the trade names of the materials. The schedule shall include diagram, drawings and such other technical data as may be required by the Engineer to satisfy himself as to suitability, durability, quality and usefulness of the material to be purchased.

Approval of the schedule shall not be construed as authorizing any deviations from the specifications unless the attention of the Engineer has been invited to the specific changes. If the materials or equipment offered under this provision is, in the opinion of the Engineer, equal to or better than specified, it will be given consideration.

Plumbing fixtures shall have smooth impervious surfaces, be free from defects and concealed fouling surface. They shall be true to line, angles, curves and colour etc. Normally they shall be of local make and of the best quality available, provided. All taps and cocks to be installed with plumbing fixtures shall be chrome plated (CP) and shall be appropriate class of work without damage or leakage on the specified pressure of potable water system, which is 128 psi.

When any fixture is provided with an overflow, the waste shall be so arranged that the standing water in the fixture cannot rise on the overflow when the stopper is closed or remain in the overflow when the fixture is empty.

Plumbing fixtures shall be installed in a manner to afford easy access for cleaning. The space between the fixture and the wall shall be closely fitted and pointed so that there is no chance for dirt or vermin to collect.

When practical, all pipes from fixtures shall be run to the nearest wall.

Where fixture comes in contact with wall and floors, the joint shall be watertight.

Wall hung fixtures shall be rigidly supported by metal supporting members so that no strain in transmitted to the connections. Flush tanks and similar appurtenances shall be secured by approved non-corrosivescrews or bolts.

Fixtures shall be set level and in proper alignment with reference to adjacent walls. No water closet shall be set closer then 1.25 ft. from its centre to any side wall. No urinal shall be set closer than 1.0 ft. from its centre to any side wall or partition nor closer than 600 inches centre to centre.

The supply lines or fittings for every plumbing fixture shall be so installed as to prevent backflow.

All cuttings, making holes etc. and making it good shall be included in the work.

5.2.2 Wash Basins

Wash basin shall be Vitreous China (with or without pedestal) of approved manufacture, shape and size. It shall be installed as a complete unit including 1/2 inch CP mixer or 1/2 inch CP pillar cock, as applicable, 1/2 inch CP stop cocks, CP brass chain with 1-1/4 inch rubber plug, CP brass bottle trap for individual wash basin and CP brass P trap for battery of wash basins as applicable, CP brass strainer, heavy cast iron brackets with bolts, screws etc. plastic water inlet connection pipe, CP brass steel waste outlet and / or waste pipe, joints jointing and sealing material, etc. with all other minor accessories required to complete the job in all respect.

5.2.3 Water Closets (Orissa)

Squatting (Asian / orissa) type water closet of Vitreous China shall be of approved make, shape and size. It shall be installed as a complete unit including 1/2 inch CP stop cock, plastic water inlet connection pipe with water cistern installed at low level including inter connection flush piping and sealing material etc. with all other minor accessories.

5.2.4 Water Closets (European Type)

European type water closet (coupled or non coupled) shall be of Vitreous China of approved manufacture, shape and size

Flush tank shall be low level type, trap shall be cast integral with pan. The seat shall be of smooth non-combustible materials like Bakulite and of the open front type fixed to the pan with hinges. The toilet paper roll holder shall be of CP brass with CP brass brackets and screws etc. and fixed to the wall adjacent to water closet.

The fittings shall also include 1/2 inch CP stop cock, plastic water inlet connection pipe nuts bolts etc. required for installation.

5.2.5 Kitchen Sinks

Kitchen sink shall be stainless steel of approved make single bowl or double bowl with integral drain board, of 36" x 20" size. It shall be installed as a complete unit with arrangement for both cold and hot water supply and shall include 1/2 inch CP stop cocks, 1/2 CP mixer, water inlet connection, CP brass strainer, CP brass / steel waste outlet and uPVCwaste pipe, heavy cast iron brackets with bolts screws etc. joints, jointing and sealing material, etc. with other minor accessories.

5.2.6 Urinal

Urinal shall be of Vitreous China of approved manufacture, shape and size. Urinal shall be wall hung type either with integral water seal trap or with separate CP brass P trap. The complete unit shall be installed including 15mm CP stop cock, plastic water inlet connection pipe, automatic cast iron white stove enamel painted flush tank of 4 literscapacity with heavy duty cast iron brackets, bolts screws, joints, jointing and sealing material etc. with all other minor accessories. Whether two urinals are located nearby, one flush tank for a set of 2 or 3 urinals shall berequired.

5.2.7 Shower Head

Shower head shall be of local best quality chromium plated adjustable type installed on the wall at suitable height, complete with all accessories such as chromium plated extension pipe, CP brass escutcheon etc. including concealed CP brass stop cock.

5.2.8 Mixer for Shower Head

Mixer shall be local best quality chromium plated concealed inside wall with hot and cold water taps projecting outside wall. It shall be mounted on the wall at a suitable height near the shower head complete with all accessories.

5.3 MEASUREMENT AND PAYMENT

Measurement for wash basins, water closets, kitchen sinks, urinals, shower head and mixer of shower will be made as per actual number acceptably provided and installed. The Contractor's bid against these items shall include supply and installation of complete unit as specified herein, inclusive of all work from inlet

Connection of water supply to outlet connection with the sanitary system, complete as per Contract Documents and / or as directed by the Engineer.

Payment for wash basins, water closets, kitchen sinks, urinals, shower head and mixer of shower will be made at the applicable unit price per number bid for the respective item in the Bill of Quantities. The specified herein. The amount bid shall be full payment for all the work specified herein.

6. MISCELLANEOUS ITEMS

6.1 SCOPE

The work under this section of specifications consists of providing all material and labour, equipment, appliances etc. for supply and proper installation of miscellaneous plumbing items of valves, cocks, floor traps, floor drain, cleanouts, mirror, electric water cooler, gas water heater, float valve, foot valve as specified herein or as shown on the Drawings or as directed by the Engineer. The Contractor shall furnish appropriate catalogues and literature and obtain approval of the Engineer before purchase.

6.2 MATERIAL AND INSTALLATION

6.2.1 Bronze Valves

All valves of four inch diameter and smaller shall be of bronze unless otherwise specified conforming to BS 5154 and shall be of appropriate class for the working pressure of the system on which they are installed. Open and shut indicators shall be marked on the handle. The ends may be screwed or flanged. All valves shall be of imported of Western Europe origin or Japan.

6.2.2 Taps and Cocks

All the taps and cocks shall be of brass, gunmetal or other equally suitable corrosion resisting alloy conforming to BS 1010 and shall be imported in addition be chrome plated. The nominal size specified shall be the nominal bore of the seating. The area of the waterway throughout the body shall be not less than the area of a circle of diameter equal to the nominal size of tap / cock. Washers for cold water cocks shall be of specially selected leather, rubber asbestos composition or other equally suitable material. Every tap / cock shall be tested, complete withits component parts, to a hydraulic pressure of at least 1.96 Mpa During test it shall neither leak or sweat.

6.2.3 Floor Drains

Floor drains shall be cast iron or of other anti-corrosive metal. They shall have minimum water seal of 2 inches and shall be provided with removable metal strainer. The traps shall be of self-clearing type. Theopen area of the strainer shall be at least equal to the cross section area of the drain line to which it connects. Floor drains shall have provision for connection above the water seal. Floor drain shall be well set in position so that there is no leakage at the joint between trap and the floor.

6.2.4 Cleanouts

Cleanouts shall be of the same nominal size as the pipe on which it is installed. Cleanout shall consist to tapped heavy duty cast iron ferrule caulked into cast iron fitting and heavy duty brass tapered even plug. Cleanouts shall be turned up through floors by long sweep fittings, whether the space so permits. Top finish of cleanout shall be flush with thefloor by means of finished metal plate secured in position and screwed firmly to the plug.

Cleanout shall be so installed that there is a clearance of at least 12 inches for pipes less than 3 inches diameter and at least 18 inches for pipes of 3 inches and larger diameter, for the purpose of rodding.

Cast, iron pipe used with cleanout shall be measured and paid under cast iron pipe item. All other work of ferrule, plug, concrete work, frame and cover etc. shall be measured and paid under cleanout item.

6.2.5 Glass Mirror

The glass mirror shall be of beast quality and of size, as approved by the Engineer, securely fixed on hard board packing and first class quality. The mirror shall be fixed on wall as shown on the drawing or as directed by the Engineer.

6.2.6 Towel Rail

The towel rail shall be of size as approved by the Engineer of chrome plated steel and shall be fixed to wall with chrome-plated brackets.

6.2.7 Electric Water Cooler

Cabinet shall be of heavy gauge mild steel construction painted with non-corrosive paint from inside and with special hammer finish paint from outside.

Push button type water taps shall be chrome plated. Drain pot shall be made of hard plastic with stainless steel tray. Back panel shall be easily removable for cleaning and servicing. Top cover shall be of scratch proof formica.

Water storage tank shall be either of stainless steel or copper alloy, tinned inside and outside with present insulation to maintain water temperature, with special arrangement for cleaning the tank.

Condensing unit shall be heavy duty, of renowned make, hermetically sealed with thermal overload protection for refrigerant F-12 and capillary expansion with valves for easy gas charging.

Thermostat and other control necessary for proper functioning of the unit shall be provided. When water connection and floor drain not shown on the drawing for water cooler and is required, it is to be provided at no additional cost by the Contractor.

The thermostat shall control the temperature of cooled water between + 11^{o}C to + 20^{o}C.

Water storage tank shall be rated for working pressure of 4 kg. / cm2 and test pressure of 6 kg. / cm2/.

6.2.8 Gas Water Heater

Hot water heater shall be automatic, storage and gas operated including all necessary fittings and accessories for complete installation & operation.

The minimum requirement of material and finish for the inner and outer shells shall be as given in the table below. Thicknesses of the outer and inner shells shall be adequate to withstand the rated pressure, but shall not be less than the thicknesses given in the table below.

Heater		Inside	Outside	
Capacities	Shells	Material	Finish	Finish
Less than 50 Gallons	Inner	* 14 SWG Steel	Galvanized	Galvanized
Outer	22 SWG	Steel	Galvanized	Galvanized and finished with synthetic enamel
50 to 100 Gallons	Inner	12 SWG Steel	Galvanized	Galvanized
Outer	22 SWG	Steel	Galvanized	Galvanized and finished with synthetic enamel
Over 100 Gallons	Inner 10 SWG Steel	Galvanized		Galvanized and lined with at least 1.5mm thick copper sheet
Outer	22 SWG	Steel	Galvanized	Galvanized and finished with baked enamel

- SWG – Standard Wire Gauge

The annular space between outer vessel & inner vessel shall be filled with fibre glass, glass wool or similar insulation material with thermalconductivity of not more than 0.04 W/M-^{o}C.

The working & test pressure of the heater shall be 5 bars and 10 bars respectively. The burner capacity shall be adequate for delivering water at not less than 70^{o}C at rated output capacity.

Heater shall be provided with following accessories:

i Thermostatic control
ii Safety pilot
iii Temperature & pressure relief valve
iv Burner
v Drain valve
vi Auto-shut off in case of failure of pilot lamp

6.2.9 Floor Traps

Floor traps shall be of cast iron or of other anti corrosive-metal. They shall have minimum water seal of 50 inch. And shall be provided with removable nickel bronze strainers. The traps shall be of self cleaning type. The open area of the strainer shall be greater than the cross section area of the drain line to which it connects. Floor traps shall be well set in position so that there is no leakage at the joint between trap and the floor.

6.2.10 Float Valve

Floor valve shall be of copper alloy, piston type and conform to BS 1212. Float shall be of copper conforming to BS 1968.

6.2.11 Foot Valve

Foot valve shall be installed on the suction line of the pumps whererequired or indicated on the drawing. Foot valve shall be of brass, andshall be provided with integral strainer. Foot valve shall be provided witha spring loaded vertical check disc with gasket for tight shut-off.

6.2.12 Floor Gully

Floor gullys shall be of cast iron or of other corrosive metal, and provided with removable nickel bronze strainers. The open area of the strainers shall be greater than the cross section area of the drain line to which it connects. Floor gullys shall be well set in position so that there is no leakage at the joint between gully and the floor.

6.2.13 Gully Traps

Gully traps in brick masonry chamber as shown on the drawing shall be provided with a P-trap having a 2-1/2 inches minimum water seal and a cast iron frame and cover of size 12" x 12" and shall be internally plastered with pudlo as approved by the Engineer.

6.2.14 Cowel

All vent pipes terminating above the building shall be provided with best quality cast iron cowel and a stainless clamp for clamping of water proofing membrane as approved by the Engineer.

6.3 MEASUREMENT AND PAYMENT

Measurement for payment of valves, taps & cocks, floor drain floor traps, cleanouts, glass mirror, towel rail, electric water cooler, gas water heater, floor traps, float valve, foot valve, floor gully, Gully trap and cowel shall be made on the basis of actual number acceptably provided and installed in position. The Contractor's bid against these items shall include providing and installation complete as specified herein and / or as shown on the Drawings.

Payment for valves, taps & cocks, floor drain floor traps, cleanouts, glass mirror, towel rail, electric water cooler, gas water heater, floor traps, float valve, foot valve, floor gully, Gully trap and cowel shall be made at the applicable unit rate per number bid in the Bill of Quantities. The bid amount shall be full payment for the works specified herein and as shown on the drawings.

7. FIRE PROTECTION

7.1 SCOPE OF WORK

The works covered under this section of the specifications include supply of Portable Fire Extinguishers in accordance with these specifications.

7.2 MATERIALS AND INSTALLATION

7.2.1 Portable Fire Extinguishers

Portable fire extinguishers shall contain specified quantities and types of extinguishing agents. Extinguishers shall be classified according to type of extinguishing agents and the Class of fire types for which it is intended to be used. The extinguisher container / vessel shall be of anticorrosive material or otherwise lined internally with corrosion-resistant material. The outside surfaces of the container / vessel shall be painted with at least two coats of anti-corrosive paint.

The extinguisher container shall be designed as pressure vessel and shall conform to all the applicable standards of ASME pressure vessel codes.

The container shall be fitted with spring loaded pressure safety valve. The valve shall be set to blow off at 90% of container test pressure.

7.2.2 Codes and Standards

Portable fire extinguishers shall conform to NFPA (National Fire Protection Association) of U.S.A. or F.O.C. (Fire Offices Committee) of U.K. and B.S. 5423.

7.2.3 Carbon Dioxide Extinguisher

Carbon dioxide extinguisher shall contain specified quantities of carbon dioxide gas under pressure. The extinguisher shall have knob or lever operated valve, a short length of hose and a discharge hose at the end of the hose. A siphon / dip tube shall extend from the valve to the bottom of the container. The valve shall have safety pin to prevent accidental release of the extinguishing agent.

When operating the discharge time for 10lbs. Carbon dioxide extinguisher shall not be less than 9 seconds.

7.2.4 Foam Extinguisher

Foam extinguisher shall contain specified quantities of premixed foam of 1 liter protein foam concentrate mixed with 8 liters of water extinguisher shall be pressurized with nitrogen. The extinguisher shall have a short length of hose and valved nozzle. The valve shall have safety pin to prevent accidental release of the extinguishing agent. The extinguishers shall be self-expellant. In no case antifreeze additive shall be used.

When operated the throw for 9 liters foam extinguisher shall not be less than 6 meters. The discharge time shall be not less than 60 seconds.

7.2.5 Dry Chemical Extinguisher

Dry chemical extinguisher shall contain specified quantities of dry powder chemical. The type of dry powder shall be suitable for the intended class of fire. The extinguisher shall have knob or lever operated valve, a short length of hose and a nozzle at the end of the hose. A siphon / dip tube shall extended from the valve to the bottom of the container. The valve shall have safety pin to prevent accidental release of the extinguishing agent. The discharge pressure shall be obtained from pressurized carbon dioxide catridge attached to the body of the extinguisher. The operation of the knob or lever shall pierce the catridge to obtain the expellant pressure. The operated the discharge time of 4.5 kg. Dry power extinguisher shall not be less than 9 seconds.

7.2.6 Installation

Portable fire extinguisher shall be installed at one foot high above finished floor.

Where only extinguishers are installed they shall be fixed to wall orcolumn with painted steel clamps or stored in steel or concrete fire extinguisher cabinet as shown on the drawings or as directed by the Engineer. Where clamped to the wall / column the clamp shall be such thatextinguisher be conveniently fixed removed without loss of time.

Where stored in cabinets they shall be constructed of steel or concrete with glazed steel door painted with at least two coats of anti-corrosive bright red paint colour. The locking arrangement will be such that the door can be opened from inside by breaking the glass and from outside with key.

7.2.7 Marking

Portable Fire extinguishers shall be painted with colour code according to British Standard specifications. On the body of the extinguishers shall be marked / imprinted the following informations.

a) Instructions on how to use the extinguishers.

b) Name of the extinguishing agent.

c) Weight / volume of the extinguishing agent.

d) Gross weight of the extinguisher.

e) Filling pressure of the extinguishing agent.

f) Classes of fires for which the extinguishing agents may be effectively used.

g) Name of the manufacturer and the year of manufacture.

7.2.8 Measurement and Payment

Measurement of Portable Fire Extinguishers shall be made as per actual number of extinguisher acceptably provided and installed in position in accordance with the above specifications and applicable drawings.

Payment for Portable Fire Extinguishers shall be made at the applicable unit price per number quoted in the bid for the item in the Bill of Quantities.

8. ROOF DRAINAGE

8.1 ROOF DRAINS

Roof drains shall be of bitumen coated cast iron. They shall have dome shaped strainers extending at least 10 inch above the roof surface immediately adjacent to them, when installed on corner of the roof. Bottom of strainer shall be flush with the roof surface. Strainer shall have an available inlet area, above roof level, of not less than 1-1/2 times the area of the down-pipe to which the drain is connected. The connection between roof and roof drain shall be made watertight by the use of proper flashing material.

8.2 RAIN WATER SHOE

Rain water shoe shall be of bitumen / asphalt coated cast iron, anti-splash type of B.S. 416. The grade of shoe shall be same as that for rain water pipe to which it connects. The shoe shall be fixed 12 inches above the surface to which it discharges freely.

8.3 MEASUREMENT AND PAYMENT

Measurement of acceptably completed works of roof drain and rain water shoe will be made on the basis of actual number of roof drains and rain water shoe provided and installed in position as shown on the drawing or as directed by the Engineer.

Payment will be made for acceptable measured quantity of rain water shoe on the basis of unit rate per number quoted in the Bill of Quantities & shall constitute full compensation for all the works related to the item.

9. UPVC PIPE & FITTINGS

9.1 UPVC WASTE AND VENT PIPES & FITTINGS

Unplasticised (above underground) and BS 4660 (below ground) PVC pipes for waste and vent shall be non-pressure pipes conforming to BS 4514. Fittings and specials for use with UPVC pipes shall conform to BS 4346 with elastomeric (Rubber ring) or solvent cement joint to BS 4346. Clamps hangers and supports shall be as given for G.I. pipes.

9.2 MEASUREMENT AND PAYMENT

Measurement for UPVC pipes, pipes shall be in running foot length and the work to be done shall include earth work, providing and fixing of pipe, pipe fittings, jointing, cutting and breaking concrete and then making it good, applying protective painting, cleaning, testing and the measurement will be made for complete work specified herein.

Payment will be made at the unit rate of bid per running foot length of pipe. The amount bid shall be full payment for the work specified herein.

SECTION – 5180

TESTING AND COMMISSIONING

1. SCOPE

The work under this section of specifications includes furnishing all plants, labour, equipment, appliances and material and performing all operations required in connection with testing and commissioning of all water line, drainage system and fixture etc. in parts and as a whole as specified herein or as shown in the Contract Documents or as directed by the Engineer.

2. GENERAL

The testing shall include a complete visual inspection of the whole plumbing and fire fighting system and verification or performance as stipulated in the material specification and of correct functioning of the electrical and control systems.

All supply documents, operating instructions, acceptance documentation and maintenance regulations shall be checked to ensure that they correspond with equipment described and also all certificates such as that of the inspection authorities, test certificates and data about quality, temperature and pressure shall be submitted.

3. FIXTURES AND FITTINGS

3.1 TEST PROGRAMME

The type and the catalogue number of the sanitary fixtures shall be checked.

All equipment in general including the accessories shall be checked for service ability, correct operation and freedom from damage.

The flow and water capacity shall be checked on the full connection of lavatories, showers, WC's, etc. and also the draining capacity shall be measure at the same time.

4. POTABLE WATER SUPPLY SYSTEMS (HOT & COLD)

4.1 TEST PROGRAMME

The method of laying and sealing the water connections lines to the buildings and through walls shall be checked.

Visual inspection shall be made of the entire network for the water system with regard to laying, fixing, suspension of pipes and fixtures, particularly the arrangements of the fixed points and the separation of the individual connections in the various parts of the system.

The satisfactory function of all valves, air relief valve check-valve, pressure reducer, thermostats, pumps, etc. shall be checked. The test programme shall also cover:

- Checking of type, thickness and professional laying of the piping insulation.
- Checking number, form and inscription of the equipment labeling.
- Checking of all pipes and flanged connections to devices, water-heaters, air conditioning devices, drainages and vents for symmetry and lack of strain.
- Checking of the setting of pressure reducing valve with reference to the pressure conditions specified with or pressure gauge.
- Performance of pressure test for the entire network, including fixtures.

4.2 HYDRAULIC PRESSURE TEST

On completion of the pipe work installation, or sections thereof as required, pressure test shall be made before the application of insulation. The pressure tests shall be taken by sectors. All equipment and accessories shall be provided and the Engineer incharge shall be given notice that the work is ready for testing. Tests shall be made by pumping up the system to the required pressure then closing the valves between the pump and the section under test. The valve shall remain closed for the duration of the test and the pump shall be disconnected. Test pressure, as detailed below shall be applied as detailed for the period two hours or longer, as the discretion of the Engineer. If, at the end of period, there is no drop in pressure and no evidence of leak or other faults, the test will be considered satisfactory.

Should any fault be revealed by the test, leaks are to be recorded. Faults hall be made good and the pipe work retested as many times as necessary until satisfactory results are obtained. No additional charges shall be allowed for retesting of any section of the works found at fault.

After all the pipes and fixtures have been properly laid and tested, they shall be flushed clean with water and disinfected with water solution of chlorine of at least 50 ppm strength for a contact period 6 hours. The system will be finally flushed with clean water.

4.3 TEST PRESSURE AND PROCEDURE

Fill pipes slowly with potable water to exclude all air. Apply test pressure of 1.5 times the maximum working pressure.

There must be no measurable loss of pressure for at least 30 minutes.

5. DRAINAGE SYSTEMS

5.1 TEST PROGRAMME

Check the piping by means of the separation system, in relation to the satisfied capacity.

Check each connection for dimension and draining capacity.

Check the drain line for laying, fixing, compliance with specification.

Check the practical arrangement of the fixtures, fixing points, suspensions, cleaning openings, vent, pit covers and ground inlets.

Check all the covers and openings, paying special attention to the separation system for waste / sewage and the storm water.

Generally provide clean water and apparatus for testing.

5.2 TEST METHODS

a. Water Testing

All the openings in the piping system shall be tightly closed by inserting testing plug. The highest point will be left open to supply water and may be raised if necessary by temporary jointing, develop a minimum static head of 0.5 bar for of water at each section of the system. Water is filled tothe point of overflow and any drop in the level of water will indicate a leakthat will be found by inspection. The water level will be checked for no drop for at least 15 to 30 minutes. Higher stacks will be tested in sections, starting from the top section and then connecting to section to next lower section.

b. Timing

Testing shall be carried out as soon as practicable after completion of each drainage stack. All concealed work shall be tested before being finally enclosed.

6. FIRE FIGHTING SYSTEMS

6.1 STAND PIPE SYSTEM

Test Programme

Visual inspection shall be made of the entire network for the stand pipe system with regard to laying, fixing, suspension of pipes, particularly the arrangements ofthe fixed points and the separation of the individual connections in the various parts of the system.

The satisfactory function of all valves, air relief valve check-valves, pressure gauges, shall be checked.

The test programme shall also cover:

- Checking number, form and inscription of the labeling.

- Performance of pressure test for the entire network.

6.2 HYDRAULIC PRESSURE TEST

As described for potable water supply system.

6.3 TEST PRESSURE AND PROCEDURE

As described for potable water supply system.

7. MEASUREMENT AND PAYMENT

No payment shall be made for the works involved within the scope of this section of specification unless otherwise specifically stated in the Bill of Quantity or herein. The cost thereof shall be deemed to have been included in the quoted unit rate of other item ofthe Bills of Quantities.

SECTION – 5233

CAST IRON COVERS WITH FRAMES & LADDER RUNGS

1. SCOPE

The work to be done under this section of the specifications consists of furnishing all plant, labour, equipment, appliances, material and performing all operations required in connection with supply and proper installation of C.I. cover with frame, and ladder rungs, complete as specified herein, as shown on the drawings, or as directed by the Engineer.

2. CAST IRON COVER WITH FRAME

Cast iron cover and frame shall be of the size and duty as specified on the drawings. The specified size means the clear opening. The cover shall be complete with frame. Top of cover shall be roughened in an approved pattern. Locking and lifting arrangement shall also be provided. The frames shall be well set in place at the time of pouring of concrete. The cover shall tightly fit in the frame. It shall be air-tight and water-tight. The duty, weight, test and working load for 2 feet circular or square C.I. cover and frame shall be asfollows:-

Class / Duty of Cover and Frame Load	Gross Weight	Peak or Test Load	Services Working
Extra Heavy Weight	610-650lb	35.0 Ton	11.67 Ton
Heavy Weight	440-480lb	15.0 Ton	5.0 Ton
Medium Weight	285-325lb	5.0 Ton	1.67 Ton
Light Weight	155-195lb	1.0 Ton	Up to 0.33 Ton

3. LADDER RUNGS

Galvanized mild steel ladder rungs shall be fabricated to the size specified on the drawings or as directed by the Engineer. The galvanized mild steel ladder rungs shall be fitted by approved fittings at locations shown on the drawings or as directed by the Engineer.

4. MEASUREMENT AND PAYMENT

Unless otherwise specifically mentioned herein or else where in the Contract Documents, no separate measurement and payment will be made for the works involved within the scope of this section of the specifications. The cost thereof shall be deemed to have been included in the quoted unit rate of the relevant items of the Bills of Quantities.

SECTION – 5270

VALVES AND APPURTENANCES

1. SCOPE

The work to be done under this section of the specifications included furnishing all plant, labour, equipment, appliances, material and performing all operations required in connection with supply, installation, testing, disinfection (only for potable water) and commissioning of valves and appurtenances as specified herein, in bill of quantities as shown on the drawings and / or as directed by the Engineer.

2. APPLICABLE CODES AND STANDARDS

All works and materials under this section shall conform to the latest edition of the following applicable codes and standards.

When the requirements of this specifications or the drawings exceed the code requirements, the Contractor shall be bound by the specifications and / or drawings for that requirements.

B.S. 10	:	"Flanges and Bolting for Pipes, Valves and Fittings".
B.S. 21	:	"Pipe Threads for Tubes and Fittings".
B.S. 4090	:	"Cast Iron Check Valves for General Purposes".
B.S. 5150	:	"Cast Iron Wedge and Double Disk Gate Valves for General Purposes".
B.S. 5152	:	"Cast Iron Wedge and Double Disk Gate Valves for
B.S. 5153	:	"Cast Iron Check Valves for General Purposes".
B.S. 5155	:	"Cast Iron and Carbon Steel Butterfly Valves for General Purposes".
B.S. 5154	:	"Copper Alloy Globe, Globe Stop and Check, Check and Gate Valves for General Purposes".
I.S.O. 898	:	"Mechanical Properties of Fasteners, Bolts, Screws and (Part-I) Studs".

Other authoritative codes and standards which ensure equal or higher quality then those references may also be acceptable subject to approval of the Engineer.

Any conflict between the requirements of this specification and those on the drawings or bill of quantities or in the codes, standards and specifications referred to herein shall be brought to the attention of the Engineer for resolution whose decision will be final and binding.

3. APPLICABLE SECTION OF TECHNICAL SPECIFICATIONS

The following specification sections except for sub-sections "Measurement and Payment" shall be followed for carrying out associated works mentioned herein below.

Section No.	Description
2100	Formwork
2200	Reinforcement
2300	Plain and Reinforced Concrete
6700	Painting

4. GENERAL REQUIREMENTS

4.1 Valves and appurtenances shall be new and unused.

4.2 Every valve and appurtenance shall be tested at the manufacturer's works to specified hydraulic test pressure and if so directed, the test result shall be submitted to the Engineer.

4.3 Where manufacturers of valves and appurtenances are specified, they shall be of the same manufacturers unless otherwise approved by the Engineer.

4.4 Where more than one similar items of valves and appurtenances are specified, they shall be the same manufacturer.

4.5 The Contractor shall submit to the Engineer for approval of the following information regarding the specified / proposed items of valves and appurtenances.

(i) Name and address of the manufacturers.

(ii) Country of origin, made and model.

(iii) Duty and service (pressure) rating of valves and appurtenances.

(iv) Material of all components of valves and appurtenances.

(v) Factory test certificate from the manufacturers.

(vi) Warranty if so provided by the manufacturers.

(vii) Method of jointing, testing and commissioning.

4.6 Approval by the Engineer shall not be construed as authorizing any deviation(s) from the specifications unless they are specifically brought to notice of the Engineer.

4.7 Approval by the Engineer shall not relieve the Contractor from any of his contractual responsibility regarding satisfactory performance and other requirements of the pipes and fittings.

5. SPECIAL REQUIREMENTS

5.1 Valves and appurtenances shall be suitable for the intended use. Valve and appurtenances' parts in contact with water shall be of corrosion resistant material, free from toxic substances and shall not foster microbiological growth or impart taste, odour, turbidity or colour of the water.

5.2 If so directed by the Engineer, valves and appurtenances shall be bench tested at the Contractor's work site to the specified hydraulic pressure which shall be not less than the service pressure of the valve or 1-1 ½ times the working (or static) pressure whichever is greater. The test pressure shall be maintained for sufficiently long time for proof and inspection. No payment shall be made for the test and the cost. Thereof shall be deemed to be included in the quoted unit ratefor the relevant item of the work.

5.3 Each valve and appurtenance shall be permanently marked or engraved giving the following information:-

(i) Make and Nominal diameter
(ii) Class, Duty or Service (Pressure) Rating
(iii) Standards according to which the valves and appurtenances have been manufactured.

5.4 Valves and appurtenances shall be of reknown manufacturers.

5.5 Unless otherwise specified, service rating of valves and appurtenances shall not be less than the maximum pressure to which they will be subjected to.

5.6 Unless otherwise specified, valves and appurtenances shall be according to the class, schedule or duty of the pipes and fittings to which they are joined.

5.7 Valves and appurtenances ends shall be matching and compatible with the ends of pipes, fittings, valves or appurtenances to which they will be joined.

5.8 Unless otherwise approved by the Engineer, pipes and fittings, jointing materials such as rubber rings, gaskets, nuts and bolts and jointing compound etc. shall be of the same manufacturers as those of the pipes and fittings.

6. SPARE PARTS, SPECIAL TOOLS, OPERATION AND MAINTENANCE MANUAL & P.I.D.

6.1 The Contractor shall submit to the Engineer for approval the manufacturers' recommended list of spare parts sufficient for three years operation and maintenance of the valves and appurtenances.

6.2 After approval, the Contractor shall supply free of cost to the Employer the recommended spare parts. The cost thereof shall be deemed to have been included in the quoted rate of the relevant items of the Bill of Quantities.

6.3 The Contractor shall supply at mutually agreed prices to the Employer any spare part(s) additional to and over and above the manufacturer's recommended list of spare parts, if so directed by the Engineer.

6.4 The Contractor shall submit to the Engineer for approval the list of special tools such as tools kit, grease gun etc. required for operation and maintenance of the valves and appurtenances.

6.5 After approval, the Contractor shall supply free of cost to the Employer the required special tools. The cost thereof shall be deemed to have been included in the quoted rate of the relevant items of the Bill of Quantities.

6.6 After Contractor shall furnish free of cost to the Employer two copies of operation & maintenance manual containing complete information regarding dismantling, assembly, lubrication, adjustment, operation and maintenance of the valves and appurtenances. The cost thereof shall be deemed to have been included in the quoted rate of the relevant items of the Bill of Quantities.

6.7 The Contractor shall furnish free of cost to the Employer two copies of P.I. (process and instrumentation) diagram of the valves and appurtenances as installed and commissioned showing location of all valves and appurtenances.The cost thereof shall be deemed to have been included in the quoted rate of the relevant items of the Bill of Quantities.

7. INSTALLATION

7.1 Before installation, interior of the valves and appurtenances shall be thoroughly cleaned of all rust, dirt and foreign materials, inspected to ensure that all components are sound and in working condition and tested to 2 minutes the working pressure or the service pressure whichever is greater.

7.2 Valves and appurtenances shall be installed in position as shown on the drawings and / or as directed by the Engineer. Air release valve shall be provided at all high points to ensure adequate venting of the piping system. Valves shall be in perfect alignment and level and adequately supported.

7.3 After installation, all damaged paints shall be removed from the valves and appurtenances, the surfaces shall be cleaned with wire brush and repainted / retouched with at least two coats of red oxide or zinc chromate primer and one coat of synthetic enamel paint of approved colour and quality. One liter of paint shall apply to 10 Sq. meters of the surface area of each coat. The thickness ofpaint shall however, not be less than 50 microns.

7.4 After repainting / retouching valves and appurtenances shall be properly labeled.

8. TESTING

After installation, valves and appurtenances shall be tested to 1-1/2 times the working or static pressure, whichever is greater. During the test valve and appurtenances shall be operated through their full range.

9. DISINFECTIONS

Not used.

10. COMMISSIONING

After testing and disinfection (only for potable water), valves shall be set at their specified or appropriate openings or valves.

11. VALVES

11.1 GENERAL

Isolating valves shall close in clockwise direction. The direction of closure shall be permanently marked on the body of the valve. Isolating valves larger than 300 mm diameter and shall be gear driven.

Check valve shall be of non-slam type. The direction of flow shall be permanently marked on the body of the valve.

Inside surfaces of valves shall be enameled and outside surfaces shall be epoxy coated.

11.2 CAST IRON GATE VALVES

Cast iron gate valves shall be outside stem and yoke type (O.S. & Y) type with flanged ends and wheel handle and shall conform to B.S. 5150. flanges shall be drilled to B.S. 10 (Table ‘E’). Valves shall be rated for a working / service pressure of 10 bars.

The valve parts shall be of following materials.

- Valve body shall be of cast iron.
- Flanges shall be of cast iron.
- Shaft shall be of stainless steel.
- Disc shall be of cast iron with bronze trim.
- Seat shall be of cast iron with bronze trim.
- Disc and shaft seal shall be of rubber (O-ring type).
- Wheel handle shall be of cast iron.

11.3 CAST IRON CHECK VALVES

Cast iron check valves shall be of non-slam, swing type with flanged ends and wheel handle and shall conform to B.S. 5153. Flanges shall be drilled to B.S. 10, (Table 'E'). Valves shall be rated for a working / service pressure of be 10 bars.

The valve part shall be of the following materials.

- Valve body shall be of cast iron.
- Flanges shall be of cast iron.
- Shaft and spring shall be of stainless steel.
- Disc and seat shall be of cast iron with bronze trim.
- Disc and shaft seal shall be of rubber (O-ring type).
- Wheel handle shall be of cast iron.

11.4 DUCTILE IRON BUTTERFLY VALVES

Ductile iron butterfly valves shall be vertical rotating disc type with flanged ends and wheel handle and shall conform to B.S. 5155. Flanges shall be drilled to B.S. 10 (Table 'E'). Valves shall be rated for a working / service pressure of 10 bars. Valves shall close in clockwise direction.

Valves' part shall be of the following materials.

- Valve body shall be of ductile iron.
- Flanges shall be of ductile iron.
- Shaft shall be of stainless steel.
- Disc and seat shall be of ductile iron with bronze trim.
- Disc and shaft seal shall be of rubber (O-ring type).
- Wheel handle shall be of cast iron.

Valves shall be designed for operation in partially closed / throttled position for long period of time. Disc shall rotate through an angle of 90 degrees from the fully open to the fully closed position. Adjustable mechanical stops shall be provided to prevent over-travel of the disc in both the open and closed positions.

11.5 DUCTILE IRON CHECK VALVES

Ductile iron check valves shall be of non-slam, spring loaded, swing type with flanged ends and wheel handle and shall conform to B.S. 4090. Flanges shall be drilled to B.S. 10, (Table 'E'). Valves shall be rated for a working / service pressure of 10 bars.

Valves' part shall be of the following materials.

- Valve body shall be of ductile iron.
- Flanges shall be of ductile iron.
- Shaft and spring shall be of stainless steel.
- Disc (flat) and seat shall be of ductile iron with bronze trim.
- Disc and shaft seal shall be of rubber (O-ring type).

11.6 BRONZE GATE VALVES

Bronze gate valves shall conform to B.S. 5154. Valves shall be rated for aworking / service pressure of 10 bars. Valves ends shall be screwed or flanged as shown on the drawings. Threads shall be to B.S. 21 and flanges shall be drilled to B.S. 10 (Table 'E').

11.7 BRONZE CHECK VALVES

Bronze check valves shall conform to B.S. 5154. Valves shall be rated for a working / service pressure of 10 bars. Valves ends shall be screwed or flanged as shown on the drawings. Threads shall be to B.S. 21 and flanges shall be drilled to B.S. 10 (Table 'E').

11.8 STAINLESS STEEL GATE VALVES

Stainless steel gate valves shall conform to I.S.O. Standards or equivalent. Valves shall be rated for a working / service pressure of 10 bars. Valves ends shall be screwed or flanged as shown on the drawings. Threads shall be to B.S. 21 and flanges shall be drilled to B.S. 10 (Table 'E').

11.9 STAINLESS STEEL CHECK VALVES

Stainless steel check valves shall conform to I.S.O. Standards or equivalent.Valves shall be rated for a working / service pressure of 10 bars. Valves ends shallbe screwed or flanged as shown on the drawings. Threads shall be to B.S. 21 and flanges shall be drilled to B.S. 10 (Table 'E').

11.10 STAINLESS STEEL BALL VALVES

Stainless steel ball valves shall conform to I.S.O. Standards or equivalent. Valves shall be rated for a working / service pressure of 10 bars. Valves ends shall be screwed or flanged as shown on the drawings. Threads shall be to B.S. 21 and flanges shall be drilled to B.S. 10 (Table 'E').

11.11 SURGE RELIEF VALVES

Surge relief valves shall be spring operated globe type for continuous services conforming to ISO Standards or equivalent. Valves body shall be of cat iron with stainless steel trim. Spring shall be of stainless or high tensile steel. Flanges shall be drilled to B.S. 10 (Table 'E'). Valves shall be rated for a working / services pressure of 16 bars. Valves shall relieve pressure when the surge pressure in the system exceeds the present value. The setting will be adjustable between 6 to 9 bars.

11.12 AIR RELEASE VALVES

Air release valves shall be suitable for the liquid for which it is used. Valves body and cover shall be of malleable iron. Float and valve seat shall be of stainlesssteel. Valve head shall be of Viton (synthetic rubber). Valve ends shall be screwed or flanged as shown on the drawings. Threads shall conform to B.S. 21 and flanges shall be drilled to B.S. 10 (Table 'E').

12. APPURTENANCES

12.1 ANGLE PIPE STRAINERS

Angle pipe strainer shall be of removable type suitable for installation on pump's suction pipe. Angle pipe strainer shall be rated for a working / service pressure of 10 bars. Body or housing of the strainer shall be of cast iron with flanged ends. Flanges shall be drilled to B.S. 10 (Table 'E'). Strainer shall be of stainless steel. Wall thickness of the strainer shall not be less than 3 mm. Open area of the strainer shall not be less than 1-1/2 times the cross-sectional area of the pipe on which it is installed.

12.2 VIBRATION ISOLATORS

Vibration isolators shall consist of reinforced synthetic rubber below and cast iron / steel flanges drilled to B.S. 10 (Table 'E').

Isolators shall be rated for a working / service pressure fo 10 bars. Isolators shall be installed on pumps' discharge pipe to limit transfer of pumps' vibrations to discharge piping and to absorb sound resulting from the vibrations. Isolators shall allow pipe movement by not less than the following amount.

Axial Elongation	-	35 mm
Axial Compression	-	50 mm
Transverse Movement	-	35 mm
Angular Rotation	-	30^{o}

The flexibility of the below shall not reduce with time or aging.

13. MEASUREMENT AND PAYMENT

13.1 GENERAL

Except otherwise specified herein or elsewhere in the Contract Documents, no measurement and payment will be made for the under mentioned specified works related to the relevant items of the Bill of Quantities. The cost therefore shall be deemed to have been included in the quoted unit rate of the respective items of the Bill of Quantities.

13.1.1 Adopter for jointing with pipes and fittings on both ends of the valve.

13.1.2 Jointing material such as nuts, bolts, gasket and jointing compound required for jointing with pipes and fittings on both ends of the valve.

13.1.3 Supports and anchors for valves and appurtenances.

13.1.4 Keys for operation of valves.

13.1.5 Steel embedded parts and label plates.

13.1.6 Manufacturer's literature, operation & maintenance manual and P.I. Diagram.

13.2 MEASUREMENT

Measurement of acceptably completed works of valves and appurtenances will be on the basis of actual number of valves and appurtenances provided, installed in position, tested, disinfected (only for potable water) and commissioned as specified herein, in bill of quantities, as shown on the drawings and as directed by the Engineer.

13.3 PAYMENT

Payment for the acceptably measured number of valves and appurtenances shall be made on the basis of unit rate per number for each valve and appurtenance quoted in the Bill of Quantities and shall constitute full compensation for all the works related to the item.

SECTION – 5311

CONCRETE PIPE AND FITTINGS

1. SCOPE

The work covered by this section of the specifications consists of furnishing all concrete pipes and pipe fittings, plant, labour, equipment, appliances and materials and in performing all operations required for installing and testing the sewer pipes in strict accordance with the specifications of this section and applicable drawings and subject to the terms and conditions of the contract.

2. MATERIALS

2.1 GENERAL

Materials shall conform to the latest referred standard specifications and other provisions stipulated herein and shall be new and unused. Prior to procurement of the materials, the Contractor shall be required to prepare and submit to the Engineer for his approval a complete schedule of materials to be used in theworks together with a list of the names and addresses of the manufacturers and thetrade names of the materials. The schedule shall include diagrams, drawings and such other technical data as may be required by the Engineer to satisfy himself as to the suitability, durability, quality and usefulness of the material intended to be purchased.

2.2 SEWER PIPE AND PIPE FITTINGS

All sewer pipes and pipe fittings shall conform to ASTM designation C-14 Class 3 for dia 8 inch & 10 inch and C-76 Class III wall 'B' type for size dia 12 inch or larger, latest revision of the specified standard shall be applicable in all cases.

2.3 RUBBER RINGS

The rubber rings to be used for jointing sewer pipes and pipe fittings shallconform to latest revision of ASTM designation C443 "Joints for Circular Concrete Sewer and Culvert Pipe using flexible Water Rubber Type Gaskets".

The tongue or spigot end of each pipe shall be specially designed to form groove or offset to fit the manufacturer's rubber ring design. Rubber rings for use shall be supplied by the pipe manufacturer.

3. LAYING AND INSTALLATION

3.1 FACTORY TESTS

The Contractor shall inform the Engineer the schedule of pipe manufacturing in the factory for this particular project. The Engineer may visit pipe factory to inspect the pipe manufacturing process. The Engineer may assign his representative to supervise the manufacturing and testing of pipes.

The Contractor shall assign his representative at factory to supervise the pipe manufacturing and quality control.

The Contractor shall arrange the following tests at factory in the presence of Engineer or his representative on selected pipe samples.

i. Three edge bearing test.
ii Absorption Test.
iii Permeability Test.

All the manufacturing pipes shall be individually checked for cracks and other defects before transportation to the site.

All pipes shall be properly marked at factory, to identify the project consignment.

3.2 SITE DEMONSTRATION TEST

3.2.1 The Contractor shall arrange the site visits of the pipe manufacturer or his representative to explain and demonstration the pipe jointing, laying and hydraulic pressure testing procedure for all the pipe sizes, in the presence of Engineer before actual laying of sewer pipes in the trenches.

Hydraulic pressure test shall be performed on at least five laid pipe lengths joined in a straight line with approved type rubber gaskets.

Separate demonstration test will be required for each sewer pipe size to be installed. Requirements of standard hydraulic pressure test specified in the later part of this section shall be applicable to this demonstration test.

Pipe joints and pipe surfaces shall be inspected during this demonstration. If the pipe joint are found leaking and the leakage is more than theallowable limits, the demonstration will be rejected and the Contractorwill be required to remove the defective material either pipes or rubber rings whichever is applicable.

The pipes and rubber rings shall be selected at random by the Engineer from the stock lot brought at site by the Contractor. The Contractor must ensure delivery of quality material at site. The whole stock / lot shall be rejected if the pipes do not pass the demonstration test.

3.3 TRANSPORTATION

Pipes shall be handled with special care during transportation to the site of work. Pipes shall be properly secured to minimize their movement. Cranes shall be preferably used for loading and unloading of pipes. Hooks shall be padded to prevent pipe damage.

3.4 STORAGE

Pipes should be carefully stored to prevent damage, pipes should not rest directly on ground. Solid timber base should be set on ground for pipe stacking. Pipes should not be stacked so high as to over load the bottom. The height of stack shall be further limited by the head room available for any fitting gear used on site. Pipes socket should not normally rest on other pipes in the stack. The end pipe in the bottom row should be securely locked, wedges should be firmly anchored to prevent collapse of the stack.

3.5 TRENCHING

Pipe trenches shall be excavated up to required depth as indicated in the drawing. The bottom shall be carefully leveled. In-situ field density of trench bottom shall be determined. The bottom shall be compacted if insitu density is less than 60% of relative density as determined by ASTM D 2043. The test shall generally be carried out at spacing of 200 meters. If in some portion soft clayey material or loose material is encountered 300 mm of this material shall be replaced by specified bedding material in that reach. If excavation is carried below required depth, the excess excavated part shall be refilled with bedding material at no extracost to the owner. No bedding material shall be placed nor any permanent work commenced until the trench has been inspected by the Engineer and his permission to proceed to the work is given.

3.6 INSPECTION OF PIPE BEFORE LAYING

Each pipe shall be carefully examined for soundness and cleanliness immediately before laying, any defective and damaged pipe should be rejected and removed from site.

3.7 LAYING

Laying shall start at the lowest point in the area in which work is being done, pipe sections shall be laid with socket upstream.

Each length of sewer between manholes shall be in a straight line and to the true alignment, position, gradient, and the inverts as shown on the Drawings, unless otherwise directed in writing and set out by the Engineer. The Contractor shall check and satisfy himself as to the correctness of the final gradient, position and slope of the complete sewer trenches before commencing the laying operation.

At all times when the work of laying the sewer is not in progress, all openings into the pipe and the ends of the pipe in trenches shall be kept tightly closed to prevent entrance of ground water, animals and foreign materials. The Contract shall take all necessary precautions to prevent the pipe from floating due to water entering the trench from any source, and shall assume full responsibility for any damage due to this cause and shall, at his own expense, restore and replace the pipe to its specified position and grade if it is displaced due to floating.

The Contract shall maintain the inside of the pipe free from foreign materials and in a clean condition until the work is completed and approved by the Engineer.

Pipe and accessories shall be carefully lowered into the trench by means of derricks, ropes, belt slings, or other suitable methods. Under no circumstances shall any of the pipe and other materials be dropped or dumped into the trench. Care shall be taken to avoid abrasion of the pipe.

The full length of each section of pipe shall rest solidly up on the prepared bed of trench. Pipes that have the alignment, grades or joints disturbed after laying, shall be removed and relaid by the Contractor at his own cost. Pipe shall not be laid in water or when trench conditions are unsuitable for the work.

3.8 JOINTING

Rubber gasket joints shall be used for either tongue and groove or bell and spigot pipes.

Rubber gasket joints shall be installed on the pipe in accordance with the instructions of the gasket manufacture.

A lubricant shall be used for jointing the pipes as recommended by the rubber gasket manufacturer.

Whether the pipes are wet or dry the jointing faces and sealing rings need to be clean and free from oil, grease, tar, mud or sand particles.

Inn placing the pipe and making the joints care shall be taken to avoid disturbance of bedding underneath the pipe barrel. If the joints cannot be made manually, mechanical pulling devices will be needed.

4. TESTING

4.1 GENERAL

After the joints properly fixed and before backfilling the trenches, sewers shall be tested for infiltration or exfiltration as specified. The Contractor shall test all sewers and their branches in such length and time selected at or approved by the Engineer. Sections of the completed sewer shall be isolated and measurement of the infiltration shall be made by approved methods used for testing of sewer lines shall be absolutely free from insoluble impurities of any kind.

Water

No chemical or adhesive shall be used for water tighting and repairing of pipes. Test reach in no case shall exceed 1500 feet.

4.2 INFILTRATION

Sewer line shall be tested for infiltration test when crown of the pipe is below the ground water table. The pipe length under test shall be completely emptied before starting infiltration test. The ends should be effectively closed.

One hour after completely emptying the pipes, depth of water shall be measured at both ends of the pipe. Estimated quantity of water infiltration shall not exceed the specified allowable limits.

4.3 EXFILTRATION

The sewers which are constructed with ground water level below the crown of the pipe shall be tested for exfiltration.

A section of sewer shall be isolated between manholes by means of expanding stoppers or other approved methods. The length to be tested should be subjectedto an internal pressure test of 4 ft. head of water above the crown of pipe at the high end but not more than 20 ft. at the low end.

Quantity of water required to achieve the starting level in the test reach after 1 hour shall be measured which shall not exceed the specified allowable limits.

4.4 ALLOWABLE INFILTRATION OR EXFILTRATION

The calculated amount of infiltration or exfiltration over a 24 hour period shall not exceed 6 litres per millimeter dia per kilometer of sewer which rate shall be applied to the actual sewer size and length tested to determine the allowable infiltration or exfiltration over the 24 hour period.

If the measured infiltration or exfiltration exceeds the specified allowable limit, then the Contractor shall locate the points of leakage and make necessary repairs so as to reduce the leakage to less than the permissible maximum stated above.

4.5 COMMISSIONING

After successful infiltration / exfiltration testing of selected isolated pipe lengths, the contractor shall clean all the sewer lines at no extra cost with the method approved by the Site Engineer prior to handling it over to the Owner.

5. MEASUREMENT AND PAYMENT

5.1 GENERAL

Except otherwise specified here in or elsewhere in the contract document, no separate measurement and payment will be made for the under mentioned works related to the relevant item of the Bills of Quantities, but shall not be limited to the following. The cost thereof shall be deemed to have been included in the quoted unit rates of the respective items of the bills of Quantities.

5.5.1 Submission of Samples.
5.5.2 Factory tests.
5.5.3 Site demonstration test.
5.5.4 Cutting, jointing of sewer pipes.
5.5.5 Rubber rings.
5.5.6 Providing & Fixing of Concrete pipes fittings.

5.5.7 Cleaning testing and commissioning of sewer lines.
5.5.8 Testing and compaction of trench bottoms.
5.5.9 Water used for testing of sewers.

5.2 MEASUREMENT

Measurement will be made for acceptable measured quantity of providing, jointing, laying, cutting and jointing of sewer pipes and pipe fittings with rubber rings including cleaning and testing of sewer lines on the basis of unit rate per running feet quoted in the bills of quantities and shall constitute full compensationfor all the works related to the items.

5.3 PAYMENT

Payment will be made for acceptable measured quantity of providing, joining, laying, cutting and jointing of sewer pipes and pipe fittings with rubber rings including cleaning and testing of sewer lines on the basis of unit rates per running feet quoted in the bills of quantities and shall constitute full compensation for all the works related to the item.

SECTION - 5330

MANHOLE/GREASE TRAP IN THE CHAMBER, SUMPS PITS, ETC. WITH C.I. COVER AND FRAME

1. SCOPE OF WORK

The work to be done under this section of the specification includes furnishing all plants, labour, equipment, appliances, material and performing all operations required in connection with construction of manhole grease trap. Including provision an installation of cast iron cover with frame, ladder rungs, vent, inlet & outlet fittings etc. complete as specified herein, or as shown on the drawings, or as directed by the Engineer.

2. APPLICABLE SECTIONS OF SPECIFICATIONS

The following specification sections excepts for sub-sections regarding measurement and payment shall be followed for carrying-out civil associated with his section.

S.NO.	Description	Section No.
1.	Earthwork	1100
2.	Formwork	2100
3.	Reinforcement	2200
4.	Plain and reinforced concrete	2300
5.	Plumbing	5100
6.	Cast iron cover with frame and ladder rungs	5233

3. CONSTRUCTION

Manhole and grease trap, shall be of ordinary sulphate resistant, plain/reinforced cement concrete of the sizes, thicknesses and class of concrete of surplus/rejected earth, plain and reinforced cement concrete, formwork, reinforcement, benching, pipe connections and provision and installation of C.I. frames and ladder rungs, vent, inlet & outlet fittings etc. are to be done under this section and shall be executed in accordance with the specifications as stated above. C.I. frames, and ladder rungs, vent, inlet & outlet fittings shall be set in place at the time of pouring concrete.

4. MEASUREMENT AND PAYMENT

4.1 GENERAL

Except otherwise specified herein or else where in the ContractDocuments, no measurement and payment will be made for the under mentioned specified works related to the relevant items of the Bill of Quantities, but shall not be limited to the following. The cost thereof shall be deemed to have been included in the quoted unit rate of the respective items of the Bill of Quantities related to section5330.

4.1.1 Earthwork, formwork, plain and reinforced cement concrete, reinforcement and embedded parts.

4.1.2 Pipes and fittings.

4.1.3 C.I. cover with frame, steel chequered plate cover with frame, ladder rungs, vent, inlet & outlet fittings etc.

4.1.4 Concrete in benching.

4.2 MEASUREMENT

Measurement of acceptably complete works of manhole and grease trap, will be made on the basis of actual number of manholes gully trap, intercepting trap & sump pit constructed and installed in position as specified herein, as shown on the drawings and/or directed by the Engineer.

4.3 PAYMENT

Payment will be made for acceptable measured quantity of manholes/gully trap, intercepting trap in chamber, & sump pit on the basis of unit rate per number quoted in the Bills of Quantities and shall constitute full compensation for the works related to the item.

SPECIFICATION SOLARIZATION WORKS

TECHNICAL SPECIFICATIONS OF SOLAR SYSTEM COMPONENTS

SOLAR PANELS:

a. The PV module(s) shall contain mono crystalline silicon Grade-A Solar cells. (N-Type Mono PV Cell Modules due to its better performance will be given preference).

b. The PV module should work well with high-voltage input Inverters/ charge controllers (1000 Vdc).

c. The PV Panel must have clear anodized aluminium frame with Anti-reflective, hydrophobic, low-iron Tempered cover glass.

d. The Solar Modules shall meet the following IEC Standards or latest:

- IEC 61215:2005 / (IEC 61215-1, IEC 61215-1-1, IEC 61215-2):2016 (Design Qualification)
- IEC61730-1:2004 / IEC61730- 1:2016 (Safety - Requirements for construction)
- IEC 61730-2:2004 / IEC61730-2:2016 (Safety - Requirements for testing)
- IEC TS-62804-1. (ie: TUV PPP-58042 or Equivalent) Anti-PID Certification.
- IEC 61701 Salt Mist Corrosion Resistance Test.
- IEC 62716 Ammonia Corrosion Resistance Test.
- IEC 60068-2-68 Sand and Dust Erosion Resistance Test.

e. Unique Serial number, Name / Logo of manufacturer and separate date of manufacturing (DD/MM/YYYY) should be laminated inside the module so as to be clearly visible from the front side. Products of manufacturers / Companies with fully automated manufacturing plants will be exempted from the requirement of separate date, Name and Logo. However, manufacturing date of panels must be verified from their serial numbers. (For Verification of process Factory Acceptance Test (FAT) must be arranged (on-demand).

f. A properly laminated sticker containing the following details should be available at the back side of the module.

- Name of the manufacturer / distinctive logo.
- Model Name and Type of Cell Technology.
- Peak Watt Ratting (Wp) and Power Tolerance Range
- Voltage (Vmp) and Current (Imp) at STC
- Open Circuit Voltage (Voc) and Short Circuit Current (Isc)
- Maximum System Voltage (Vdc) (i.e: This should not be less than 1000 Vdc)
- Dimensions of PV Module
- Test Standard(s) to which the module has been tested and certified.

g. Following essential technical parameters of solar panel/modules should be provided with each panel supplied as well as in the technical proposal.

- I-V curve for the solar photovoltaic module/panel.
- Date and year of obtaining IEC PV module standardization qualification certificate.

- Electrical Data (i.e: Pmax, Voc/Vmp, Isc/Imp at nominal Cell Operating Temperature (NOCT).
- PV Module efficiency at STC.
- Working temperature range of PV Module

h. Each panel should have factory equipped weather proof terminal junction box having at least IP65 protection with provision of opening for replacement of DC cables, blocking diodes and easy debugging if necessary.

i. Limited performance guarantee: panel power, in standard conditions, will not be less than 90% of nominal power by the end of 10 years of operation and at least 80% at the end of 25 years of operation with 25-year limited power warranty.

j. The PV Module should have at least 10-years warranty for any defects and efficiency as mentioned above. It should be provided On Stamp Paper Signed and Sealed by Contractor at the time of Handing/Taking Over.

k. The PV Module should have at least 20% Module efficiency with Positive Power Tolerance.

l. The PV modules offered should not be more than 12 months old from the date of issue of work order.

m. PV Module should have a Snow Load bearing of 5400 Pa and Wind Load Bearing of up to 2400 pa.

n. The Solar Module should be free from visual and cosmetics defects.

o. Contractor should provide verifiable Flash test reports with serial numbers from manufacturer for each panel (at the time of supply).

p. All information regarding solar panel with above mentioned featured data should be accessible and verifiable online on the manufacturer website

INVERTER

a) GRID-TIE / ON-GRID AND ON-GRID HYBRID INVERTER

1. UL-1741 Certified or IEC 62109-1 and IEC 62109-2 or Equivalent Certificates.
2. Minimum 95% Conversion Efficiency at rated capacity (High Frequency Inverters).
3. The inverter should have built-in MPPT controller.
4. The Priority of the inverter should be set that load will be running from the solar energy then Grid and, in the end, will be running from the Battery Backup.
5. Inverter (Hybrid Only) must be capable of configuring for Charging Lithium Iron Phosphate batteries (LiFePO4).
6. Hybrid Inverter (If quoted along with Lithium Batteries) must be capable of communication with the BMS of Lithium Batteries.
7. Rated output voltage of inverter / Controller shall be pure sine wave AC.
8. Total Harmonic Distortion (THD) in AC output should not exceed 3% at rated capacity.
9. The degree of protection of the ON-Grid Inverter Installation should be IP-65 rated and for indoor Hybrid Inverter installation, the IP rating should be IP-20 or above.
10. Wide input voltage range capability. (i.e: Voltage Range can be adjustable / selectable)
11. Natural convection cooling for maximum reliability
12. Outdoor enclosure for unrestricted use under any environmental conditions
13. Capability to connect external sensors for monitoring environmental conditions.
14. The output of the inverter must synchronize automatically its AC output to the exact AC voltage

and frequency of the grid.

15. Inverter should have active RS232/485 etc communication port, the Data available through this port can be used for Remote Monitoring.
16. Liquid crystal display should at least be provided on the inverters front panel or on separate data logging/display device to display following
    a. DC Input Voltage
    b. DC Input current
    c. AC Power output (kW)
    d. Current time and date
    e. Temperatures (C)
    f. Converter status
17. Inverter circuit must include protection against:
    - Over or Low voltages and currents beyond critical level of the inverter's circuits.
    - Protection against accidental short circuits.
    - Protection against lightning induced transients.
    - Over load protection.

b) <u>OFF-GRID HYBRID INVERTER:</u>

1. The Inverter must be pure sine wave output suitable for 230 Volt, 50 Hz.
2. Inverter must be capable of configuring for Charging Lithium Iron Phosphate batteries (LiFePO4).
3. The Inverter / system must have a MPPT Solar Charge Controller.
4. Minimum 92% Conversion Efficiency at Rated Capacity (High Frequency Inverters).
5. Total harmonic distortion (THD) in AC output should not exceed 3% at rated capacity.
6. The inverter must be user programmable for selecting PV, Grid and Battery Priority as well as Built-in programmed and user defined voltage and current settings of the charge controller for Lithium Iron Phosphate batteries (LiFePO4).
7. The Inverter must have Protective function limit for:
    a. AC under voltage protection
    b. AC over voltage protection
    c. Battery under voltage Alarm
    d. Low Voltage Disconnect
    e. High Voltage Disconnect
    f. Overload and Short Circuit Protection
    g. Over Temperature Protection
8. The inverter must be ISO 9001, ISO 14001 and CE Certified.
9. The inverter must have IEC 62109-1 and IEC 62109-2, or Equivalent Certificates.
10. The degree of protection of the outdoor inverter Installation should be IP-65 rated and for indoor Inverter installation, the IP rating should be IP-20 or above.
11. Wide input voltage range capability.
12. Inverter should have active RS232/485 etc communication port, the Data available through this port can be used for Remote Monitoring.
13. Inverter (with Lithium Batteries) must be capable of communication with the BMS of Lithium Batteries.

PV MOUNTING STRUCTURE:

a. The panel mounting and structure should be made of hot dipped (80 microns Average) galvanized steel of minimum thickness of 12 SWG Channel / Pipe or 8 SWG Angle.

b. A sketch of the mounting frame (As per Actual Site Requirements) showing dimensions of the frame parts should be provided at the time of supply.

c. PV to ground clearance must not be less than 1.5 feet. The height of the upper edge of the structure should not exceed 10 feet above the ground and 6 Feet for Roof Top Installations.

d. To avoid Shading, Distance between two rows of PV panels and from walls or any structure should be maintained at a minimum of 1.6 times the height of structure/walls.

e. The pit size for concrete works should be minimum 1.5x1.5x2 feet for each individual leg or 1.5x2.5x2 for double leg and the concrete should be extended at least 1 foot above the ground. The concrete ratio should be 1:2:4.

f. For rooftop PV structure the pit size for concrete works should be minimum 1x1x1 feet for each individual leg or 1.5x1.5x1 for double leg and the concrete should be 1:2:4.

g. The Surface azimuth angle of PV Module 180^{o} and the Tilt angle (slope) of PV Module should be $\pm 25^{o}$.

h. The PV modules will be mounted on metallic structures of adequate strength and appropriate design, which can withstand load of modules and high wind velocities up to 150 km per hour.

i. Due to land non-availability or any other problem, Structure design can be modified as per site requirement. Pole Mounted or manual Tracker Structure can be provided.

j. Array fasteners (nut/bolts/washers) between PV Module and Structure shall be stainless steel. Washers should be installed on both sides of Module frame.

k. The minimum space between two PV Modules should be 2.54 cm (1 inch), to avoid air push over PV Modules.

l. Mechanism / arrangement for cleaning of PV Panels should be provided. i.e Space and ladder between panels or at the back side of structure, so that the operator can safely climb and clean the panels.

m. All other array fasteners Structure shall be stainless steel or galvanized steel that provides the required mechanical strength.

n. The PV modules will be mounted on metallic structures at the inner holes for cantilevered installation, which will evenly distribute the load of the panel around the support structure on both sides and in the middle.

CABLE / WIRING and CIRCUIT BREAKERS:

a. The AC / DC cables should be made of 99.9% copper strands and Flexible.

b. DC Cable from PV Module to Junction Box / Inverter for each string should be minimum size 6 mm^2.

c. From PV Panel to Junction Box, XLPE or XLPO insulated and sheathed, UV stabilized single core stranded / flexible cables (Conforming preferably to TUV 2PfG-1169 PV1-F) be used.

d. From DC Combiner to Inverter, XLPE or XLPO Cable, Non-Armoured, 3 Core should be installed (3 feet deep) for underground wiring for transmission underground suitable for minimum 1000Vdc.

e. From Inverter to batteries, the DC cable can be single insulated, Single Core and suitable for minimum 300 Vdc transmission.

f. DC circuit breakers (not fuse) of at least 800V and suitable ampere rating must be installed between PV modules and controller/inverter.

g. AC Circuit Breaker(s) of suitable rating must be installed between Controller / Inverter to Load and Grid to Controller / Inverter.

h. AC/DC breakers should be marked with the manufacturer model number, rated voltage, ampere rating and batch / serial number.

i. To prevent solar panels from damage an appropriate size of DC Breaker should be installed for each PV string and Surge Protection should be installed for combined Array (before Main DC Breaker/Inverter).

j. DC Breaker, AC Breaker & Change overs should be placed in an enclosure of at least IP54 standard.

k. Cables shall be clearly labelled with essential electrical parameters including manufacturer name, Voltage Range, standards etc.

l. All wiring shall be aesthetically neat and clean, over all wiring/connection losses shall not exceed 1% of the total rated output power.

m. All connections / socket outlet among array, controller, inverters, batteries and load etc must be made in junction boxes of adequate protection level.

n. New AC wiring (Neutral and Phase) for load connected should be provided by contractor, along with breakers, sockets, buttons etc.

o. The DC Combiner Junction Box should be properly earthed including earthing of door as well.

p. The DC Combiner should contain proper bus bars of adequate size each for Positive, Negative and Earthing.

q. The Inverter Junction Box should be properly earthed.

r. All wiring should be in proper conduit of capping casing. Wire should not be hanging loose.

s. All wires should be terminated properly by using lugs / thimble connectors/sleeves.

t. Distribution board must be installed with proper screws.

u. Following lab tests are mandatory; Conductor resistance test, Insulation resistance test, Pressure test, Spark test.

v. Electrical Hazards Safety Labels should be pasted on DC Combiner / Inverter Enclosure/ Charge Controller /Battery Enclosures.

w. AC Combiner Box made of 16 SWG, Powder Coated, Separate Bus Bar for each Phase, Neutral and Earth Connection. All circuits must be properly tagged as per site installations.

EARTHING/GROUNDING:

a. The PV Panel frame and structure should be connected by the shortest practical route to an adequate earth contact (of Less than 5 Ohms Resistance) as per requirement of equipment manufacturer and site earth conditions, using an uninterrupted conductor.

b. The Sizing of Earthing conductor will be done as per NEC Table 250:122.

c. The grounding conductor should be 99% Copper, PVC insulated/ Bare Copper.

d. Panel, Inverter, Battery/Battery Box (if required), Main Distribution Board should be connected to an adequate earth contact / Grounding.

e. Ground enhancement material (GEM) shall be used below and above the Earthing plate for

proper grounding. Gravel or coarse sand shall be pour along with soil the pit.

f. Grounding/Earthing plate should be made of Copper plate of 4mm thickness & Size minimum 1.0 x 1.0 ft.

g. Grounding/Earthing conductor should be connected to the copper plate by proper connector of minimum depth of 6 feet.

h. All nut/bolt and Earthing clamp shall be stainless steel or galvanized steel.

i. Proper Earthing will be checked on site by Earth Test Meter.

BATTERIES:

- The battery should be Deep Cycle Lithium LiFePO4.
- The battery must ensure safe and reliable operation in the whole range of ambient temperatures from -5° C to 50° C.
- The maximum permissible self-discharge rate should not be more than 5 percent of rated capacity per month at 25^{o} C.
- Battery rating should be based on 10 Hours discharge Rate.
- The battery shall have a certificate of compliances, issued by a recognized laboratory.
- The Batteries should have three years Comprehensive replacement warranty.
- The battery shall meet the requirements and recommendations given in IEC 62133, UL 1642 or equivalent. Lab Test Reports for battery cycle life should be provided.
- The Battery must support parallel connection to increase capacity in case of future expansion. Each Battery should have following minimum information
    - Model Number, Serial Number and Type of battery.
    - Rated Voltage and Capacity.
    - Origin of made.
    - Manufacturer Name with distinct logo.
- In case of rechargeable battery bank (having more than one battery), the Interconnection shall be made using lead plated copper bus bars or properly insulated flexible copper conductors.
- Battery disconnect switch/breaker of suitable size should be installed between batteries and inverter/charge controller.

LITHIUM BATTERIES (LiFePO4):

i. Cycle life of the Lithium LiFePO4 battery before 80% capacity of Initial Capacity must be minimum **5750** cycles @ 50% depth of discharge (DOD) at discharge rate of 10 Hours.

ii. The battery must have Integrated Battery Management System (BMS) to ensure battery safety and reliability.

iii. The BMS of the battery must have the following specifications:

- Temperature protection
- Over charge protection
- Low voltage disconnect
- High voltage disconnect

- Short circuit alarm function
- Self-balancing function

iv. The LiFePO4 Battery must have LED status and alarm indication

v. The charge and discharge rate of the battery must be designed at 0.2 C minimum but capable of handling 0.5 C charge and discharge currents

BOX / STAND FOR BATTERIES, INVERTER:

a. The batteries should be housed in a vented compartment/stand that prevents users from coming in contact with battery terminals. This compartment/stand should be strong enough to accommodate the weight of the battery.

b. A mechanism to prevent opening and entry of the battery should be provided

c. This compartment should be manufactured of mild steel of at least 16 SWG.

d. The compartment should be powder coated paint.

e. The entire enclosure / stand must be constructed to last at least twenty years without maintenance and should be protected against corrosion. The enclosure should have a clean and neat appearance Battery Box /stand should be installed at a place in accordance with user's preference.

AC ENERGY EFFICIENT LED LIGHT BULBS:

Shape	**Cap/ Fitting / Base Type**	**Color**	**Lumen per Watt**	**Color Temperature**	**Color Rendering Index (CRI)**	**Life Time of Lamp (Hours)**	**Power Factor and Rated Voltage**
Globe	E27	Cool or Warm	Min 100W	2700K/6500K	70	10,000	>= 0.70 & 220 Vac

Note:

- LED light Bulbs should be marked with the manufacturer model number, rated voltage and wattage.

AC ENERGY EFFICIENT CEILING FANS:

Sweep		**Rated Power**	**Speed**
Inches	MM	Watts	Rpm
56	1400	50 Max	>=320

a. 10% + in Power Consumption is Allowed as per PSQCA Standard

b. Rated Voltage: 230 V~ (±10V)

c. Rated Frequency: 50 Hz

d. Insulation Class: 155 (F) or better

e. Motor Core: Electrical Steel Sheet

f. Winding Wire: 99.99% Super Enameled Copper CA Wire or 99.99% Pure Copper Wire.

Note:

- Energy efficient fan should be marked with the manufacturer model number, rated voltage, and wattage.

PVC CHANNEL DUCTS & PIPES:

a. A product of good quality standard material with suitable size to be used.

b. Ducting must be done with proper steel nails and clips.

c. All ducting (wiring) must be align.

FLEXIBLE PVC PIPE:

a. The flexible PVC pipe should be of good quality material with suitable size should be used.

CIVIL WORK:

The Civil Works should be carried out for roof-top and ground installation of PV Modules/mounting structures. Also, Civil work for earthing system as per the statutory requirements.